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Al-Quds University**



**Dental Hazardous Waste Management at the  
Governmental Dental Clinics in the Gaza Strip**

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# **Dental hazardous waste management at the governmental dental clinics in the Gaza Strip**

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**Jerusalem- Palestine**

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## **Dedication**

This thesis is dedicated to: The sake of Allah, my Creator and my Master,

My great teacher and messenger, Mohammed (May Allah bless and grant him), who taught us the purpose of life,

My homeland Palestine,

My great parents, who never stop giving of themselves in countless ways and lead me through the valley of darkness with light of hope and support,

My beloved brother and sisters, who stand by me when things look bleak,

To all my family, the symbol of love and giving,

To all academic and administrative staff of the School of Public Health, Al-Quds University,

My friends and colleagues in the work who encourage and support me, all the people in my life who touch my heart, I dedicate this research. I also want to thank my generous supervisor Prof.Yousef Aljeesh who has been an inspiration to me to follow in his footsteps from the time when I start preparing the research.

**Roba Atef Alagha**

**Declaration:**

I certify that this thesis submitted for the degree of master, is the result of my own research, except where otherwise acknowledged, and that this study (or any part of the same) has not been submitted for a higher degree to any other university or institution.

**Signed**  
**Roba Atef Alagha**

**Date:** 31/5/2021

## **Acknowledgments**

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## **Abstract**

*Dental diagnostic and treatment modalities require various chemicals, biomedical and radiological materials such as silver amalgam and needles. Some of these materials pose a risk of causing harm to individuals exposed to them. The study aimed to assess the status of dental hazardous waste management at the governmental dental clinics in the Gaza Strip. The study utilized descriptive, analytical, cross-sectional design. The census of the study consisted of 90 participants (58 male and 32 female) with a response rate of 92%. The researcher used a self-administered questionnaire developed by the researcher. The questionnaire was submitted to a group of experts to evaluate face and content validity. The researcher conducted a pilot study on 20 participants selected randomly, and Cronbach alpha coefficient was 0.880. The results also indicated that management of infectious dental waste was above moderate (71.52%), management of non-infectious dental wastes was moderate (59.54%), biomedical waste management was above moderate (70.22%), and the overall management of hazardous dental wastes was moderate (67.10%). The results reflected that the study participants had high knowledge (86.2%), and above moderate practice of hazardous dental waste management (83.7%). There were statistically significant differences in knowledge about hazardous dental waste management related to age ( $P= 0.003$ ) and years of experience ( $P= 0.001$ ). There were statistically significant differences in practice of hazardous dental waste management related to governorate ( $P= 0.034$ ), qualification ( $P= 0.047$ ) and years of experience (0.009), while there is no significant difference between practice and specialty ( $P=0.152$ ). The results also indicated that most of the personal protective equipment is available in the clinics. Common challenges that face dentists and nurses during disposal of the hazardous dental wastes included shortage of the plastic bags for dental waste management, shortage of the colored bins, and shortage of sterilization solutions. The study concludes that management of hazardous dental wastes was moderate. There was high knowledge and above moderate practice of hazardous dental waste management. The study recommended the need to increase awareness about the potential risks of dental wastes, improve safety measures in the work environment to protect employees from hazards of dental wastes.*

## Table of Contents

|   |           |
|---|-----------|
| Dedication.....   |           |
| Declaration: .....  | i         |
| Acknowledgments .....   | ii        |
| Abstract.....   | iii       |
| Table Of Contents.....  | iv        |
| List Of Tables .....  | vi        |
| List Of Figure .....  | viii      |
| List Of Appendices .....  | ix        |
| List Of Abbreviations: .....  | x         |
| <b>Chapter 1 Introduction .....</b>                                   | <b>1</b>  |
| 1.1 Background.....   | 1         |
| 1.2 Problem Statement.....  | 3         |
| 1.3 Justification Of The Study .....                                  | 4         |
| 1.4 Objectives .....  | 5         |
| 1.4.1 General Objective:.....   | 5         |
| 1.4.2 Specific Objectives:.....                                       | 5         |
| 1.5 Research Questions.....   | 5         |
| 1.6 Context Of Study .....  | 6         |
| 1.6.1 Geographical And Demographical Context: .....                   | 6         |
| 1.6.2 Socioeconomic Context: .....                                    | 7         |
| 1.6.3 Health Care System:.....  | 9         |
| 1.6.4 Governmental Primary Health Centers: .....                      | 10        |
| 1.7 Operational Definition .....                                      | 10        |
| <b>Chapter 2 Conceptual Framework And Literature Review .....</b>     | <b>12</b> |
| 2.1 Conceptual Framework.....   | 12        |
| 2.2 Literature Review .....   | 13        |
| 2.3 Classification Of Dental Waste.....                               | 14        |
| 2.4 Sources Of Hazardous Dental Waste.....                            | 14        |
| 2.5 Health And Environmental Effects Of Dental Waste .....            | 15        |
| 2.5.1 Health Risk:.....   | 15        |
| 2.5.1.1 Acute Infectious Wastes: .....                                | 16        |
| 2.5.1.2 Chemical And Pharmaceutical Waste:.....                       | 17        |
| 2.5.1.3 Residues Of Toxic Drugs:.....                                 | 18        |
| 2.5.1.4 Radioactive Medical Waste: .....                              | 19        |
| 2.5.1.5 Dental Amalgam Fillings:.....                                 | 20        |
| 2.5.2 Management Of Medical Waste During The Covid-19 Pandemic: ..... | 22        |



|  |     |
|--|-----|
| 2.8 Knowledge And Practice Of Dental Waste Management .....                      | 27  |
| <b>Chapter 3 Methodology</b> .....   | 29  |
| 3.1 Study Design.....  | 29  |
| 3.2 Study Population.....  | 29  |
| 3.3 Sample Size And Sample Process .....   | 29  |
| 3.4 Study Instruments And Data Collection .....                                  | 30  |
| 3.4 Pilot Study.....   | 31  |
| 3.5 Eligibility Criteria.....  | 31  |
| 3.5.1 Inclusion Criteria:.....   | 31  |
| 3.5.2 Exclusion Criteria:.....   | 31  |
| 3.6 Study Setting.....   | 32  |
| 3.7 Study Period.....  | 32  |
| 3.8 Ethical Consideration And Procedures .....                                   | 32  |
| 3.9 Validity And Reliability Of The Instrument.....                              | 33  |
| 3.9.1 Validity:.....   | 33  |
| 3.9.2 Reliability:.....  | 35  |
| 3.10 Data Analysis.....  | 36  |
| 3.11 Limitations Of The Study .....  | 37  |
| <b>Chapter 4 Results And Discussion</b> .....                                    | 38  |
| 4.1 Descriptive Results .....  | 38  |
| 4.1.1 Characteristics Of Study Participants.....                                 | 38  |
| 4.1.2 Dental Waste Management: .....   | 41  |
| 4.1.2.1 Infectious Waste Management:.....  | 41  |
| 4.1.2.2 Non-Infectious Waste Management: .....                                   | 45  |
| 4.1.2.3 Biomedical Waste Management: .....                                       | 49  |
| 4.1.2.4 Overall Management Of Hazardous Dental Wastes: .....                     | 51  |
| 4.1.3 Knowledge And Practice Of Dentists And About Dental Waste Management:..... | 52  |
| 4.2 Inferential Results .....  | 64  |
| <b>Chapter 5 Conclusion And Recommendations:</b> .....                           | 81  |
| 5.1 Conclusion .....   | 81  |
| 5.2 Recommendations.....   | 82  |
| 5.3 Suggestions For Further Research .....                                       | 82  |
| <b>References:</b> .....   | 83  |
| <b>Annexes</b> .....   | 102 |

## List of Tables

|   |    |
|---|----|
| Table (3.1): Correlation between the domains of dental waste management.....  | 33 |
| Table (3.2): Correlation between the domains of knowledge and practice of waste<br>management .....                             | 34 |
| Table (3.3): Cronbach alpha coefficient for dental waste management .....   | 35 |
| Table (3.4): Cronbach alpha coefficient for knowledge and practice of waste<br>management .....                                 | 35 |
| Table (3.5): Split-half method .....  | 36 |
| Table (4.1-a): Characteristics of study participants (n= 90).....   | 39 |
| Table (4.1-b): Characteristics of study participants (n= 90).....   | 40 |
| Table (4.2-a): Infectious waste management (n= 90).....   | 41 |
| Table (4.2-b): Infectious waste management (n= 90).....   | 42 |
| Table (4.3-a): Non-infectious waste management(n= 90).....  | 45 |
| Table (4.3-b): Non-infectious waste management (n= 90).....   | 46 |
| Table (4.4-a): Biomedical waste management(n= 90) .....   | 49 |
| Table (4.5): Overall hazardous dental waste management.....   | 51 |
| Table (4.6-a): Knowledge about dental hazardous waste management(n= 90) .....   | 52 |
| Table (4.7): Levels of knowledge about hazardous dental waste management(n=<br>90).....   | 56 |
| Table (4.8-a): Practice of dental waste management (n= 90).....   | 57 |
| Table (4.8-b): Practice of dental waste management (n= 90).....   | 58 |
| Table (4.9): Levels of practice about hazardous dental waste management(n= 90) .....  | 62 |
| Table (4.10): Participants' evaluation of hazardous dental waste management (n=<br>90).....                                     | 62 |
| Table (4.11): Differences in hazardous dental waste management related to gender<br>(n= 90).....                                | 64 |
| Table (4.12): Differences in knowledge and practice of hazardous dental waste<br>management related to gender(n= 90).....       | 64 |
| Table (4.13): Differences in hazardous dental waste management related to age(n=<br>90).....                                    | 65 |
| Table (4.14): Differences in knowledge and practice of hazardous dental waste<br>management related to age(n= 90) .....         | 66 |
| Table (4.15): Differences in hazardous dental waste management related to<br>governorate(n= 90).....                            | 67 |
| Table (4.16): Differences in knowledge and practice of hazardous dental waste<br>management related to governorate(n= 90) ..... | 68 |
| Table (4.17): Differences in hazardous dental waste management related to<br>specialty(n= 90) comment.....                      | 69 |
| Table (4.18): Differences in knowledge and practice of hazardous dental waste<br>management related to specialty(n= 90) .....   | 70 |
| Table (4.19): Differences in hazardous dental waste management related to<br>qualification(n= 90).....                          | 70 |

|  |    |
|--|----|
| Table (4.20): Differences in knowledge and practice of hazardous dental waste management related to qualification(n= 90) .....       | 71 |
| Table (4.21): Differences in hazardous dental waste management related to years of experience(n= 90).....                            | 72 |
| Table (4.22): Differences in knowledge and practice of hazardous dental waste management related to years of experience (n= 90)..... | 73 |
| Table (4.23): The needed equipment for hazardous dental waste management.....  | 74 |
| Table (4.24): Availability of personal protective equipment .....  | 75 |
| Table (4.25): Ranking of challenges that face dentists and nurses during disposal of the hazardous dental wastes .....               | 76 |

## List of Figure

|   |    |
|---|----|
| Figure (4.1): Distribution of study participants according to governorate .....           | 38 |
| Figure (4.2): Distribution of study participants according to country of graduation ..... | 39 |
| Figure (4.3): Pareto chart to know the vital few .....                                    | 78 |

## **List of Appendices**

|  |     |
|--|-----|
| Annex (1) Gaza Governorates distribution map.....                  | 102 |
| Annex (2): The study instrument (Questionnaire).....               | 103 |
| Annex (3): Helsinki Committee Approval Letter.....                 | 112 |
| Annex (4): Manpower Development - Ministry of Health Approval..... | 113 |
| Annex (5) Study activities time table: .....                       | 114 |
| Annex (6): List of adjudicators.....                               | 115 |
| Annex (7) Estimated budget: .....                                  | 116 |

## **List of Abbreviations:**

|                 |  |
|-----------------|--|
| <b>ADA</b>      | American Dental Association  |
| <b>AHP</b>      | Aerosolized hydrogen peroxide systems  |
| <b>AIDS</b>     | Acquired Immunodeficiency Syndrome   |
| <b>AMA</b>      | American Medical Association   |
| <b>ANOVA</b>    | Analysis of Variance   |
| <b>BMW</b>      | Biomedical Wastes  |
| <b>CDC</b>      | Centers for Disease Control and Prevention                                     |
| <b>Covid-19</b> | Corona virus disease of 2019   |
| <b>DSM-5</b>    | Diagnostic and Statistical Manual of Mental Disorders                          |
| <b>DWM</b>      | Dental Waste Management  |
| <b>GS</b>       | Gaza Strip   |
| <b>HCFs</b>     | Healthcare Facilities  |
| <b>HCW</b>      | Healthcare Waste   |
| <b>HIV</b>      | Human Immunodeficiency Virus   |
| <b>HWM</b>      | Hazardous Wastes Management  |
| <b>ICRC</b>     | International Committee of the Red Cross                                       |
| <b>IPC</b>      | Infection Prevention and Control   |
| <b>IWM</b>      | Infectious Waste Management  |
| <b>Km</b>       | Kilometer  |
| <b>MOH</b>      | Ministry of Health   |
| <b>MSDS</b>     | Material Safety Data Sheet   |
| <b>MWM</b>      | Medical Waste Management   |
| <b>NGOs</b>     | Non-Governmental Organizations   |
| <b>NIWM</b>     | Non-Infectious Waste Management  |
| <b>OPT</b>      | Occupied Palestinian Territory   |
| <b>OWM</b>      | Overall Waste Management   |
| <b>PCBS</b>     | Palestinian Central Bureau of Statistics                                       |
| <b>PHC</b>      | Primary Health Care  |
| <b>PPE</b>      | Personnel protective equipment   |
| <b>PW</b>       | Pharmaceutical waste   |
| <b>SPSS</b>     | Statistical Package for Social Sciences  |
| <b>UK</b>       | United Kingdom   |
| <b>UNRWA</b>    | United Nations Relief and Works Agency for Palestine Refugees in the Near East |
| <b>UP</b>       | Urban Papers   |
| <b>USSR</b>     | Union of Soviet Socialist Republics  |
| <b>WB</b>       | West Bank  |
| <b>WHO</b>      | World Health Organization  |

# **Chapter 1**

## **Introduction**

### **1.1 Background**

Healthcare waste generation is an essential part of healthcare operations. Improper healthcare waste management and disposal can be harmful to humans and the environment (Odonkor, S. T., & Mahami, T., 2020). Biomedical waste (BMW) generated in dental clinics if not managed properly, can create various health hazards to dental professionals, dental auxiliaries, patients and other dental health care service providers who work in dental office. Each dental health care provider should have knowledge about handling and disposal of biomedical waste (BenakattiV., & KanathilaH., 2018).

One of the main problems that require attention is the growing output of dental solid waste and its consequences the health of the general public. According to World Health Organization (WHO), around 75% to 90% of the waste generated across healthcare facilities can be considered as non-hazardous; it is the remaining 10–25% which cannot be ignored (S.Ali et.al, 2017). In different areas of Palestine, the current practice is to dispose of dental waste along with other medical waste as part of the solid waste management system which is collected and disposed of in unconstrained landfills (Al-Khatib et al.2007).

Special waste products including medical waste are of particular importance. Medical waste disposal management needs the correctness of the statistics and accurate information of all parts and components of this type of the waste. These waste products can lead to a series of harmful effects including health and occupational hazards, environmental and esthetic hazards such as water, air and soil pollution, and social, economic and political problems (Momeni et al. 2017). Dental waste is a subcategory of hazardous BMW. It includes various materials like soaked cotton, sharp needles, extracted teeth, human tissue

parts, and so forth, which are usually contaminated with body fluids like blood and saliva (Singh, T., Ghimire, T. R., & Agrawal, S. K., 2018). The dilemma of Hazardous Wastes Management (HWM) has been recognized serious worldwide. The Arab region as the rest of the planet is still faced with serious challenges emanating from our current unsustainable patterns of production and consumption (Hussein, L., 2006).

Thousands of tons of hazardous and non-hazardous waste are produced in the world every year. It is the duty of the dentist to evaluate each waste generated from their practice should be determining whether it is hazardous waste or not. A waste that has not been evaluated must be assumed to be hazardous (Bashir U. & Khan T., 2019). Poor management of waste potentially exposes health practitioners, handlers waste, patients is essential to the medical waste materials to segregate at the point of generation, probably treated and safely disposed (WHO, 2014a).



## **1.2 Problem statement**

Medical waste management (MWM) has become a critical issue as it poses potential health risks and damage to the environment (Adnane MI et al. 2013). It is also of greater importance due to its potential environmental hazards and public health risks with high propensity to result in epidemics (Dehghani MH et al. 2008). The MWM is an evolving issue that is enhanced by a lack of awareness, training, and financial resources to support solutions. Both collection and disposal of this waste are of high significance as it can directly affect the health risks to the public and environmental health (Abu Mhady A, 2017).

Dental waste includes mercury, lead, processing solutions from X-ray units as developer and fixer, sharps, and blood-soaked dressings are used in the dental field (Lakbala, P. 2020). One of the main problems that require attention is the growing output of dental waste and its impact on the health of the public. This is a serious problem in the Gaza Strip (GS) especially in the last few years, due to the rapid rising in the number of dental clinics; hence there is an obvious increase in dental waste. Dental waste is a type of medical waste (Al-Batnij, A. O. et al., 2018). The main basis for dental waste management (DWM) in the European Union is the Waste Framework directive that requires Member States to take important measures to ensure waste is disposed of without harming human health or the environment. Palestine like many developing countries experiences the problem of getting sufficient medical supply and even worse is the disposal of medical waste. This is due to the lack of enforcement of legislation for handling, treatment, and disposal. According to my observation, there is a knowledge deficit and lack of risk awareness among the medical personnel about the management of the dental waste products (Hussein L., 2006).

### **1.3 Justification of the study**

The main goal of managing waste is to protect community and the surrounding environment from possible harm (Bland, A. D., 2015). Healthcare waste is described by WHO as untreated and discarded materials which are produced from healthcare activities that have high potential for transmitting infectious agents to humans. Hence, BMW management in dental practice is equally critical as well as in the medical practice (Haralur, S. B. et al., 2015). Because of the increase in population density and the number of graduated dental students; there is an obvious increase in the generation of dental waste in the GS. The impact of such hazardous waste causes a large public health problem. In the absence of laws and regulations, impelling efforts are needed to address the issue of dental health waste disposal. Dental care providers must know that some of the materials and procedures that they used to provide dental health services may have dangerous effects on the environment. The improper disposal of dental waste, lack of financial support can lead to contamination and being a danger to public health and the environment. So, to minimize the risk to public health, it is mandatory to evaluate MWM (Qeshta, R. 2016).

Dentists, dental nurses and other health care personnel who are working in the dental field as dental assistants must be educated on the risks to deal with dental waste properly. The study will help to improve public awareness regarding the health risk of dental waste; the study will also provide relevant recommendations to dental clinics on possible ways of determining managing dental waste properly.

## **1.4 Objectives**

### **1.4.1 General Objective:**

The general objective of the study is to assess the status of dental hazardous waste management at the governmental dental clinics in the Gaza Strip.

### **1.4.2 Specific Objectives:**

1. To assess the status of dental hazardous waste management at the governmental dental clinics in the Gaza Strip.
2. To examine the differences in the participants' perception about hazardous dental waste management at the governmental dental clinics in the Gaza Strip in relation to selected sociodemographic characteristics.
3. To identify the participants' level of knowledge and practice about hazardous dental waste management at governmental dental clinics in the Gaza Strip.
4. To identify the needed equipment for hazardous dental waste management as perceived by study participants.
5. To examine the availability of personal protective equipment at governmental dental clinics in the Gaza Strip.
6. To assess the challenges those face the study participants during the disposal of hazardous dental wastes.

## **1.5 Research questions**

1. What is the status of hazardous dental waste management at the governmental dental clinics in the Gaza Strip?
2. What is the participants' level of knowledge and practice about hazardous dental waste management at governmental dental clinics in the Gaza Strip?

3. Are there statistically significant differences in the participants' perception about hazardous dental waste management at the governmental dental clinics in the Gaza Strip to selected sociodemographic characteristics (gender, age, governorate, specialty, qualification, and years of experience)?
4. What are the needed equipments for hazardous dental waste management as perceived by study participants?
5. What is the degree of availability of personal protective equipment at governmental dental clinics in the Gaza Strip?
6. What are the challenges that face the study participants during the disposal of hazardous dental wastes?

## **1.6 Context of study**

### **1.6.1 Geographical and demographical context:**

The GS is a narrow zone with a surface area of 365 km<sup>2</sup> located in the southwest part of Palestine with about 1.91 million residents (Abuzerr, S. et al., 2020). It is composed of 5 governorates: North Gaza, Gaza, Deir El-Balah, Khan Younis, and Rafah (Annex 1). In the Occupied Palestinian Territories (OPT), Gaza governorate is ranked as the second-highest number of populations with 13.4% of the total population after Hebron with 15.1% of the total population. Although the GS is a narrow sector of land, it is one of the highest population densities in the world, in 2016 the population density /Km<sup>2</sup> was 5305 (PCBS, 2017).

After the end of the first war, historical Palestine was under the control of the British Mandate and from 1948 to 1967 the GS was under the Egyptian Administration, then it was occupied by the Israeli army in June 1967. Then according to the Oslo agreement the Israelis officially handed the GS to the Palestinian Authority in 1994 with partial

autonomy that leads to improvement of the social and economic status of the Gazan people till the setting up of Intifada in 2000 where the political and socioeconomic situation started to collapse and reached to the maximum disaster in June 2007 where a terrible event occurred " the internal division" and Gazans started to suffer from its sequences, a tight siege has been imposed on the GS to control borders, movement of goods and travelers and from that terrible event Israel launched three large scale assaults on the GS which resulted in thousands of deaths and injuries among people and destruction of thousands of houses, manufacture compounds, agricultural resources (Elshaer, 2015).

According to updated reports, the GS is considered a high densely settled area around the world. Referring to the Palestinian Central Bureau of Statistics (PCBS), in 2016 the total number of Palestinians around the world was 12.7 million, of which 4.88 million were living in the OPT (38.4%) and 1.4 million in Israel, 5.1 million in Arab countries, and 655 thousand in the foreign countries. According to the (PCBS), in 2016, of the 4.88 million who live in the OPT, 2.97 million live in the West Bank (WB )(60.8%), and 1.91 million live in the Gaza Strip (39.2%) (PCBS, 2017).

According to the PCBS, there are about 5,101,152 Palestinians in Palestine in 2020. There are nearly 3,053,183 of them in the WB and 2,047,969 in the GS (PCBS, 2020).

### **1.6.2 Socioeconomic context:**

The Palestinian economy did not make any real growth in 2018, while the Gaza economy shrinking by about 7%, the WB economy grew at a low performance of less than 1%. While the population increase has reached 3%, thus curbing the ability of the Palestinian Authority to provide the necessary services due to the increase in the population (Shaban O., 2019). People suffer from the tight blockage that restricts the passing of goods and aids across the borders, both importing and exporting goods to and from Gaza are restricted.

There is a severe decline in the Palestinian economy due to the current political situation and the blockade imposed on the GS. Israeli-imposed border closures, which became more restrictive after Hamas seized control of the GS in June 2007, have increased unemployment rates, elevated poverty rates, and a sharp contraction of the private sector that had relied primarily on export markets. The unemployment rate in GS was 45% compared with 13% in the WB, while the unemployment rate for males in Palestine was 20% compared with 42% for females (PCBS, 2019).

The economic status in Palestine is highly affected by the protracted political and security situation. The most recent International Monetary Fund report states “real GDP growth in the WB and Gaza will likely reach 3.3% in 2016 (2.7% in the West Bank, and 5.5% in Gaza) insufficient to reduce unemployment and boost per-capita incomes”. Since the Oslo agreement of 1993, the Palestinian economy has faced a series of ongoing shocks: the division of the WB and the Paris Protocol of the same year, the First and Second Intifadas, and the siege of Gaza and resultant three wars (Kteily-Hawa, R., Khalifa, D. S., & Abuelaish, I., 2020). In 2011, the poverty rate reached 38.8 %, in the GS. Moreover, 76.1 % of Palestinians in Gaza had a monthly income below the national poverty line. The poverty percentage among Palestinian individuals according to consumption patterns was 29% (14% in the WB, and 53% in GS).

Data revealed that 17% of the individuals in Palestine suffered from deep poverty in 2017, according to consumption patterns (6% in the WB, and 34% in GS). The relative poverty line and the deep poverty line according to consumption patterns (for reference household consisted of 2 adults and 3 children) in Palestine in 2017 were 2,470 NIS (USD 671), and 1,974 NIS (USD 536) respectively. People living in poverty often go hungry and have limited access to safe drinking water, adequate sanitation, or healthcare services. They are more likely to live in dangerous environments with low-quality housing in areas prone to

natural disasters and risky traffic. People living in poverty are also more likely to undertake high-risk work. All these conditions of poverty significantly increase someone's chances of being disabled by malnutrition, disease, or injury (United Nations-UN, 2012).

### **1.6.3 Health care system:**

Health System in Palestine:

Primary health care centers in Palestine by health care provider sector:

The number of PHC centers in Palestine reached 732 in 2018, of which 585 are in the WB and 147 in GS. 468 primary health care centers belong to the Palestinian MOH, which constitutes 63.9% of the total number of primary health care centers. The number of primary healthcare centers managed by NGOs reached 182, constituting 24.9 % of all primary healthcare facilities, while the number of UNRWA centers reached 65, and the military medical centers reached 17 centers (Health annual report, 2018).

There are four main providers of health care services in the WB and the GS: the Ministry of Health, UNRWA, non-governmental organizations, and the Palestinian Military Medical Services, each with its respective network of primary health care centers and hospitals. For example, UNRWA operates an extended network of clinics providing free services to registered refugees and the nongovernmental organizations are a mixture of traditional charities, Islamic charitable committees, Christian charities, and non-profit organizations, often supported by the Palestinian Diasporas and mainly offering primary care, maternal health care, rehabilitation and specialized care in referral hospitals, complementing the public sector services. In 2009, there were 129 Palestinian non-governmental organizations involved in health. The Palestine Red Crescent Society, with its extended network of volunteers, has gradually shifted the focus of its programs to emergency services. The private for-profit sector increasingly occupies a major role in service provision<sup>36</sup> although

the dual practice is prevalent, a common finding in many countries, which blurs the line between the public and private sectors. Traditional alternative medicine continues to play an important role in health care. Additionally, Israeli hospitals admit patients referred from both the GS and the WB at a very high cost, further exacerbating financial problems (MOH, 2014).

#### **1.6.4 Governmental primary health centers:**

In 2000, the primary health care centers in the governmental sector were reached 43 centers that provide dental services into 22 centers of them. However, by 2010 the centers were reached 59, and dental services were provided in 24 centers. In 2020 there are 28 dental clinics at the primary health care centers according to a personal interview with Dr.Ashraf Shurrab (Director of the Department of Dentistry, Ministry of Health).

### **1.7 Operational definition**

The Waste Act defines hazardous waste as those which contain organic or inorganic components that may owing to their inherent chemical, physical, or toxicological characteristics have a harmful impact on health and the environment (Govan, P. 2014).

Operationally in this study, the bio-hazardous waste will be identified as any waste which contains noticeable fluid blood, containers or equipment containing fluid blood and several other categories of waste, such as chemotherapeutic waste (trace amounts) and bacterial cultures that are not normally generated in a general dental practice (Fred Hutchinson Cancer Research Center, 2016).

Medicine products, wasted chemicals, and radioactive substances are among some of the hazardous wastes developed by hospitals. If infectious wastes are still not disposed properly of, disease outbreaks may exist (Noor, T. et al., 2020). Infectious waste is defined



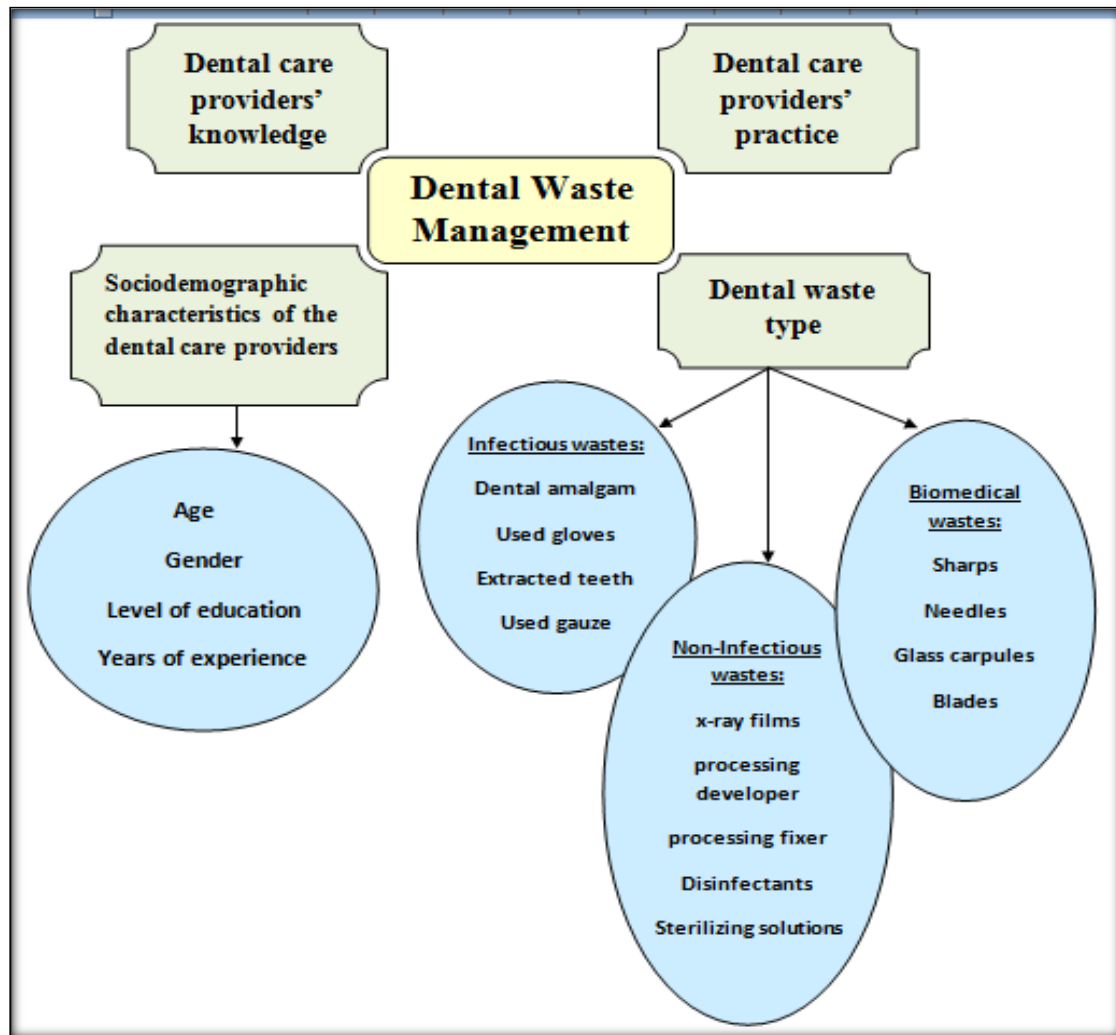
as waste contaminated with blood and bodily fluids (e.g., discarded testing samples), infectious agent cultures and products from experimental research (e.g., waste from autopsies), and waste from patients in isolation departments and equipment (e.g., swabs, bandages, and disposable medical devices) (Vallero, D. A., 2019).

Non-infectious waste is defined as waste not capable of harming people (Askarian, M., Heidarpour, P., & Assadian, O., 2010). It may include sterilization solutions, x-ray developer, x-ray fixer and disinfectants. BMW is the waste generated by humans, animals, and research experiments mostly during processing, testing, examination, therapy, vaccination, and surgical procedures (Chakraborty, S. et al., 2013).

## Chapter2

### Conceptual Framework and Literature Review

#### 2.1 Conceptual framework



**Figure (2.1): Diagram of conceptual framework (Self-developed)**

The conceptual framework illustrates the main domains that assess the dental waste management. The diagram showed two main types of variables, dependent variables which include the types of dental waste which are infectious waste like (dental amalgam, used gloves, extracted teeth and used gauze), non-infectious waste as (x-ray film, processing developer, processing fixer, sterilizing solutions and disinfectants), biomedical waste which include (sharps, needles, glass carpules and blades). Dependent variables also

include dental care providers' knowledge and dental care providers' practice. The conceptual framework demonstrates the relationship between independent variables which include sociodemographic characteristics and dental waste management.

## **2.2 Literature Review**

Bio-hazardous waste is composed of waste that is contaminated with blood, instruments and medical or dental equipment containing blood and several other types of waste, for example chemotherapeutic waste and bacterial cultures that are not normally generated in a general dental practice (Fred Hutchinson Cancer Research Center, 2016). In addition, exposure to infectious wastes may have harmful effects of secondary disease transmission among cleaners, healthcare workers and patients (Alverson, 2020).

Dental waste is a part of medical wastes, which is composed of waste that is produced after diagnosis, production or testing of biological or post-operative treatment of a medical procedure (ICRC, 2011). There are many components of dental waste produced from dental clinics and health centers and include chemical waste, pressurized containers, radioactive waste, clinical waste, and general waste.

Improper waste management has a direct negative impact on the community health, the health care workers, and the environment. Recently, BMW management gained attention from health care providers, health facilities, and community organizations; therefore, proper management of BMW has become a worldwide humanitarian issue today (Jyoti et al., 2019). A study conducted in GS at El Shifa and Al Aqsa Hospitals for assessment of MWM showed that both hospitals did not quantify medical wastes, but medical wastes were separated in each department (Abu Mhady et al., 2019).

### **2.3 Classification of dental waste**

There are many components of dental waste produced from the dental governmental clinics including chemical waste, radio-active waste, clinical waste, and general waste. Dental wastes are defined as any waste which consists wholly or partly of human ortissue, blood or other body fluids, excretions, drugs or other pharmaceutical products, swabs or dressings, syringes, needles or other sharp instruments, being waste which unless rendered safe may cause hazardous to any person coming into contact with it (Putrajaya, 2009).

WHO has classified medical waste into eight categories:

1. General Waste: waste that does not pose any particular biological, chemical, radioactive or physical hazard.
2. Pathological: human tissues, organs or fluids and contaminated animal carcasses.
3. Radioactive: such as products contaminated by radio-nuclides including radioactive diagnostic material or radio-therapeutic materials.
4. Chemicals: disinfectants, x-ray fixer, and x-ray developer.
5. Infectious to potentially infectious waste: waste contaminated with blood and other body fluids.
6. Sharps: syringes, needles, disposable scalpels, and blades.
7. Pharmaceuticals: expired, unused and contaminated drugs and vaccines.
8. Pressurized containers (Benakatt et al., 2018).

### **2.4 Sources of hazardous dental waste**

The wastes generated by dental clinics may be described as hazardous wastes if they were from the following sources (Managing solid waste generated by dental clinics, 1995):

1. X-ray fixer containing silver that makes it hazardous waste. Fixer liquid, along with advent solution, is widely used for oral radiology. The fixer liquid is considered as

a hazardous material because it contains a high concentration of silver and should not be directly discharged into the sewer or trash bin. Silver recycling is the best way of its management (Lakbala, P. 2020).

2. X-ray film: The darker areas are, the more the silver content, and thus the more is the hazardous effect.
3. Lead foil and mercury amalgam/ silver.

Also, there are other sources that could make the waste hazardous. This may be at lower level. It includes wastes like cleaners for developer systems and cleaners that contain chromium so, we can check the cleaner's Material Safety Data Sheet (MSDS), if the MSDS lists have some form of chromium, for example sodium dichromate, the waste cleaner solution should be managed as hazardous waste (Managing Waste Generated by Dental Clinics, 1995).

In addition, used sharps or dressings swabs are considered hazardous waste because they contain body fluid as blood. To protect waste hauler from infection, containers of sharps cannot be compacted (AL-Khatib & Darwish, 2004).

## **2.5 Health and environmental effects of dental waste**

The percentage of infectious waste in dental clinics was reported to be in the range of 10 to 25% of the total generated waste. Additionally, there are cross-infectious risks related to the mismanaged waste. Among others, hazardous wastes may include cadmium, chromium and amalgam (Michael et al., 2010).

### **2.5.1 Health risk:**

As a result of the increasing demand for dental care, there is a rise in the production of BMW. If these wastes are not disposed correctly, they can be risky to human health and

environment. It is worth to say that about one-fourth of health-care waste is hazardous and can cause several health problems (Khubchandani et al., 2020). Dental care providers are highly exposed to various workplace risks in during their work. Generally, these occupational harmful effects are categorized as biological, physical, psychological, and chemical hazards (Naz et al., 2020).

As the types of dental solid waste differ, the hazardous wastes also differ. It can be chromium, cadmium, and amalgam that may have adverse effects on humans. The hazardous effect of Chromium is on the liver, kidneys and may cause respiratory damage. The adverse effect of cadmium is by causing kidney diseases and tumors of the lung (Michael et al., 2010). The effect on health depends on the type of waste as follows:

#### **2.5.1.1 Acute infectious wastes:**

According to the WHO (2012), about 16 billion injections worldwide are administered annually. Unsuccessfully, not all syringes, and needles are disposed of safely, potentially creating risks of injury, infection and susceptibility for reuse especially in low-income countries (Caniato et al., 2016).

Injuries with sharp objects and needle sticks can transmit blood borne pathogens such as hepatitis virus B and C, and human immunodeficiency virus (HIV). These infections will inflict health, economical, personal and negative social impacts on healthcare providers and their families, along with physical and psychological health impacts including anxiety and depression (Hassan et al., 2018).

Regarding to Health Care without Harm, sharps waste is a category of infectious waste as lancets, syringes, orthodontic wires, needles, broken glass slabs, anesthetic carpules, blades and any other materials that can pierce the skin. The combination of contamination with pathogens and the ability to break through the skin's protection makes sharps waste one of

the riskiest wastes produced in healthcare facilities (HCFs) (Health Care without Harm. Treating Sharps Waste, 2017).

A study on knowledge and awareness of standard precautions among health care workers at Nizam's Institute of Medical Science, Hyderabad showed that 53.3% of respondents were very knowledgeable and 46.7% were somewhat knowledgeable (Peter et al., 2018).

Therefore, among healthcare waste (HCW) types, contaminated sharps represent one of the most dangerous HCW subsets dental solid waste may contain much infectious medical wastes and large amounts of different variety of pathogens. Combined with the presence of sharps in the waste, the risk of skin prick or cut with sharp contaminated materials becomes more serious. It may cause inflammatory skin diseases which arise due to the exposure to pathogens found in the medical waste such as cotton and gauze bedside (Case Studies of Five Dental Mercury Amalgam Separator Programs, 2008).

#### **2.5.1.2 Chemical and pharmaceutical waste:**

Pharmaceuticals include anesthetics, sedatives, antibiotics and analgesics. Wastes comprising of outdated, contaminated, and discarded medicines should be collected in a yellow-colored container (Biomedical waste management rules, 2016. central pollution control board).

PW is common in dental waste resulting from dental clinics. It causes genetic mutations, cancer, and damage to the employees, labor and the surrounding environment. In case of fire or explosions, it may cause pollution to environment (Hamde, 2003).

According to the Palestinian Ministry of Health, total PW disposed of in 2011 was 317.6 m<sup>3</sup>. PW consists of “expired, unused, spilled, and contaminated pharmaceutical products that are no longer required and need to be disposed of properly. This also includes discarded items used in the handling of pharmaceuticals, such as connecting tubing and drug vials. In a

health care facility, PW has discharged down the drain or sent to a landfill (Tabash et al., 2016).

In addition, may vital environmental damage happen when residual chemicals thrown in public sewer network due to the inability of sewage treatment plants to eliminate and get rid of those materials compared with the ease of getting rid of microbes. Some pharmaceutical residues have devastating effects on microbial systems.

In other studies, dental personnel may also be exposed to mercury vapor from dental effluent treatment devices (King et al., 2002). In other case some PW residues of antibiotics and other drugs used to treat teeth diseases when mixed with the remnants of heavy metals such as mercury, phenolic compounds, and toxic derivatives resulted in causing harmful effects to the natural environmental system (Chin et al., 2000).

In addition to that chemical dental X-ray waste is considered one of the serious problems. In most developed countries, there is professional management of dental waste. Everything is monitored and controlled in a systematic process, nothing is left for coincidence. For example, 90% of the silver used in fixer solutions used for developing X-ray films is recovered. After that, the remaining solution with a silver content of less than 10% of its original content can be safely discarded into the drain (Al-Khatib & Darwish, 2004).

#### **2.5.1.3 Residues of toxic drugs:**

Toxic drugs used for patients that were discharged and disposed of may cause damage to health labor and to the ability of these materials to attack human cells and cause faults. Exposure to this type of damage may be through inhalation of dust or gas (Neto et al., 2012).

The ability of these materials in the formation of cancerous tumors and mutations is high. These drugs are irritating the cells and tissues after topical exposure of the skin and eye,



symptoms such as headache, nausea, and some of the changes and skin abnormalities are common (Hamde, 2003).

Inappropriate management of waste produced in health care departments creates a direct health care result on the whole population, the health care practitioners, and the environment. The regular almost high amount of likely infectious and hazardous waste is created in health care departments around the world. Indiscriminate disposal of BMW and exposure to such waste feigns a serious peril to the environment and to human health. BMW management has lately developed as an issue of major concern not only to health care departments, nursing home authorities but also to the environment. The BMW generated from health care units depends upon a number of factors such as waste management methods, type of health care units, occupancy of healthcare units, specialization of healthcare units, and the ratio of reusable items in use. The proper management of BMW has become a global humanitarian issue today (Jyoti et al., 2019).

#### **2.5.1.4 Radioactive medical waste:**

The severity of diseases that is caused by exposure to radioactive waste depends on the type and amount of radiation. Symptoms vary from simple symptoms such as headaches and vomiting to more serious symptoms such as cancers (WHO, 1999).

The proper disposal and storage of radioactive waste in its original form is extremely important and costly, so pre-processing, including the correct protocol for storage allocation, is needed for appropriate waste disposal (Bhadouria,V. S., Akhtar, M. J., & Munshi, P., 2020).

#### **2.5.1.5 Dental amalgam fillings:**

Dental amalgam contained about 50% mercury, which is harmful to the nervous system (Mitchell M., 2018). Amalgam waste is listed as hazardous waste by the European Waste Catalogue (Daou, 2015).

The release of amalgam particles into the water or solid waste is of major concern as bacteria convert it into methyl mercury, which is a potent neurotoxic. Nowadays, new types of filling material are being developed, but the amalgam is still used and is expected to be used wider as durable and long-lived material (Mutter, 2011).

Dental assistants and dentists are highly exposed to various forms of mercury during their work. More specifically, elemental mercury vapors (HgO) are considered a major form due to manipulation of dental amalgam in their several routine occupational tasks, including preparation, restoration, and removal of dental amalgam. Nearly, 80% of the inhaled mercury vapor is captured in the bloodstream, circulates throughout the body, and can pass through both the placental and the blood brain barriers (Jamil et al., 2016).

Minor Neurocognitive Disorder is another new addition to the DSM-5 (Diagnostic and Statistical Manual of Mental Disorders) evidenced by a knowledgeable informant, meaning a friend, family member, or clinician, and suggests a modest impairment, which does not interfere with independent daily living (Grohol, 2016).

Environmental contamination with heavy metals is a global concern. Occupational exposure to mercury can result from inappropriate collection and disposal of amalgam waste, which could be nephrotoxic and neurotoxic. Additionally, Mercury predisposes the individual to multisystem disturbances. Moreover, pregnant and lactating women, and young children have higher sensitivity to mercury. Also, silver used in radiographic fixer

liquids and lead can have negative effect on the environment and the water ecosystem (Danaei et al., 2014).

Mercury vapors can cause damage to the central nervous system, thyroid, kidneys, lungs, immune system, eyes, gums and skin. Neurological and behavioral disorders include tremors, insomnia, memory and vision problems, neuromuscular effects, and headaches (Khwaja & Abbasi, 2014). Furthermore, dental mercury is a possibly provoking factor in development of Alzheimer's disease, Parkinson's disease, autoimmune disorders, immunodeficiency, kidney disorder, chronic fatigue syndrome, and psychological problems (Sawairet al., 2010).

The mercury in amalgam can reach the environment in many ways such as solid waste, water, and air (Kizlary et al., 2005). However, the problem is the presence of a special type of bacteria that will convert mercury into methyl mercury, which is a potential neurotoxin (Mumtaz et al., 2010). Recently, it is preferred to use tooth-colored restorations over dental amalgam restorations (Ajiboye et al., 2020).

Storage of amalgam waste should be in special white rigid containers with a mercury suppressant, and it should be sent to the recovery process before the terminal disposal. To decrease the amount of mercury vapor, amalgam should be stored under small amounts of photographic fixer in a locked container. Unused elementary mercury should be stored in a tightly sealed receptacle and should be transferred for recycling. Scrap amalgam should be stored in sponge type mercontainer. An essential filtration system should be used in all dental clinics to decrease the amount of mercury solids reaching the sewer system. The amalgam separators can eliminate 95% of mercury waste that is penetrating the sewage system (Bashir & Khan, 2019).

A cross-sectional study carried out to assess the status of DWM in private and public dental clinics in Iran found that the majority of dental clinics disposed their infectious waste with domestic waste, two-thirds of them used standard method for sharps disposal, none of the dental centers disposed their pharmaceutical waste and x-ray fixer waste by standard methods, and about 10% of clinics recycled the amalgam and lead foil packets waste to the manufacture (Danaei et al., 2014).

#### **2.5.1.5.1 Amalgam separation:**

The good news is that amalgam mercury removal is a simple process that can be done. After distillation, the mercury in amalgam can be extracted and reused in new goods. The American Dental Association (ADA) has addressed the issue of amalgam recycling as a way to reduce the harmful effects of this filling material (American Dental Association, October 2007). Several companies in Europe offer amalgam separator manufacturing, installation, and maintenance services to dentists. However, some mercury ends up in urban and BMW sources, causing local taxpayers to incur extra costs (Mudgal et al., 2012).

#### **2.5.2 Management of medical waste during the COVID-19 pandemic:**

COVID-19 was discovered in China in December 2019. As of May 21, 2020, COVID-19 has spread to 188 countries and regions. The rate of medical waste increased due to the rapid rise in the rate of confirmed cases of COVID-19. The daily COVID-19 related medical waste in China is nearly 468.9 tons according to the press conference for the joint prevention and control mechanism of China's state council (the state council Office- Peoples republic of China, 2020). Ensuring that COVID-19 related medical waste is timely, efficiently, and harmlessly disposed has also become a necessary part of the combat against the pandemic (Ugom, 2020).

A proper pre-treatment and sterilization of reusable instruments should be carried out and properly stored in a safe storage area according to the local protocols. The clinical waste generated after treatment of COVID-19 positive patients must be categorized as infectious clinical waste and stored in clinical waste bags within a designated area. The surface of the package bags should be labeled and disposed according to the local regulations and rules for the management of medical waste (Peng, 2020).

The COVID-19 pandemic has led to a sudden collapse of waste management chains. Safely managing medical and domestic waste is crucial to successfully containing the disease. Mismanagement can also lead to increased environmental pollution. Wuhan, the COVID-19 epicenter of China, experienced a massive increase of medical waste from between 40 and 50 tons/day before the outbreak to about 247 tons on 1 March. Meanwhile, the widespread lockdown has caused a substantial increase in domestic waste in the United Kingdom. These large amounts of waste require collection and recycling, both of which are compromised as a result of manpower shortages and efforts to enforce infection control measures. With fewer options available, traditional waste management practices such as landfills and incineration are replacing more sustainable measures such as recycling, with adverse effects on the environment. The U.K. Environment Agency further threatens the environment by allowing temporary storage of waste and incineration ash at sites that have not been granted a permit as is usually required. To address the overflow of medical waste, the United Kingdom and other affected countries should install mobile treatment systems near hospitals and healthcare centers. To reduce the socio-economic and environmental impacts of waste management, the whole system must be considered, including waste generation, collection, transport, recycling and treatment, recovered resource use, and disposal of remains. Protecting waste management chains will help achieve Sustainable

Cities and Communities as outlined in the UN Sustainable Development Goals (You, Sonne & Ok, 2020).

The global pandemic has led to an incredible amount of recorded medical waste. For example, the COVID-19 pandemic in China is reported to have extended medical waste from PPE like gloves, face masks, and eye protection due to a surge in PPE and immediate disposal after usage (Ma et al. 2020).

COVID-19 infection may have a variety of consequences, including xerostomia, and other complications. When xerostomia occurs, it can lead to dental caries, cheilitis (lip inflammation), ulcerations and/or inflammation of the buccal mucosa and tongue, oral candidiasis, parotid gland enlargement, sialadenitis, and halitosis, among other things. Oral microbiota changes, opportunistic fungal infections, ulcerations, and gingivitis can occur as a result of a compromised immune system and a susceptible oral mucosa. Access to dental care has been disrupted by the lockdown, which may have an effect on community oral health care in general. Poor oral care of critically ill patients receiving life-saving treatments like ventilators and oxygenation may have a negative impact on their oral health. Because of the reciprocal relationship between systemic diseases and periodontitis, access to appropriate chronic care and medication may have an indirect effect on oral health, especially periodontal health. As a result, such patients' well-being would be impacted (Farook, F. F. et al., 2020).

Some claim that the COVID-19 pandemic drastically altered the generation dynamics of this waste, creating an environmental and public health crisis worldwide, in the face of the 2020 waste pandemic (Vianna, M. S., & et. Al., 2021).

Sustainable management of medical waste is doubtful and expanded, particularly in crises like the COVID-19 pandemic. Due to the origination of the global pandemic, modification

to existing waste facilities to control the unusual medical waste and its associated viral dissemination effect necessitates satisfactory information on the quantity of medical waste produced, hot spots for waste production, and possible treatment facilities (Sharma et al. 2020).

According to the WHO, improper handling and disposal of these residues not only pollute the atmosphere, but also aid the spread of the current COVID-19. Residues from services destined to attend cases of the COVID-19 pandemic must be identified and handled as infective and treated appropriately before final disposal (Vianna, M. S., et al., 2021).

## **2.6 The risk of COVID-19 in the dental clinics:**

The COVID-19 epidemic started with a single transmission from animal to human, accompanied by continuing human-to-human spread, according to genetic and epidemiologic studies. Direct transmissions, such as sneezing, coughing, and inhaling tiny airborne particles, are common COVID-19 transmission routes. While standard COVID-19 clinical presentations do not have eye symptoms, analysis of conjunctival samples from confirmed and suspected COVID-19 cases reveals that COVID-19 transmissions are not exclusive to the respiratory tract and that eye contact may be a way for the virus to invade. It is mandatory for all the patients who visit the dental clinic to complete a detailed medical history form, a COVID19 screening checklist, and serious emergency questionnaire evaluation. Dental professionals should check a patient's body temperature by using just a non-contact forehead thermometer or infrared cameras sensors that take measurements to make sure that the body temperature is within the normal limit. Cleaning and disinfection of the medical kits (blood pressure cuffs, thermometers, etc.) using 70% concentration of ethanol is important step. To avoid the COVID-19 risk, advise patients for doing self quarantining and immediately contact their physician (Fini, M. B., 2020).

The ADA and the Centers for Disease Control and Prevention (CDC) recommend keeping the waiting room free of magazines and avoiding scheduling two or more appointments at the same time. If this is not practicable, the minimum distance between two patients in either direction must be at least 2 meters. Dentistry is also one of the most vulnerable occupations to COVID-19 each clinical case must be accurately monitored and considered by the dental care provider; procedure defaults cannot be accepted. There are, however, suggestions in the literature on how to handle emergencies (Villani, F. A. et al., 2020).

Dental handpieces use high-speed gas to rotate with flowing water, resulting in a significant amount of droplets and aerosol combined with the saliva and/or blood of the patient. As a result, it can be deduced that COVID-19 is capable of spreading via dental practice; this transmission can occur from patients to clinic staff or from clinic patients to other clinic patients. Corona viruses have been found to survive for many days on metal, glass, and plastic surfaces. As a result, surfaces in dental clinics can effectively help spread infection by collecting droplets and aerosol mixed with patients' saliva and/or blood. Corona viruses can keep their virulence active at room temperature for up to 9 days. Their activity was substantially higher at 50 percent humidity than it was at 30 percent. As a result, it appears that keeping surfaces clean and dry will be critical in preventing COVID-19 transmission in the dental setting (Fallahi, H. R. et al., 2020).

## **2.7 Environmental Disinfection of a Dental Clinic during the Covid-19 Pandemic:**

No one can deny that there is a direct relation between DWM perfectness and the methods of environmental disinfection in the dental clinic especially during the rapid and horrible spread of the COVID-19 Pandemic. Improved dental clinic ventilation can dilute and clear potentially infectious aerosols. Viruses or bacteria take off and live in the air, where they could infect other people or land on other surfaces. The humid environment in the area inside the unstable gas cloud, the hot atmosphere makes the contained droplets to minimize



contamination for a longer period of time than occurs in the presence of discrete droplets. As a result, it is important to enforce respiratory infection management in dental practices and health care offices, as well as a successful preventive plan. Droplets from infected patients may contaminate dental equipment and surfaces, posing a risk of microorganism transmission especially during DWM.

Aerosolized hydrogen peroxide systems (AHP) use a solution containing 5%–7% hydrogen peroxide with or without 50 ppm silver to produce a dry-mist hydrogen peroxide aerosol of hydrogen peroxide (Nocospay). The generator injects hydrogen peroxide solution into a room, followed by passive aeration and water, and is extremely effective against microbes. Since this method uses a low concentration of hydrogen peroxide, metabolically inert spore and catalyses-negative bacteria are less vulnerable (Scarano, A., Inchingolo, F., & Lorusso, F., 2020).

## **2.8 Knowledge and practice of dental waste management**

Appropriate management of dental waste is a challenge for healthcare providers who are working in dental clinics. Awareness and adequate knowledge about the hazardous effects of those wastes are important prerequisites for proper practice of DWM. A descriptive study carried out in Saudi Arabia aimed to assess knowledge and practice about DWM. The results indicated that one-third of the study participants received professional training on waste management. There was low knowledge and moderate practice of DWM. The results also reflected that knowledge about the effective procedure for segregating, collecting, transporting, and treating dental waste was below standards. The risks associated with dental waste disposal can be classified into two categories. First, a number of hazardous materials used in dentistry have a greater impact on the environment, and second, the more urgent dangers of infectious materials contained in dental waste that is

improperly handled can affect dental staff, cleaners, people in the whole community, and the environment in general (Sabbahi et al., 2020). In addition, Aghalari et al. (2020) reported that training is necessary to enable the dentists to perform the activities related to the reduction, separation and recycling of wastes as well as to implement the plan of collection, transportation and disposal of infectious, sharp, chemical-toxic and amalgam wastes according to the relevant criteria.

In India, a study carried out to determine level of knowledge and practices regarding DWM. The results indicated significant relationship between knowledge and practice of DWM, and qualification was significantly associated with knowledge and practice of DWM (Abhishek et al., 2016). Another study conducted to identify knowledge, attitude, and practices of BMW management found that knowledge and practice regarding segregation of BMW was limited. Most of the subjects were aware of hazardous effects of amalgam and had amalgam separator. Moreover, one-third of dentists were not following BMW guidelines for sharp management and most of them were disposing of sharps in general waste bins (Tompe et al., 2020).

In addition, Khubchandani et al. (2020) found that the vast majority of respondents agreed that waste needs to be segregated, but 70% were unaware of the rules regarding BMW management. Also, about 50% of the participants exhibited wrong answers regarding proper disposal of wastes, while only 10.1% correctly disposed mercury. A cross-sectional study conducted in Nepal aimed to examine knowledge, attitude and practice of dental professionals. The study indicated that about one-fifth of professionals had high knowledge, 37% had positive attitude, and 23% expressed good practice regarding DWM (Gautam et al., 2020).

## **Chapter 3**

### **Methodology**

#### **3.1 Study design**

The design of this study is descriptive, analytical, and cross-sectional. This design was chosen because it is the best design to describe the current status of dental waste management in governmental PHC centers. It is less expensive and enabled the researcher to meet the study objectives in a short time.

#### **3.2 Study population**

The target population consists of all dental staff workers (dentists and nurses) who work in the dental governmental PHC centers and hospitals (Naser Medical Complex and Al-Shifaa Medical Complex) in the GS at the time of the study. All dental staff workers who had at least 1 year of work experience and are permanently employed were included in the study. Study participants who were available during the data collection period and willing to take part in the study were considered who were nearly 98 dentists and nurses.

#### **3.3 Sample size and Sample process**

The study was carried out in 30 healthcare facilities including 28 dental clinics at the Governmental PHC centers, and 2 Maxillofacial Surgery Clinics at both Naser Medical Complex and Al-Shifaa Medical Complex that provide dental care services in each different geographical area in the GS which contain nearly 98 dentists and nurses. The number of respondents who agrees to participate in the study was 90 out of 98 (Response rate was 92%).

### **3.4 Study instruments and Data collection**

A self-report structure questionnaire was used in this study. The questionnaire consisted of five domains:

1. The first section represented infectious wastes which include dental amalgam, used gloves, extracted teeth and used gauze.
2. The second section represented non-infectious wastes which consist of x-ray films, processing developer, processing fixer, disinfectants and sterilizing solutions.
3. The third section represented biomedical wastes which include sharps, needles, glass carpules and blades.
4. The fourth section was concerned with the knowledge of the dentists and nurses about waste segregation, collection, treatment, and final disposal practices.
5. The fifth section was concerned with the practices of the dentists and nurses about waste segregation, collection, treatment, and final disposal practices.

The data was collected by the researcher to avoid any possible bias. Great care was taken to ensure confidentiality; the researcher gave the participants enough time to answer the questions and encouraged them to be open in answering. The researcher explained the purpose of the questionnaire to the dentists and nurses before obtaining consent. Also, any vague information was simplified by the researcher to ensure an exact and real answer by the participants.

### Criteria for measurements of variables

| Weighted percent | Interpretation |
|------------------|----------------|
| 20% - 36%        | Very low       |
| >36% - 52%       | Low            |
| >52% - 68%       | Moderate       |
| >68% - 84%       | Above moderate |
| >84% - 100%      | High           |

Source: (تميمي، 2004)

### 3.4 Pilot study

Pilot testing was done before the beginning of data collection to check the validity of the questionnaire. Twenty participants were included from four different governorates in the GS (5 from North Gaza, 6 from Khanyounis, 2 from Rafah, and 7 from middle Gaza) to do the pilot study. Refining of the questionnaire was done according to the result of the pilot study and it was included in the study.

### 3.5 Eligibility criteria

#### 3.5.1 Inclusion criteria:

The participants who were included in this study were all dentists and nurses who were working in the selected study sites of the governmental dental clinics.

#### 3.5.2 Exclusion criteria:

The participants who are excluded in this study were all dentists and nurses who are working in the private, UNRWA, and NGOs dental clinics.

### **3.6 Study setting**

This study was carried out in the governmental PHC centers and hospitals (Naser Medical Complex and Al-Shifaa Medical Complex) that provide dental care services across five Gaza Governorates including North Gaza Governorate, Gaza Governorate, Middle Gaza Governorate, Khan-Yunis Governorate, and Rafah Governorate.

### **3.7 Study period**

The study consumed 15 months; it started in February 2020 after the acceptance of the proposal, then conducting the administrative procedures and gaining ethical approval. A pilot study was conducted in September 2020. Data collecting, data entry, and data analysis continued to January 2021 and writing the final report continued to March 2021.

Annex (2) describes the activities of the research and the duration of each activity.

### **3.8 Ethical Consideration and procedures**

The researcher is committed to all ethical considerations required to conduct research. First, ethical approval was obtained from both the school of public health Al-Quds University and the Helsinki Committee to carry out the study. Second, an approval letter was sent to the director-general of PHC in the GS. Participants were informed about the purpose of the study and were made to understand that participation was not obligatory and refusal to participate in the study would not affect their employment status. The study respondents were assured of confidentiality and informed that they could withdraw from the study at any time and were at liberty not to answer any question they did not want to. All respondents were advised that completing the survey implied informed consent to use the data for research purposes. In addition, all personal identifiers were removed from the summary data to ensure confidentiality.

### 3.9 Validity and reliability of the instrument

#### 3.9.1 Validity:

Validity refers to the degree to which an instrument measures what it is supposed to be measuring. High validity is the absence of systematic errors in the measuring instrument. When an instrument is valid it truly reflects the concept, it is supposed to measure. Achieving good validity requires care in the research design and sample selection.

Face and content validity were done by submitting the questionnaire to a panel of expert persons in the field of Public Health, Dentistry, Biostatistics, and Epidemiology to evaluate the questionnaire and the method of analyzing the data, and modifications were done according to the recommendations of experts after consulting the supervisor.

#### Internal consistency:

The researcher calculated the correlation between the domains. Also, the researcher calculated the correlation between the total score of each domain and the total score of the questionnaire as follows:

**Table (3.1): Correlation between the domains of dental waste management**

|  |      | IWM     | NIWM    | BWM     | OWM     |
|--|------|---------|---------|---------|---------|
| Infectious Waste Management (IWM)      | R    | 1       | 0.479** | 0.597** | 0.828** |
|  | Sig. |         | 0.007   | 0.000   | 0.000   |
| Non-infectious Waste Management (NIWM) | R    | 0.479** | 1       | 0.530** | 0.824** |
|  | Sig. | 0.007   |         | 0.003   | 0.000   |
| Biomedical Waste Management (BWM)      | R    | 0.597** | 0.530** | 1       | 0.839** |
|  | Sig. | 0.000   | 0.003   |         | 0.000   |
| Overall Waste Management (OWM)         | R    | 0.828** | 0.824** | 0.839** | 1       |
|  | Sig. | 0.000   | 0.000   | 0.000   |         |

\*\*significant at 0.01

As shown in table (3.1), there is a statistically significant correlation between all the domains. Also, there is a statistically significant correlation between each domain and the total score of the dental waste management questionnaire.

**Table (3.2): Correlation between the domains of knowledge and practice of waste management**

|           |      | <b>Knowledge</b> | <b>Practice</b> | <b>Total KP</b> |
|-----------|------|------------------|-----------------|-----------------|
| Knowledge | R    | 1                | 0.627**         | 0.867**         |
|           | Sig. |                  | 0.000           | 0.000           |
| Practice  | R    | 0.627**          | 1               | 0.932**         |
|           | Sig. | 0.000            |                 | .000            |
| Total KP  | R    | 0.867**          | 0.932**         | 1               |
|           | Sig. | 0.000            | 0.000           |                 |

As shown in table (3.2), there is a statistically significant correlation between the domains of knowledge and practice. Also, there is statistically significant correlation between each domain and the total score of knowledge and practice questionnaire.



### 3.9.2 Reliability:

#### a. Cronbach alpha method:

The researcher used the Cronbach alpha method to examine the reliability for each domain of the questionnaire. The results are shown in the following tables.

**Table (3.3): Cronbach alpha coefficient for dental waste management**

| Domain                          | Number of items | Alpha coefficient |
|---------------------------------|-----------------|-------------------|
| Infectious waste management     | 12              | 0.746             |
| Non-infectious waste management | 10              | 0.802             |
| Biomedical waste management     | 9               | 0.756             |
| <b>Total</b>                    | <b>31</b>       | <b>0.880</b>      |

As presented in table (3.3), the items of the questionnaire showed high reliability as the total Cronbach alpha coefficient was 0.880.

**Table (3.4): Cronbach alpha coefficient for knowledge and practice of waste management**

| Domain                           | Number of items | Alpha coefficient |
|----------------------------------|-----------------|-------------------|
| Knowledge about waste management | 12              | 0.737             |
| Practice of waste management     | 15              | 0.744             |
| <b>Total</b>                     | <b>27</b>       | <b>0.835</b>      |

As presented in table (3.4), the items of the questionnaire showed high reliability as the total Cronbach alpha coefficient was 0.835.

### **b. Split-half method**

**Table (3.5): Split-half method**

| <b>Domain</b>                              | <b>Number of items</b> | <b>Correlation</b> | <b>Spearman-Brown equation</b> |
|--|------------------------|--------------------|--------------------------------|
| Dental waste management                    | 31                     | 0.720              | 0.837                          |
| Knowledge and practice of waste management | 27                     | 0.571              | 0.727                          |

The researcher calculated the correlation coefficient between the total scores of odd statements and the total score of even statements, the correlation value for dental waste management was ( $R = 0.720$ ), then the researcher used the spearman-Brown equation, the correlation value was ( $R = 0.837$ ). The correlation value for knowledge and practice part was ( $R = 0.571$ ), then the researcher used Spearman-Brown equation, the correlation value was ( $R = 0.727$ ).

From the above results, the questionnaire had good validity and reliability, and suitable to be used in this study.

### **3.10 Data Analysis**

The researcher used Statistical Package for Social Sciences (SPSS) version 22.0 programs for statistical analysis. The first stage of data entry was via the entry and coding of variables, followed by actual data entry. At the analysis stage, data cleaning and data management for the variables of interest were done. Descriptive analysis including figures, frequency tables, Means, and cross-tabulation was used to describe the main features of the data. Inferential analysis including; t-test, and one-way analysis of variance (ANOVA) test were used to show the relationship between independent and dependent variables, t-test, was used to compare between two means to show the relationship between sociodemographic characteristics such as gender and dental hazardous waste management. Also, (F) test was used to compare between more than two means especially to show the

relationship between sociodemographic characteristics such as age, level of education, name of the clinic or hospital, and years of experience and dental hazardous waste management. Also, to examine if there is a difference between dentists' and nurses' knowledge according to their demographic characteristics, t-test, and ANOVA was conducted. In addition, weight Mean was used to assess the highest and lowest waste hazardous management domains regarding infectious, non-infectious, and biomedical wastes domains. All these tests and others were used to analyze the quantitative data; Confidence interval at 95% and p-value < 0.05 will be considered statistically significant.

### **3.11 Limitations of the study**

- Unstable political situation, where full Israeli siege on the GS is imposed which totally is isolated from all the surrounding areas which lead to a dearth of many types of equipments and materials in the PHC governmental dental clinics, thus affecting methods for disposing of the dental waste products.
- The emergency state in the GS nowadays due to the procedures which were being taken for facing the pandemic corona virus COVID-19.
- Absence of computerized information system in the governmental PHC clinics, which leads to an increased period of data extraction.

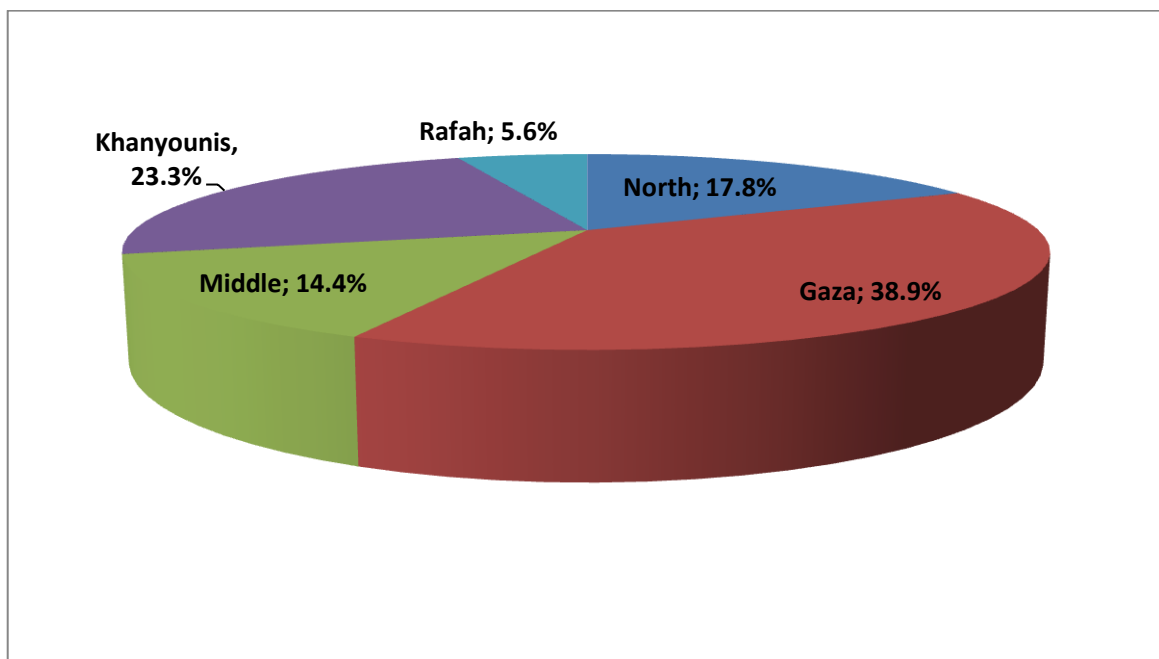
## Chapter 4

### Results and Discussion

This chapter presents the findings of statistical analysis of data. Description of demographic characteristics of study participants was illustrated and the results of different variables and dimensions were identified. Moreover, the differences between selected variables and correlations were explored as illustrated below.

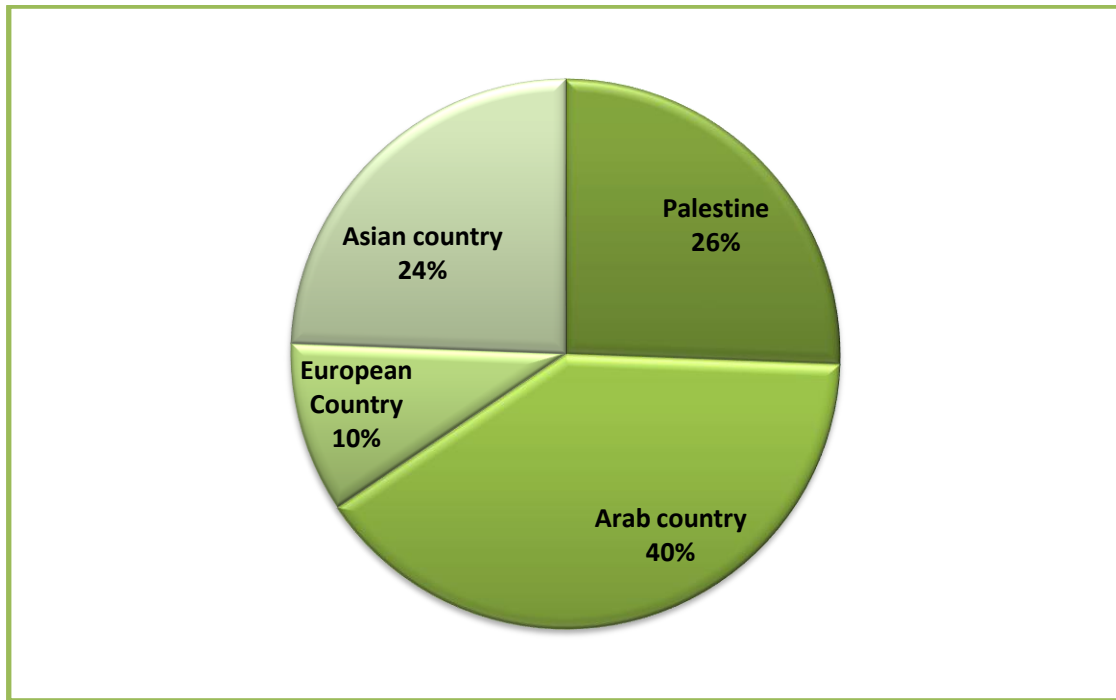
#### 4.1 Descriptive results

##### 4.1.1 Characteristics of study participants



**Figure (4.1): Distribution of study participants according to governorate**

The sample of the study consisted of 90 participants who are working in all the governmental dental clinics in Gaza Strip; 38.9% were from Gaza governorate, 23.3% from Khanyounis, 17.8% from the North, 14.4% from the middle, and 5.6% from Rafah governorate.



**Figure (4.2): Distribution of study participants according to country of graduation**

Figure (4.2) showed that 40% of study participants graduated from universities in Arab countries, 25.6% graduated from Palestinian universities, 24.4% graduated from universities of Asian countries, and 10% graduated from universities of European countries.

**Table (4.1-a): Characteristics of study participants (n= 90)**

| Variable | Category                          | N  | Percent |
|----------|-----------------------------------|----|---------|
| Gender   | Male                              | 58 | 64.4    |
|          | Female                            | 32 | 35.6    |
|          | Total                             | 90 | 100.0   |
| Age      | 26 – 35 years                     | 17 | 18.9    |
|          | 36 – 45 years                     | 32 | 35.6    |
|          | 46 – 56 years                     | 41 | 45.5    |
|          | Total                             | 90 | 100.0   |
|          | Mean= 42.922      SD= 7.644 years |    |         |

**Table (4.1-b): Characteristics of study participants (n= 90)**

| <b>Variable</b>            | <b>Category</b>           | <b>N</b> | <b>Percent</b> |
|----------------------------|---------------------------|----------|----------------|
| <b>Specialty</b>           | Dentist                   | 76       | 84.4           |
|                            | Nurse/assistant           | 14       | 15.6           |
|                            | Total                     | 90       | 100.0          |
| <b>Qualification</b>       | BS (Dentist)              | 76       | 84.4           |
|                            | BS (Nurse)                | 5        | 5.6            |
|                            | Diploma (Nurse/assistant) | 9        | 10.0           |
|                            | Total                     | 90       | 100.0          |
| <b>Years of experience</b> | 1 - 9 years               | 21       | 23.3           |
|                            | 10 - 19 years             | 39       | 43.4           |
|                            | 20 – 30 years             | 30       | 33.3           |
|                            | Total                     | 90       | 100.0          |
|                            | Mean= 14.7o               |          |                |

As shown in table (4.1), 58 (64.4%) of study participants were males and 32 (35.6%) were females. The mean age was 42.922, SD 7.644 years, and 41 (45.5%) aged 46 – 56 years. In addition, 76 (84.4%) are dentists and 14 (15.6%) are nurses or assistants, 76 (84.4%) have bachelor degree in dentistry, 5 (5.6%) have bachelor degree in nursing, and 9 (10%) have diploma certificate. Moreover, the mean years of experience was 14.777, SD 7.709 years, 39 (43.4%) have an experience of 10 – 19 years, and 30 (33.3%) have an experience of 20 – 30 years.

#### 4.1.2 Dental waste management:

##### 4.1.2.1 Infectious waste management:

**Table (4.2-a): Infectious waste management (n= 90)**

| No. | Item  | Never | Rare | Sometimes | Often | Always | Mean  | SD    | Mean % |
|-----|---|-------|------|-----------|-------|--------|-------|-------|--------|
| 1   | You wear personnel protective equipment PPE (gloves, face shields, goggles and facemasks) when handling the infectious dental wastes. | 2.2   | 6.7  | 17.8      | 32.2  | 41.1   | 4.033 | 1.032 | 80.66  |
| 2   | Your clinic produces pathological wastes as body parts (tissue or surgical specimen).   | 8.9   | 10.0 | 27.8      | 21.1  | 32.2   | 3.577 | 1.280 | 71.54  |
| 3   | You dispose the extracted teeth in the regular dustbin.   | 30.0  | 24.4 | 14.4      | 18.9  | 12.2   | 3.411 | 1.405 | 68.22  |
| 4   | You collect amalgam scraps and hand them over to waste management service for recycling purpose.                                      | 61.1  | 15.6 | 11.1      | 4.4   | 7.8    | 1.822 | 1.259 | 36.44  |
| 5   | You dispose excess amalgam restoration in the regular dustbin.  | 41.1  | 25.6 | 13.3      | 8.9   | 11.1   | 3.766 | 1.366 | 75.32  |
| 6   | During removal of old amalgam restoration, you use a copious amount of coolant.   | 4.4   | 5.6  | 8.9       | 32.2  | 48.9   | 4.155 | 1.090 | 83.10  |
| 7   | You throw the non-contact amalgam in a separate bottle.   | 44.4  | 17.8 | 20.0      | 7.8   | 10.0   | 2.211 | 1.353 | 44.22  |
| 8   | Color coded bags are used to segregate the waste.   | 15.6  | 4.4  | 14.4      | 21.1  | 44.4   | 3.744 | 1.457 | 74.88  |
| 9   | Infectious waste management is done according to the rules and regulations in the clinic.   | 10.0  | 4.4  | 14.4      | 24.4  | 46.7   | 3.933 | 1.305 | 78.66  |

**Table (4.2-b): Infectious waste management (n= 90)**

| No.            | Item  | Never | Rare | Sometimes | Often | Always | Mean         | SD           | Mean %       |
|----------------|---|-------|------|-----------|-------|--------|--------------|--------------|--------------|
| 10             | Collection of the infectious dental waste is done daily.  | 5.6   | 3.3  | 12.2      | 20.0  | 58.9   | 4.233        | 1.142        | 84.66        |
| 11             | The bags or containers are replaced immediately with new ones at the same time.                           | 7.8   | 5.6  | 15.6      | 20.0  | 51.1   | 4.011        | 1.267        | 80.22        |
| 12             | The infectious dental waste is usually stored in a separate area appropriate to the quantities of wastes. | 11.1  | 4.4  | 5.6       | 28.9  | 50.0   | 4.022        | 1.323        | 80.44        |
| <b>Average</b> |   |       |      |           |       |        | <b>3.576</b> | <b>0.603</b> | <b>71.52</b> |

Regarding infectious waste management (IWM) the results are as presented in table (4.2). It is noted that the highest paragraph was number (10) “Collection of the infectious dental waste is done daily” with a mean score 4.233 and mean percent of 84.66%. This indicates a high agreement from participants on this item. From the researcher’s point of view, this is a critical step in IWM especially nowadays due to the sprawl of COVID-19 worldly. There is a study conducted in China (2020) which indicates that the time and route of COVID-19 related medical waste collection and transportation was different from the general waste in order to reduce the risk of leakage and damage during the transfer process in the hospital and to improve the transfer efficiency. In the same study, it was revealed that the in-hospital storage time was lessened, in the past it should not exceed 48 hours, but now it is not permitted to exceed more than 24 hours (Peng, J. et al., 2020).

Followed by the paragraph number (6) which is “During removal of old amalgam restoration, you use a copious amount of coolant” with a mean score of 4.155 and a mean



percent of 83.10%.The lowest score was in "Throwing the non-contact amalgam in a separate bottle" with a mean score of 2.211 and a mean percent of 44.22%. Non-contact amalgam is an amalgam not contacting the patient's oral cavity, as the excess of amalgam restoration after setting even in the capsule or outside it (Singh, R. D. et al 2014).

Followed by "Collecting amalgam scraps and hand them over to waste management service for recycling purposes" with a mean score of 1.822 and a mean percent of 36.44%.WHO identified mercury as one of the top ten chemicals that can be harmful to the health(WHO, 2013).The amalgam waste should remain in a properly labeled sealed container that is appropriate for storing contaminated amalgam waste and should be sent for the contents to be recycled, mainly mercury and silver (Al-Khatib, I. A., & et al., 2010). Dental amalgam is a filling material that is nearly 50% mercury, which is a heavy metal that poses known harmful effects on the nervous system and the environment (Mitchell M., 2018).

The guidelines of "Best Management Practices for Amalgam Waste" have published a special guide to manage amalgam waste which reported that:

Although mercury from dental amalgam is stable, it should not be disposed of in the garbage, infectious waste "red bag", or sharps container, also it should not be rinsed down the drain. The researcher revealed that better management should be introduced for a friendly environment method of disposal of both excess and non-contact amalgam.

Regarding item number (9) which is "Infectious waste management is done according to the rules and regulations in the clinic", the results were that less than half of the participants answered by always, this means there is no commitment with ideal methods for waste management and the regulations for the dental clinic. This result is consistent with the results of a study conducted in Iran by Danaei, M., et al., (2014) showed that

89.1% of dental offices and clinics disposed their infectious waste with domestic waste. Less than 10% of centers recycled the amalgam and lead foil pockets waste to the manufacture, which is consistent also with the findings of the item number (4) which were only (7.8%) their answer was always, and nearly (61.1%) their answer was never when they were asked if they collect amalgam scraps and hand them over to waste management service for recycling purpose or not.

According to the findings of item number (1) which is “You wear personnel protective equipment PPE (gloves, face shields, goggles and facemasks) when handling the infectious dental waste”, there are only (41.1%) of participants revealed that they always wear the PPE during handling of the infectious waste. From the researcher’s point of view, this is a low percent of the participants who are committed by the IPC (Infection prevention and control), hence, she recommended establishment of monitoring and evaluation program in all governmental dental clinics to identify the cause of this problem and then enforcement of rules and regulations.

The use of gloves, disposable aprons, facemasks, and eye protection are the constituents of PPE. Using PPE is one of the standard IPC precautions and reduces the risk of acquiring contamination from potentially infectious body fluids and transmitting microorganisms via hands or clothing (Cochrane, J., & Jersby, M., 2019).

Regarding item number (11) which is “The bags or containers are replaced immediately with new ones at the same time” more than half of the respondents answered by always, while (20%) of them answered by often. This result is somewhat different from a study conducted in the GS by Qeshta R., (2016) which revealed that (92%) of the participants reported yes when they were asked about replacement of the bags or containers

immediately with new ones at the same time, and nearly (7%) reported no when they were asked the same question.

Item number (8) which is “Color-coded bags are used to segregate the waste” there is a percent of (44.4%) of participants who saw it is always being done in a proper way, but the others did not. For that reason, the researcher recommended making educational & training courses about the ideal steps for dental waste management. Furthermore, there is a study conducted in India showed that (82.6%) of participants said that it is mandatory to segregate waste into different categories at the source of origin (Rudraswamy, Sampath and doggalli, 2012), additionally, there is another study conducted in Pune city in India by Jamkhande, A. et al. (2019) revealed that segregation and color coding of waste before disposal was followed by only 73.3% and 79.5% of dentists, respectively.

Overall, the mean score of IWM was 3.576 and a mean percent 71.52%, which indicated that management of infectious dental waste was above moderate.

#### 4.1.2.2 Non-infectious waste management:

**Table (4.3-a): Non-infectious waste management(n= 90)**

| No. | Item  | Never | Rare | Sometimes | Often | Always | Mean  | SD    | Mean % |
|-----|---|-------|------|-----------|-------|--------|-------|-------|--------|
| 1   | The x-ray machine in the clinic is used for diagnostic purposes.  | 42.2  | 10.0 | 18.9      | 13.3  | 15.6   | 2.500 | 1.523 | 50.00  |
| 2   | You collect the lead foils of the used x-ray films separately and dispose to local waste collection body. | 51.1  | 10.0 | 8.9       | 17.8  | 12.2   | 2.300 | 1.532 | 46.00  |

**Table (4.3-b): Non-infectious waste management (n= 90)**

| No             | Item   | Never | Rare | Sometimes | Often | Always | Mean         | SD           | Mean %       |
|----------------|--|-------|------|-----------|-------|--------|--------------|--------------|--------------|
| 3              | Liquid hazardous waste as processing developer discharge is settled to the sanitary sewer. | 40.0  | 10.0 | 5.6       | 25.6  | 18.9   | 2.733        | 1.633        | 54.66        |
| 4              | Sterilization solutions and the disinfectants waste are disposed in the waste water.       | 10.0  | 2.2  | 11.1      | 35.6  | 41.4   | 3.955        | 1.235        | 79.10        |
| 5              | Preparing for replacement of conventional radiograph with digital x-ray system is present. | 47.8  | 12.2 | 10.0      | 16.7  | 13.3   | 2.355        | 1.531        | 47.10        |
| 6              | Plastic bags or containers are usually filled to three quarters of its size.               | 11.1  | 8.9  | 21.1      | 34.4  | 24.4   | 3.522        | 1.265        | 70.44        |
| 7              | The containers of the non-infectious wastes are labeled properly.                          | 24.4  | 6.7  | 17.8      | 30.0  | 21.1   | 3.166        | 1.478        | 63.32        |
| 8              | Sodium hypochlorite is being used for sterilization in your clinic.                        | 5.6   | 6.7  | 10.0      | 26.7  | 51.1   | 4.111        | 1.175        | 82.22        |
| 9              | The used fixer solution hand is disposed to recycling companies.                           | 21.1  | 12.2 | 7.8       | 15.6  | 43.3   | 2.522        | 1.629        | 50.44        |
| 10             | The disposed developer solution hand is sent to recycling companies.                       | 25.6  | 10.0 | 6.7       | 15.6  | 42.2   | 2.611        | 1.687        | 52.22        |
| <b>Average</b> |  |       |      |           |       |        | <b>2.977</b> | <b>0.749</b> | <b>59.54</b> |

Table (4.3) presented non-infectious waste management (NIWM). The highest score was in "Sodium hypochlorite is being used for sterilization in your clinic" with a mean score of 4.111 and a mean percent of 82.22%. From the researcher's point of view, there was more commitment to the infection control protocol and sterilization for all of the surfaces in the dental clinic than usual due to the spread of the pandemic COVID 19. Surface disinfection with 0.1% sodium hypochlorite or 70% ethanol markedly minimizes corona virus infectivity on surfaces within one minute exposure time (Kampf, G. et al, 2020). Followed by "Sterilization solutions and the disinfectants waste are disposed in the wastewater" with a mean score of 3.955 and a mean percent of 79.10%.

Regarding item number (3) which is "Liquid hazardous waste as processing developer discharge is settled to the sanitary sewer" (40%) of the respondents their answer was never, (10%) of them answered by rare, (5.6%) of them answered sometimes, (25.6%) answered often and only (18.9%) answered always. These results are inconsistent with a study conducted in India which showed that (71%) dentists responded that developer and fixer can be drained into the sewer (Bangennavar BF. et al., 2015).

Referring to the item (7) which is "The containers of the non-infectious wastes are labeled properly", the results were (24.4%) answered never, (6.7%) answered rarely, (17.8%) answered sometimes, (30.0%) answered often and only (21.1%) who answered by always which is a serious problem, thus, the researcher recommended establishing strict measures regarding this important step. Labeling of waste bags is used to identify the point of origin, record the type and amount of waste produced in each area and allow problems with waste segregation to be traced back to the point of generation (WHO, 2017a).

The lowest score was in "Preparing for replacement of conventional radiograph with digital x-ray system is present" with a mean score of 2.355 and mean percent of 47.10%. In

my opinion, there is no preparation for using a digital x-ray system due to financial constraints at MOH, and these results were in accordance with WHO report that indicated that budgetary restrictions are the main reason for shortage at the central level. In addition, there are many dental governmental clinics that do not have even a conventional x-ray machine. Followed by "collecting the lead foils of the used x-ray films separately and dispose to local waste collection body" with a mean score of 2.300 and a mean percent of 46%. The films and the developing solutions used in processing of films contain some risky components which are very toxic to the environment, as well as to living organisms. Therefore, this type of toxic waste requires simple, but suitable collection and treatment measures, to be transformed into environmentally friendly products (Constantiniuc, M. et al, 2020). In our study, the results are inconsistent with the study of Makkar, M., &Kaur, K. A. (2015), which showed that the X-ray film foils into the common dustbin is forbidden because lead is a heavy metal which has a negative effects on the nervous system. It should not be incinerated or treated as general waste. Some of the factories may use lead as a raw material for the manufacture of batteries, but the quantity required is high. Un-used films contain un-reacted silver that can be toxic in the environment. The usage of digital X-ray within the dental office can markedly lessen the amount of silver waste generated. Using a digital imaging unit minimizes the purchase of new X-ray films (Clifton, 2007).

Overall, the mean score of NIWM was 2.977 and the mean percent 59.54%, which indicated that management of non-infectious dental wastes was moderate.

#### 4.1.2.3 Biomedical waste management:

**Table (4.4-a): Biomedical waste management(n= 90)**

| No.            | Item  | Never | Rare | Sometimes | Often | Always | Mean         | SD           | Mean %       |
|----------------|---|-------|------|-----------|-------|--------|--------------|--------------|--------------|
| 1              | Biomedical dental wastes are being disposed in yellow containers.                             | 18.9  | 5.6  | 15.6      | 22.2  | 37.8   | 3.544        | 1.507        | 70.88        |
| 2              | You use puncture proof containers for the disposal of used sharps as needles and blades.      | 8.9   | 2.2  | 5.6       | 13.3  | 70.0   | 4.333        | 1.245        | 86.66        |
| 3              | Scalpels are disposed in the regular garbage.   | 30.0  | 6.7  | 15.6      | 11.1  | 36.7   | 2.822        | 1.686        | 56.44        |
| 4              | Disposal of used glass carpules is mainly in the puncture proof containers.                   | 12.2  | 4.4  | 22.2      | 26.7  | 34.4   | 3.666        | 1.323        | 73.32        |
| 5              | The current methods of biomedical dental waste management in your department are appropriate. | 6.7   | 6.7  | 22.2      | 44.4  | 20.0   | 3.644        | 1.084        | 72.88        |
| 6              | Separation for the dental biomedical wastes from other wastes is performed before disposal.   | 17.8  | 10.0 | 20.0      | 27.8  | 24.4   | 3.311        | 1.411        | 66.22        |
| 7              | The containers of the biomedical wastes are labeled properly.                                 | 17.8  | 6.7  | 24.4      | 24.4  | 26.7   | 3.355        | 1.408        | 67.10        |
| 8              | Needle stick injury during biomedical waste management is an extra burden on work.            | 6.7   | 2.2  | 28.9      | 21.1  | 41.1   | 3.877        | 1.178        | 77.54        |
| 9              | Containment of sharps does not help in safe management of the clinic waste.                   | 23.3  | 11.1 | 23.3      | 22.2  | 20.0   | 3.044        | 1.444        | 60.88        |
| <b>Average</b> |   |       |      |           |       |        | <b>3.511</b> | <b>0.693</b> | <b>70.22</b> |

Table (4.4) presented biomedical waste management (BWM). The highest score was in "using puncture proof containers for the disposal of used sharps like needles and blades" with a mean score of 4.333 and a mean percent of 86.66%. These results are consistent with a study carried out by Agarwal B. et al., (2011) which revealed that "All sharp instruments must be disposed of by the suitable methods, its management can be done by collecting sharps in a red or yellow puncture-resistant container with a lid that is not able to be removed, the sharps container should be clearly labeled with biohazard sign".

Similar results of a study in India was conducted by Jamkhande, A., et al. (2019) showed that 72.3% of dentists correctly answered about the disposal of sharps in white translucent puncture-proof containers. Sharps and, more needles are considered the most hazardous type of health-care waste for health-care workers, because of the risk of needle-stick injuries which carry a high susceptibility for infection (WHO 2017b).

Followed by "Needle stick injury during biomedical waste management is an extra burden on work" with a mean score of 3.877 and a mean percent of 77.54%. The lowest score was in "Scalpels are disposed of in the regular garbage" with mean score of 2.822 and a mean percent of 56.44%.

Item number (5) which is "the current methods of biomedical dental waste management in your department are appropriate", nearly (44.4%) answered often. This result is consistent with a study conducted in Botswana which showed that 66.9% (423/632) of respondents had some training in MWM, and 90.5% (572/632) claimed to have knowledge about the consequences of poor MWM, particularly health risks. There was a significant agreement among the respondents that segregation of medical waste should be done at the point of generation (mean score = 4.43 out of 5) (Mugabi, B., Hattingh, S., & Chima, S. C., 2018).



The results of the item number (6) which is “Separation for the dental biomedical wastes from other wastes is performed before disposal”, with mean score 1.411, and mean percent 66.22%. From the researcher’s point of view, this indicates an improper separation of the biomedical wastes and this problem should be solved as soon as possible because hazards of mismanagement of BMW have aroused concern in the light of its far-reaching effects on human health and the environment. The segregation of biomedical waste is done at point sources in developed countries. On the other hand, in developing countries due to the mixing of hazardous biomedical waste with general waste or due to poor sanitation, the problems of mismanagement of biomedical waste are rising (Patil, P. M., & Bohara, R. A., 2020).

To avoid the mixing of BMW with regular domestic waste, it is highly essential to segregate the biomedical/hazardous waste at the source of its origin. Color-coded bags or containers are recommended for different types of infection waste so it can be traced from point of origin to point of disposal.

Overall, the mean score of BWM was 3.511 and the mean percent 70.22%, which indicated that management of biomedical dental wastes was above moderate.

#### **4.1.2.4 Overall management of hazardous dental wastes:**

**Table (4.5): Overall hazardous dental waste management**

| <b>Domain</b>                                    | <b>Mean</b>  | <b>SD</b>    | <b>Mean %</b> | <b>Level</b>    |
|--|--------------|--------------|---------------|-----------------|
| Infectious waste management                      | 3.576        | 0.603        | 71.52         | Above moderate  |
| Non-infectious waste management                  | 2.977        | 0.749        | 59.54         | Moderate        |
| Biomedical waste management                      | 3.511        | 0.693        | 70.22         | Above moderate  |
| <b>Overall hazardous dental waste management</b> | <b>3.355</b> | <b>0.543</b> | <b>67.10</b>  | <b>Moderate</b> |

Table (4.5) showed that IWM was above moderate (m= 3.576, 71.52%), NIWM was moderate (m= 2.977, 59.54%), and BWM was above moderate (m= 3.511, 70.22%). The overall management of hazardous dental wastes was moderate with a mean score 3.355 and a mean percent 67.10%.

#### 4.1.3 Knowledge and practice of dentists and about dental waste management:

**Table (4.6-a): Knowledge about dental hazardous waste management(n= 90)**

| No. | Item  | Yes  | No   | Don't know | Mean  | SD    | Mean % |
|-----|---|------|------|------------|-------|-------|--------|
| 1   | Is the dental waste hazardous to the human health?  | 95.6 | 4.4  | 0          | 2.955 | 0.207 | 98.5   |
| 2   | Is the dental waste hazardous to the environment?   | 92.2 | 6.7  | 1.1        | 2.911 | 0.323 | 97.0   |
| 3   | Should a color- coded container be available for different type of dental waste inside the clinic?  | 91.1 | 8.9  | 0          | 2.911 | 0.286 | 97.0   |
| 4   | Should waste management responsibility be included in the job description of all dental care providers?   | 87.8 | 10.0 | 2.2        | 2.855 | 0.412 | 95.2   |
| 5   | Have you received formal training courses about dental waste management in the last year?   | 48.9 | 46.7 | 4.4        | 2.444 | 0.582 | 81.5   |
| 6   | Are training given to newly hired staff hazardous dental waste management?  | 54.4 | 27.8 | 17.8       | 2.366 | 0.770 | 78.8   |
| 7   | Should dental colleges organize a continuing dental education program to upgrade existing knowledge about biomedical waste management?                                  | 91.1 | 4.4  | 4.4        | 2.866 | 0.454 | 95.5   |
| 8   | Is there a supervision process for dental waste management in your work place?  | 60.0 | 27.8 | 12.2       | 2.477 | 0.706 | 82.5   |
| 9   | Is there coordination at the process of dental waste management between all relevant departments (pharmacy, nursing, infection control, environmental health, etc ...)? | 45.6 | 33.3 | 21.1       | 2.244 | 0.783 | 74.8   |
| 10  | Does your clinic coordinate with other organizations in relation to the waste concern?  | 31.1 | 24.4 | 44.4       | 1.866 | 0.863 | 62.2   |

**Table (4.6-b): Knowledge about dental hazardous waste management (n= 90)**

| No.            | Item   | Yes  | No   | Don't know | Mean         | SD           | Mean %      |
|----------------|--|------|------|------------|--------------|--------------|-------------|
| 11             | Is there a protocol for the dental hazardous waste management in your organization?          | 70.0 | 14.4 | 15.6       | 2.544        | 0.751        | 84.8        |
| 12             | Are there rules and regulations about dental hazardous waste management in your organization | 70.0 | 18.9 | 11.1       | 2.588        | 0.685        | 86.3        |
| <b>Average</b> |  |      |      |            | <b>2.586</b> | <b>0.311</b> | <b>86.2</b> |

Table (4.6) presented participants' knowledge about the management of hazardous dental wastes. Our study results revealed that a high percent of respondents (98.5%) agreed that the dental waste is hazardous to human health. In addition, nearly (97%) of respondents showed their agreement that the dental waste is hazardous to the environment. There was a study conducted in Palestine showed that the ways of disposal of dental waste were generally improper and exposed dental practitioners to health hazards and may lead to environmental contamination (Darwish, 2006).

The lowest score was in knowing that there was a coordination of the process of dental waste management between all relevant departments; pharmacy, nursing, infection control, environmental health, etc., with mean score 2.244 and mean percent 74.8%, which is consistent with the study of Chartier et al., (2014) which approved that in Palestine, there is poor coordination between different department and MOH and other related organization which could have a destructive implementation of best waste management. This was followed by knowing that the clinic coordinates with other organizations in relation to the waste concern with mean score 1.866 and mean percent 62.2%. Regarding question number (3) there are (91%) of respondents revealed that a color-coded container should be available for a different type of dental waste inside the clinic, this result is consistent with

the results of a study done by Narang et al.(2012) in Punjab reported that 85 % dentists were aware of BMW color coding but only 60% dentists were practicing it.

In regarding both the questions number (5) and number (6), if they have received any formal training courses about dental waste management in the last year nearly half of them have received (48.5%) and (46.7%) did not receive training, while (4.4%) do not know if they received or not. And when the respondents asked if there is a training course is being given for newly hired staff, (54.4%) answered by yes and only (27.8%) answered by no, while (17.8%) do not know. From the researcher point of view, this is a good indicator and the results of our study are inconsistent with a study conducted in the GS which revealed that there is a problem in training health care teams about handling the medical waste, also showed that there is a lack of training courses about MWM as 23% only of the study participants who received training on the management of medical waste (Sarsour et al., 2014).

Another study was done in Iran showed that generally; dentists did not have sufficient awareness of dental waste management in Bandar Abbas. Also, mostly they do not meet the waste disposal standards. Therefore, continuous training of dentists, especially at the start of their work in offices and clinics, on the management of dental wastes is essential in raising their awareness. To protect the environment from pollution, as well as to make sure of health care worker's and patient's safety, MWM programs are especially effective in preventing water and soil contamination. Establishing waste management rules and regulations requires regular monitoring and training. So, it is necessary to establish a comprehensive system of health care for waste management in Iran as in those of developed countries (Lakbala, P., 2020).

The researcher recommended the construction of a training program for the dentists and nurses especially the newly hired. In regard to the item number (7) which is “should dental

colleges organize a continuing dental education program to upgrade existing knowledge about biomedical waste management?” there are nearly (91.1%) of respondents answered the previous question by yes, and only (4.4%) answered by no, while (4.4%) did not know. These results are in line with a study was conducted in Peru by Diaz-Soriano, A., & et al., (2020) showed that Peruvian Public University students have the knowledge and are aware of the need for adequate management and/or recycling of biomedical waste dental care products, with none of the possible associated variables studied significantly affecting this relationship. Therefore, the researcher showed and explained the importance of establishing educational programs among the Colleges of Dentistry in the GS, and this to be taken into consideration when preparing the curriculum of the dental subjects and should be an obligatory course.

Results in our study showed the percentage of the respondents who know if there is a protocol, rules and regulations about dental hazardous waste management in their organizations or not, the results according to the table (4.6) the items (11) and (12) showed that nearly (70%) of respondents showed their agreement for both items. A study in the United Arab of Emirates showed that 83.7% of the dental staff was unaware of any document outlining the policy of waste management (Hashim, 2011).

Only 62.2% of respondents showed that there is coordination with other organizations in relation to the waste concern. The results are in line with the study of Kala study (2009) shows that the management of medical waste in Palestine was not given the appropriate concern.

A study was carried out at Nizam’s Institute of Medical Science, Hyderabad on knowledge about standard precautions among health care personnel revealed that 53.3% of participants were very knowledgeable and 46.7% were somewhat knowledgeable (Peter AM, Jose J, D’Souza PR et al. 2018).

Overall, the mean score of total knowledge was 2.586 with mean percent 86.2%, which indicated that the study participants have high knowledge about hazardous dental waste management.

**Table (4.7): Levels of knowledge about hazardous dental waste management(n= 90)**

| Level of knowledge        | n  | Percent |
|---------------------------|----|---------|
| Low (33.3 – 55.27)        | -  | -       |
| Moderate (>55.27 – 77.58) | 16 | 17.8    |
| High (>77.58)             | 74 | 82.2    |
| Total                     | 90 | 100.0   |

Table (4.7) showed that 52 (57.8%) of study participants have high knowledge about dental hazardous waste management, 31 (34.4%) have above moderate knowledge, while 7 (7.8%) of study participants have moderate knowledge. These results mean the level of knowledge is not bad, but it should be better. The researcher revealed that there is a slight deficit in the level of knowledge may be related to one of the following causes which include the lack of exposure to pre-employment orientation programs related to waste management, refresher conferences during employment are not enough, and absence of waste management instructions to be used as a guide for dentists, dental nurses or dental assistants.

One of the most important factors to take into consideration is the social responsibility of health-care staff and the participation of the population in the durability of any environmental conservation program. The most important way to generate public interest and participation in the aforementioned issues is to understand and identify the knowledge and awareness about the management of these medical wastes. So, the development of recycling programs nowadays is considered a cornerstone in most middle- to high-income

countries, with health workers being educated in the separation of waste products (Diaz-Soriano, A. et al., 2020).

According to the findings in table (4.7), these results are in line with the results of a study which was conducted in Bengaluru city which revealed that there is a good level of knowledge about BMW generation regulations, hazards, and management among health care workers in Bengaluru city. A high number of practitioners were aware of various types and color-coding of waste, but were not practicing the same in their clinics. Formal monitoring and training are strongly required at all levels, and there is a need for continuing dental education on dental waste management practices to these dental care providers (Lakshmikantha, R. et al., 2016).

It is important to measure the level of knowledge, being the primary yardstick that allows one to differentiate between the right and the wrong, is a mixture of comprehension, experience, perception and skill (Gawad M. A. Alwabr& Khalid A. S. Al-Salehi., 2020).

**Table (4.8-a): Practice of dental waste management (n= 90)**

| No. | Item   | Yes  | No  | Don't know | Mean  | SD    | Mean % |
|-----|--|------|-----|------------|-------|-------|--------|
| 1   | Do you use any personal protective equipment (gloves, mask, and lab coat) during waste disposal? | 92.2 | 6.7 | 1.1        | 2.911 | 0.323 | 97.0   |
| 2   | Is the infectious waste should be segregated from the main waste stream?                         | 91.1 | 4.4 | 4.4        | 2.866 | 0.454 | 95.5   |
| 3   | Are all the dental care practitioners in the clinic vaccinated against HBV?                      | 78.9 | 8.9 | 12.2       | 2.666 | 0.686 | 88.8   |

**Table (4.8-b): Practice of dental waste management (n= 90)**

| No.            | Item   | Yes  | No   | Don't know | Mean         | SD           | Mean %      |
|----------------|--|------|------|------------|--------------|--------------|-------------|
| 4              | Have you studied hazardous waste management methods in college or university?  | 60.0 | 38.9 | 1.1        | 2.588        | 0.517        | 86.3        |
| 5              | Do you feel the need to setup an organizing authority to provide guidelines and management of the proper disposal of dental radiographic waste?    | 77.8 | 12.2 | 10.0       | 2.677        | 0.650        | 89.2        |
| 6              | Do you use a sponge type Mercontainer to store the scrap amalgam   | 11.1 | 84.4 | 4.4        | 2.066        | 0.390        | 68.8        |
| 7              | Do you collect lead foil packets in a marked container?  | 21.1 | 57.8 | 21.1       | 2.000        | 0.653        | 66.6        |
| 8              | Is the waste management plan applied and compliance by dental care providers?  | 50.0 | 28.9 | 21.1       | 2.288        | 0.796        | 76.3        |
| 9              | Are dental materials properly stored in a protected area to prevent premature damage?  | 73.3 | 16.7 | 10.0       | 2.633        | 0.661        | 87.7        |
| 10             | Are dentists and nurses applying rules and regulations during dealing with safe treatment and disposal of hazardous dental waste?                  | 71.1 | 13.3 | 15.6       | 2.555        | 0.751        | 85.2        |
| 11             | Is transfer of the dental hazardous waste according to the governmental dental clinic protocol being done properly?                                | 61.1 | 16.7 | 22.2       | 2.388        | 0.830        | 79.6        |
| 12             | Is hazardous waste properly separated and conveniently stored off the ground in suitable containers that are clearly labeled and kept under cover? | 58.9 | 21.1 | 20.0       | 2.388        | 0.803        | 79.6        |
| 13             | Do you use a yellow biomedical waste bag to collect the blood-soaked wastes?   | 65.6 | 28.9 | 5.6        | 2.600        | 0.595        | 86.6        |
| 14             | Do you categories your waste into hazardous waste?   | 77.8 | 12.2 | 10.0       | 2.677        | 0.650        | 89.2        |
| 15             | Is the clinic wastewater discharged into municipal sewage pour?  | 67.8 | 3.3  | 28.9       | 2.388        | 0.908        | 79.6        |
| <b>Average</b> |  |      |      |            | <b>2.513</b> | <b>0.312</b> | <b>83.7</b> |



Table (4.8) presented the practice of hazardous dental waste management. The highest score was in using personal protective equipment (gloves, mask, and lab coat) during waste disposal with mean score 2.911 and mean percent 97%, followed by infectious waste segregated from the main waste stream with mean score 2.866 and mean percent 95.5%. The majority of dentists and nurses (88.8%) were vaccinated against HBV, which is a good indicator. The lowest score was in collecting lead foil packets in a marked container with mean score 2.000 and mean percent 66.6%.

The researcher recommended that time training and sensitization programs regarding BMW guidelines are warranted for dentists and nurses to bridge the gap.

The researcher recommended that time training and sensitization programs regarding BMW guidelines are warranted for dentists and nurses to bridge the gap.

Referring to item number (8) which is "Is the waste management plan applied and compliance by dental care providers?", nearly half of the participants agreed that there is compliance with the applied plan for dental waste management, and (28.9%) answered by no, while only (21.1%) they did not know. Knowledge is an important issue in the success of the hazardous dental waste management steps as shown by the following study, which revealed that the establishment of a comprehensive plan for dental waste management is mandatory to improve the awareness of the dental care providers on the hazardous waste issue. For this cause, it is important to educate the dentists, dental nurses, and dental assistants for improvement of their knowledge on dental waste management (Koolivand, A., Gholami-Borujeni, F., &Nourmoradi, H., 2015). So, these findings according to the researcher's point of view are not good and the conflict should be solved by increasing awareness for both dentists and nurses by establishing awareness programs related to the waste management plan.

Regarding item number (10) which is “Are dentists and nurses applying rules and regulations during dealing with safe treatment and disposal of hazardous dental waste?” the majority of respondents nearly (71.1%) showed their agreement, and only (13.3%) were disagree while (15.6%) did not know. The results of this study were inconsistent with those from the study of Akkajit, P., Romin, H., & Assawadithalerd, M. (2020), which showed that many respondents generally disposed medical waste into the community’s municipal solid waste bin located on a public road nearly (36%), while few (8.7%) did not know how to dispose of medical waste.

The results of the item number (11) which is “Is transfer of the dental hazardous waste according to the governmental dental clinic protocol being done properly? Showed that (61%) of participants agreed that the transfer of waste is being done properly, and (16.7%) were disagree. These findings are consistent with a study done in India, where only 75% of the participants were aware of biomedical waste BMW regulations applicable to dentists. All respondents agree that waste should be segregated into different categories but only 67% followed the rules. Only 68% clinic and hospital were having tie-up with waste management companies, and the rest 32% were disposing of all kind of waste into general garbage. Thirty-four percent of dentists had the opinion that any plastic bag can be used for waste disposal. In this survey, only 32% of dentists were using red bags to throw plastic such as gloves and rubber dam. In the survey, it was found that 67% of the participants were disposing the pharmaceuticals into regular waste (Sood, A. G., & Sood, A. (2011). Transportation of BMW in developed countries has been done according to international regulations, which is transported only by a licensed transporter (Patil, P. M., & Bohara, R. A., 2020).

From the researcher’s point of view, there is a misunderstanding of the ideal disposal ways for dental hazardous waste focused a need to improve the knowledge of dentists and nurses

in the GS and thus improve BWM to prevent harmful effects on the environment as well as on the human being.

More than half of the respondents answered the question number (12) which is "Is hazardous waste properly separated and conveniently stored off the ground in suitable containers that are clearly labeled and kept under cover?" by yes, and (21%) answered no, while (20%) their answer did not know. These results are in line with the results of a study conducted in Thailand by Akkajit, P., Romin, H., & Assawadithalerd, M. (2020), showed that the waste generated in the dental clinics were not properly handled and may cause the spread of biological agents that represents a risk for infection to the community and also the environment.

Regarding item number (14) which is "Do you categorize your waste into hazardous waste?" the answer by yes was (77.8%) of respondents, which is a good indicator in applying the ideal plan for categorization of dental hazardous waste as represented by the International Journal of Biological & Medical Research.

When the respondents were asked if they discharge the clinic wastewater into municipal sewage pour or not (item number 15), there were (67.8%) of them answered by yes, this result is in line with a study was conducted in Iran which showed that most of the dentists (75.2%) of dental office wastewaters were discharged directly into the municipal sewage system (Lakbala, P., 2020).

Overall, the mean score of total practice was 2.513 with mean percent 83.7%, which indicated that the study participants have above moderate practice of hazardous dental waste management.

**Table (4.9): Levels of practice about hazardous dental waste management(n= 90)**

| <b>Level of practice</b>  | <b>n</b> | <b>Percent</b> |
|---------------------------|----------|----------------|
| Low (33.3 – 55.27)        | 1        | 1.1            |
| Moderate (>55.27 – 77.58) | 16       | 17.8           |
| High (>77.58)             | 73       | 81.1           |
| Total                     | 90       | 100.0          |

Table (4.9) showed that 51 (56.7%) of study participants exhibited high level of practice of hazardous dental waste management, 31 (34.4%) exhibited above moderate practice, 7 (7.8%) exhibited moderate practice, while 1 (1.1%) of study participants exhibited low level of practice of hazardous dental waste management. These results interfere with the results of a study which was carried out in Yemen and showed that there was a low level of practice (52%) among participants (Alwabr, G. M., & Al-Salehi, K. A., 2020).

The results of our study are in line with the results of a study which was conducted in India which showed that practice score of BMW management was mostly satisfactory in doctors (90%), nursing staff (78%) and lab technician (68%) but overall assessment about practices related to BMW management suggested that they need good quality training periodically. Additionally, the practice score was poor in case of sanitary workers (62%) and reason for this could be that they are having poor knowledge and attitude (Gupta, V., Mohapatra, D., & Kumar, V. 2015). Similar results were seen in the study of Bhatt et al., (2013) which was conducted also in India, where more than two thirds of the doctors and nursing staff were having correct practices (Bhatt S., et al 2013). Another study results were inconsistent with our study, which was done recently in Himachal Pradesh hospitals showed that there is an inadequate transportation facilities, bad handling and storage practices and recycling without chemical disinfection (Thakur, V., & Sharma, S., 2020).

**Table (4.10): Participants' evaluation of hazardous dental waste management (n= 90)**

| <b>Evaluation</b> | <b>N</b> | <b>Percent</b> |
|-------------------|----------|----------------|
| Excellent         | 6        | 6.7            |
| Very good         | 40       | 44.4           |
| Good              | 19       | 21.1           |
| Acceptable        | 9        | 10.0           |
| Unacceptable      | 16       | 17.8           |

Table (4.10) showed that 40 (44.4%) of study participants evaluated hazardous dental waste management as very good, 19 (21.1%) evaluated it as good, 6 (6.7%) evaluated it as excellent, while 9 (10%) evaluated it as acceptable, and 16 (17.8%) evaluated it as unacceptable. These results are inconsistent with a study which was conducted in Nablus district in Palestine in 2010 by Al-Khatib, I. A., & et al. which revealed that there was an improper practice which was distinct from the source of waste production to the final disposal. Additionally, in another study there are nearly (32%) of participants are not satisfied with current dental waste management (Qeshta, R., 2016).

## 4.2 Inferential results

**Table (4.11): Differences in hazardous dental waste management related to gender (n= 90)**

| Variable                        | Gender | N  | Mean  | SD    | T      | P value |
|---------------------------------|--------|----|-------|-------|--------|---------|
| Infectious Waste Management     | Male   | 58 | 3.576 | 0.644 | -0.015 | 0.988   |
|                                 | Female | 32 | 3.578 | 0.530 |        |         |
| Non-infectious Waste Management | Male   | 58 | 3.020 | 0.781 | 0.729  | 0.468   |
|                                 | Female | 32 | 2.900 | 0.692 |        |         |
| Biomedical Waste Management     | Male   | 58 | 3.482 | 0.705 | -0.520 | 0.604   |
|                                 | Female | 32 | 3.562 | 0.679 |        |         |
| Total                           | Male   | 58 | 3.359 | 0.554 | 0.108  | 0.914   |
|                                 | Female | 32 | 3.346 | 0.532 |        |         |

Table (4.11) showed that there were statistically no significant differences between male and female participants in IWM ( $P= 0.988$ ), NIWM ( $P= 0.468$ ), BWM ( $P= 0.604$ ), and the total score of hazardous dental waste management ( $P= 0.914$ ).

These results are in line with a study which was conducted in Thailand which revealed that there is no significant difference between MWM & gender ( $P=0.342$ ) (Akkajit, P., Romin, H., & Assawadithalerd, M., 2020).

**Table (4.12): Differences in knowledge and practice of hazardous dental waste management related to gender(n= 90)**

| Variable  | Gender | N  | Mean  | SD    | T      | P value |
|-----------|--------|----|-------|-------|--------|---------|
| Knowledge | Male   | 58 | 2.579 | 0.306 | -0.289 | 0.773   |
|           | Female | 32 | 2.599 | 0.325 |        |         |
| Practice  | Male   | 58 | 2.514 | 0.316 | 0.065  | 0.984   |
|           | Female | 32 | 2.510 | 0.312 |        |         |

Table (4.12) showed that there were statistically no significant differences between male and female participants in knowledge ( $P= 0.773$ ), and practice of hazardous dental waste management ( $P= 0.984$ ).

These results are in line with the study of Qeshta R., (2016) which showed that there were no statistical significant differences between dental waste management according to gender in practice and knowledge ( $p=0.577$ ,  $p=0.060$  respectively). Furthermore, there is another study revealed the same results which was conducted by Puri, S. & et al. in Brazil (2019), revealed that there were no statistical significant differences between dental waste management and gender ( $p=0.511$ ). Also, gender was significantly not associated with knowledge of participants ( $P = 0.20$ ) as shown in a Nigerian study (Aluko, O., & et al., 2016).

**Table (4.13): Differences in hazardous dental waste management related to age(n= 90)**

| Age (years)                     |       | N  | Mean  | SD    | Df | F     | P value |
|---------------------------------|-------|----|-------|-------|----|-------|---------|
| Infectious Waste Management     | 26-35 | 17 | 3.313 | 0.611 | 2  | 2.245 | 0.112   |
|                                 | 36-45 | 32 | 3.687 | 0.707 | 87 |       |         |
|                                 | 46-56 | 41 | 3.599 | 0.482 | 89 |       |         |
|                                 | Total | 90 | 3.576 | 0.603 | 2  |       |         |
| Non-infectious Waste Management | 26-35 | 17 | 2.635 | 0.675 | 87 | 3.279 | 0.042 * |
|                                 | 36-45 | 32 | 2.921 | 0.743 | 89 |       |         |
|                                 | 46-56 | 41 | 3.163 | 0.742 | 2  |       |         |
|                                 | Total | 90 | 2.977 | 0.749 | 87 |       |         |
| Biomedical Waste Management     | 26-35 | 17 | 3.300 | 0.699 | 89 | 1.309 | 0.275   |
|                                 | 36-45 | 32 | 3.635 | 0.710 | 2  |       |         |
|                                 | 46-56 | 41 | 3.501 | 0.672 | 87 |       |         |
|                                 | Total | 90 | 3.511 | 0.693 | 89 |       |         |
| Total                           | 26-35 | 17 | 3.083 | 0.498 | 2  | 2.727 | 0.071   |
|                                 | 36-45 | 32 | 3.414 | 0.599 | 87 |       |         |
|                                 | 46-56 | 41 | 3.421 | 0.491 | 89 |       |         |
|                                 | Total | 90 | 3.355 | 0.543 | 2  |       |         |

\*Significant at 0.05

Table (4.13) showed that there were statistically no significant differences in IWM ( $P=0.112$ ), BWM ( $P=0.275$ ), and the total score of hazardous dental waste management ( $P=0.071$ ) related to age study participants, while there were statistically significant differences in NIWM ( $P=0.042$ ). Post hoc LSD test indicated that differences in NIWM were in favor of study participants aged 46 – 56 years.

There is a study conducted in Cameroon at Biyem-Assi district hospital showed that there is a significant difference between BWM and age ( $p=0.001$ ) the effect of age on biomedical waste management was noted. Healthcare workers with more than 10 years of professional experience had better knowledge of biomedical waste management. Post hoc LSD test indicated that differences in BWM were in favor of study participants aged 30 – 45 years (Woromogo, S. H., et al., 2020). These results could be explained by the fact that professional experience offers the healthcare personnel the opportunities to be confronted with new situations and to learn from them.

**Table (4.14): Differences in knowledge and practice of hazardous dental waste management related to age(n= 90)**

| Age (years) |       | N  | Mean  | SD    | Df | F     | P value |
|-------------|-------|----|-------|-------|----|-------|---------|
| Knowledge   | 26-35 | 17 | 2.392 | 0.359 | 87 | 6.215 | 0.003 * |
|             | 36-45 | 32 | 2.703 | 0.255 | 89 |       |         |
|             | 46-56 | 41 | 2.575 | 0.295 | 2  |       |         |
|             | Total | 90 | 2.586 | 0.311 | 87 |       |         |
| Practice    | 26-35 | 17 | 2.423 | 0.283 | 89 | 0.877 | 0.420   |
|             | 36-45 | 32 | 2.541 | 0.355 | 2  |       |         |
|             | 46-56 | 41 | 2.528 | 0.288 | 87 |       |         |
|             | Total | 90 | 2.513 | 0.312 | 89 |       |         |

\*Significant at 0.05

Table (4.14) showed that there were statistically no significant differences in practice ( $P=0.420$ ), while there were statistically significant differences in knowledge about hazardous dental waste management related to age of study participants ( $P=0.042$ ). Post hoc LSD test



indicated that participants aged 26 – 35 years had significant lower knowledge compared to older participants.

Poor knowledge and improper handling of MWM present a tremendous risk to the health of the patients, health care workers specially nurses as well as to the public besides contributing to the serious health effects on the environment as well (Abou Hashish, E. A., Mari, S. H., & AlSulami, H. Z., 2020).

**Table (4.15): Differences in hazardous dental waste management related to governorate(n= 90)**

| Governorate                     |            | N  | Mean  | SD    | Df | F     | P value |
|---------------------------------|------------|----|-------|-------|----|-------|---------|
| Infectious Waste Management     | North      | 16 | 3.322 | 0.839 | 4  | 1.008 | 0.408   |
|                                 | Gaza       | 35 | 3.616 | 0.552 | 85 |       |         |
|                                 | Mid-zone   | 13 | 3.544 | 0.329 | 89 |       |         |
|                                 | Khanyounis | 21 | 3.698 | 0.626 |    |       |         |
|                                 | Rafah      | 5  | 3.683 | 0.450 |    |       |         |
|                                 | Total      | 90 | 3.576 | 0.603 |    |       |         |
| Non-infectious Waste Management | North      | 16 | 2.675 | 0.653 | 4  | 2.303 | 0.065   |
|                                 | Gaza       | 35 | 2.937 | 0.781 | 85 |       |         |
|                                 | Mid-zone   | 13 | 3.238 | 0.579 | 89 |       |         |
|                                 | Khanyounis | 21 | 2.947 | 0.785 |    |       |         |
|                                 | Rafah      | 5  | 3.680 | 0.637 |    |       |         |
|                                 | Total      | 90 | 2.977 | 0.749 |    |       |         |
| Biomedical Waste Management     | North      | 16 | 3.055 | 0.657 | 4  | 2.767 | 0.032 * |
|                                 | Gaza       | 35 | 3.568 | 0.714 | 85 |       |         |
|                                 | Mid-zone   | 13 | 3.683 | 0.484 | 89 |       |         |
|                                 | Khanyounis | 21 | 3.545 | 0.707 |    |       |         |
|                                 | Rafah      | 5  | 3.977 | 0.552 |    |       |         |
|                                 | Total      | 90 | 3.511 | 0.693 |    |       |         |
| Total                           | North      | 16 | 3.017 | 0.525 | 4  | 2.743 | 0.034 * |
|                                 | Gaza       | 35 | 3.374 | 0.569 | 85 |       |         |
|                                 | Mid-zone   | 13 | 3.489 | 0.370 | 89 |       |         |
|                                 | Khanyounis | 21 | 3.397 | 0.552 |    |       |         |
|                                 | Rafah      | 5  | 3.780 | 0.310 |    |       |         |
|                                 | Total      | 90 | 3.355 | 0.543 |    |       |         |

\*Significant at 0.05

Table (4.15) showed that there were statistically no significant differences in IWM ( $P=0.408$ ) and NIWM ( $P=0.065$ ) between governorates, while there were statistically significant differences in BWM ( $P=0.032$ ) and the total score of hazardous dental waste management ( $P=0.034$ ). Post hoc LSD indicated that participants from the north had significant lower awareness about BWM and overall dental waste management compared to study participants from other governorates.

**Table (4.16): Differences in knowledge and practice of hazardous dental waste management related to governorate(n= 90)**

| Governorate |            | N  | Mean  | SD    | Df | F     | P value |
|-------------|------------|----|-------|-------|----|-------|---------|
| Knowledge   | North      | 16 | 2.505 | 0.351 | 4  | 1.522 | 0.203   |
|             | Gaza       | 35 | 2.609 | 0.305 | 85 |       |         |
|             | Mid-zone   | 13 | 2.698 | 0.175 | 89 |       |         |
|             | Khanyounis | 21 | 2.500 | 0.348 |    |       |         |
|             | Rafah      | 5  | 2.750 | 0.256 |    |       |         |
|             | Total      | 90 | 2.586 | 0.311 |    |       |         |
| Practice    | North      | 16 | 2.487 | 0.240 | 4  | 2.732 | 0.034 * |
|             | Gaza       | 35 | 2.527 | 0.324 | 85 |       |         |
|             | Mid-zone   | 13 | 2.671 | 0.195 | 89 |       |         |
|             | Khanyounis | 21 | 2.365 | 0.355 |    |       |         |
|             | Rafah      | 5  | 2.706 | 0.264 |    |       |         |
|             | Total      | 90 | 2.513 | 0.312 |    |       |         |

\*Significant at 0.05

Table (4.16) showed that there were statistically no significant differences in knowledge about hazardous dental waste management between governorates ( $P=0.203$ ). This result interferes with the result of Qeshta R., study which was conducted in the GS (2016) which revealed that there were statistical significance differences between dental staff ( $p=0.000$ )

due to location, these differences were toward staffs whose clinic in the middle area. While there were statistically significant differences in practice ( $P= 0.034$ ). Post hoc LSD indicated that study participants from Khanyounis had significant lower practice compared to Mid-zone and Rafah, this result is consistent with the result of Qeshta R., study which was conducted in the GS (2016) which revealed that there were statistical significance differences between dental staff ( $p=0.009$ ) due to location, these differences were toward staffs whose clinic in Rafah. While there were no significant differences in practice compared to participants from Gaza and the North governorate.

**Table (4.17): Differences in hazardous dental waste management related to specialty(n= 90) comment**

| Variable                        | Specialty       | N  | Mean  | SD    | t      | P value |
|---------------------------------|-----------------|----|-------|-------|--------|---------|
| Infectious Waste Management     | Dentist         | 76 | 3.591 | 0.573 | 0.517  | 0.607   |
|                                 | Nurse/assistant | 14 | 3.500 | 0.765 |        |         |
| Non-infectious Waste Management | Dentist         | 76 | 3.015 | 0.773 | 1.122  | 0.265   |
|                                 | Nurse/assistant | 14 | 2.771 | 0.584 |        |         |
| Biomedical Waste Management     | Dentist         | 76 | 3.497 | 0.699 | -0.445 | 0.657   |
|                                 | Nurse/assistant | 14 | 3.587 | 0.684 |        |         |
| Total                           | Dentist         | 76 | 3.368 | 0.542 | 0.515  | 0.608   |
|                                 | Nurse/assistant | 14 | 3.286 | 0.564 |        |         |

Table (4.17) showed that there were statistically no significant differences in IWM ( $P= 0.607$ ), NIWM ( $P= 0.265$ ), BWM ( $P= 0.657$ ), and the total score of hazardous dental waste management ( $P= 0.608$ ) related to specialty.

**Table (4.18): Differences in knowledge and practice of hazardous dental waste management related to specialty(n= 90)**

| Variable  | Specialty       | N  | Mean  | SD    | t      | P value |
|-----------|-----------------|----|-------|-------|--------|---------|
| Knowledge | Dentist         | 76 | 2.582 | 0.302 | -0.273 | 0.785   |
|           | Nurse/assistant | 14 | 2.607 | 0.371 |        |         |
| Practice  | Dentist         | 76 | 2.493 | 0.316 | -1.446 | 0.152   |
|           | Nurse/assistant | 14 | 2.623 | 0.276 |        |         |

Table (4.18) showed that there were statistically no significant differences in knowledge ( $P= 0.785$ ), and practice of hazardous dental waste management ( $P= 0.152$ ) related to specialty. These findings are similar to the study of Qeshta R., (2016) which showed that there were no statistical significant differences between dental waste management according to specialty in knowledge and practice ( $p=0.002, 0.375$  respectively).

**Table (4.19): Differences in hazardous dental waste management related to qualification(n= 90)**

| Qualification                   |                           | N  | Mean  | SD    | Df | F     | P value |
|---------------------------------|---------------------------|----|-------|-------|----|-------|---------|
| Infectious Waste Management     | BS dentist                | 76 | 3.591 | 0.573 | 2  | 0.712 | 0.494   |
|                                 | BS nurse                  | 5  | 3.266 | 0.936 | 87 |       |         |
|                                 | Diploma dentist assistant | 9  | 3.629 | 0.678 | 89 |       |         |
|                                 | Total                     | 90 | 3.576 | 0.603 |    |       |         |
| Non-infectious Waste Management | BS dentist                | 76 | 3.015 | 0.773 | 2  | 1.067 | 0.349   |
|                                 | BS nurse                  | 5  | 2.520 | 0.630 | 87 |       |         |
|                                 | Diploma dentist assistant | 9  | 2.911 | 0.544 | 89 |       |         |
|                                 | Total                     | 90 | 2.977 | 0.749 |    |       |         |
| Biomedical Waste Management     | BS dentist                | 76 | 3.497 | 0.699 | 2  | 1.797 | 0.172   |
|                                 | BS nurse                  | 5  | 3.133 | 0.552 | 87 |       |         |
|                                 | Diploma dentist assistant | 9  | 3.839 | 0.638 | 89 |       |         |
|                                 | Total                     | 90 | 3.511 | 0.693 |    |       |         |
| Total                           | BS dentist                | 76 | 3.368 | 0.542 | 2  | 1.436 | 0.244   |
|                                 | BS nurse                  | 5  | 2.973 | 0.558 | 87 |       |         |
|                                 | Diploma dentist assistant | 9  | 3.460 | 0.515 | 89 |       |         |
|                                 | Total                     | 90 | 3.355 | 0.543 |    |       |         |

Table (4.19) showed that there were statistically no significant differences in IWM ( $P=0.494$ ), NIWM ( $P=0.349$ ), BWM ( $P=0.172$ ), and the total score of hazardous dental waste management ( $P=0.244$ ) related to qualification.

It is mandatory to teach dental students the ideal methods for medical waste management and waste management courses should be a basic part of the academic curricula for the dental students (Lakshmikantha, R. & et al., 2016).

**Table (4.20): Differences in knowledge and practice of hazardous dental waste management related to qualification(n= 90)**

| Qualification |                           | N  | Mean  | SD    | Df | F     | P value |
|---------------|---------------------------|----|-------|-------|----|-------|---------|
| Knowledge     | BS dentist                | 76 | 2.582 | 0.302 | 2  | 1.505 | 0.288   |
|               | BS nurse                  | 5  | 2.416 | 0.428 | 87 |       |         |
|               | Diploma dentist assistant | 9  | 2.713 | 0.312 | 89 |       |         |
|               | Total                     | 90 | 2.586 | 0.311 |    |       |         |
| Practice      | BS dentist                | 76 | 2.493 | 0.316 | 2  | 3.170 | 0.047 * |
|               | BS nurse                  | 5  | 2.400 | 0.298 | 87 |       |         |
|               | Diploma dentist assistant | 9  | 2.748 | 0.175 | 89 |       |         |
|               | Total                     | 90 | 2.513 | 0.312 |    |       |         |

\*Significant at 0.05

Table (4.20) showed that there were statistically no significant differences in knowledge about hazardous dental waste management ( $P=0.288$ ), while there were statistically significant differences in practice ( $P=0.047$ ) related to qualification. Post hoc LSD test

indicated that diploma dentist assistant showed significant better practice compared to BS dentists and BS nurses.

In developing countries like Palestine, HCW has not given enough attention, and the levels of knowledge among healthcare personnel of hazards and possible risks of healthcare waste are much lower (Hosny, G., Samir, S., & El-Sharkawy, R., 2018).

**Table (4.21): Differences in hazardous dental waste management related to years of experience(n= 90)**

| Years of experience             |       | N  | Mean  | SD    | Df | F     | P value |
|---------------------------------|-------|----|-------|-------|----|-------|---------|
| Infectious Waste Management     | 1-9   | 21 | 3.353 | 0.562 | 2  | 3.970 | 0.022 * |
|                                 | 10-19 | 39 | 3.767 | 0.539 | 87 |       |         |
|                                 | 20-30 | 30 | 3.486 | 0.650 | 89 |       |         |
|                                 | Total | 90 | 3.576 | 0.603 |    |       |         |
| Non-infectious Waste Management | 1-9   | 21 | 2.666 | 0.648 | 2  | 2.468 | 0.091   |
|                                 | 10-19 | 39 | 3.092 | 0.585 | 87 |       |         |
|                                 | 20-30 | 30 | 3.046 | 0.945 | 89 |       |         |
|                                 | Total | 90 | 2.977 | 0.749 |    |       |         |
| Biomedical Waste Management     | 1-9   | 21 | 3.412 | 0.737 | 2  | 1.326 | 0.271   |
|                                 | 10-19 | 39 | 3.646 | 0.599 | 87 |       |         |
|                                 | 20-30 | 30 | 3.403 | 0.766 | 89 |       |         |
|                                 | Total | 90 | 3.511 | 0.693 |    |       |         |
| Total                           | 1-9   | 21 | 3.144 | 0.495 | 2  | 3.256 | 0.043 * |
|                                 | 10-19 | 39 | 3.502 | 0.394 | 87 |       |         |
|                                 | 20-30 | 30 | 3.312 | 0.686 | 89 |       |         |
|                                 | Total | 90 | 3.355 | 0.543 |    |       |         |

\*Significant at 0.05

Table (4.21) showed that there were statistically no significant differences in NIWM ( $P=0.091$ ), and BWM related to years of experience ( $P=0.271$ ), while there were statistically significant differences in IWM ( $P=0.022$ ) and the total score of hazardous dental waste management ( $P=0.043$ ) related to years of experience. Post hoc LSD test indicated that participants with 1 – 9 years of experience showed significant lower awareness about hazardous dental waste management compared to participants with more years of experience. There is a difference between these results and the results of a study conducted by Al-Qorom S., (2014) which showed that as the dentist gets older, he became careless about professional health issues. And it revealed that there is statistically significant differences between the presence of a system for recycling amalgam in the clinic and the years of experience ( $p=0.001$ ).

**Table (4.22): Differences in knowledge and practice of hazardous dental waste management related to years of experience (n= 90)**

| Years of experience |       | N  | Mean  | SD    | Df | F     | P value |
|---------------------|-------|----|-------|-------|----|-------|---------|
| Knowledge           | 1-9   | 21 | 2.400 | 0.306 | 2  | 7.312 | 0.001 * |
|                     | 10-19 | 39 | 2.700 | 0.273 | 87 |       |         |
|                     | 20-30 | 30 | 2.566 | 0.304 | 89 |       |         |
|                     | Total | 90 | 2.586 | 0.311 |    |       |         |
| Practice            | 1-9   | 21 | 2.438 | 0.254 | 2  | 5.008 | 0.009 * |
|                     | 10-19 | 39 | 2.627 | 0.300 | 87 |       |         |
|                     | 20-30 | 30 | 2.417 | 0.326 | 89 |       |         |
|                     | Total | 90 | 2.513 | 0.312 |    |       |         |

\*Significant at 0.05

Table (4.22) showed that there were statistically significant differences in knowledge ( $P=0.001$ ) and practice of hazardous dental waste management ( $P=0.009$ ). Post hoc LSD test

indicated that participants with 1 – 9 years of experience showed significant lower knowledge about hazardous dental wastes compared to participants with more years of experience. In addition, participants with 10 – 19 years of experience showed significant better practice of hazardous dental waste management compared to participants with 1 – 9 years of experience and participants with 20 – 30 years of experience. This means that there is a proportional relationship between knowledge and hazardous dental waste management. With the increase of the number of years of experience, there is an increase in the level of knowledge of hazardous dental waste management.

**Table (4.23): The needed equipment for hazardous dental waste management**

| <b>Equipment</b>   | <b>n</b> | <b>Percent</b> |
|--|----------|----------------|
| Safety box   | 15       | 16.7           |
| Special company for waste treatment + transportation containers      | 6        | 6.7            |
| Transportation containers + special company for waste disposal       | 4        | 4.4            |
| Colored bags + safety box + transportation containers                | 4        | 4.4            |
| Colored bags + storage room + safety box + transportation containers | 4        | 4.4            |
| Colored bags + storage room + safety box + treatment methods         | 4        | 4.4            |
| Colored bags + special saver for chemicals + safety box              | 3        | 3.3            |
| Transportation container   | 3        | 3.3            |
| Special company for waste disposal                                   | 3        | 3.3            |
| Others   | 44       | 49.1           |

Table (4.23) showed that 15 (16.7%) of study participants said that safety box was the most common equipment needed for hazardous dental waste management, followed by 6 (6.7%) who stated that they need a special company for waste treatment and transportation containers. These findings are somewhat different from a study which was conducted in



GS by Qeshta.R., (2016) which showed that nearly two-thirds of the participants used safety box for disposal and only one-third of them used black bags.

Moreover, Pazokian and Borhani (2017) advocated for improving facilities and equipment and providing sufficient and efficient personnel are needed to achieve a significant level of effectiveness in clinical services.

**Table (4.24): Availability of personal protective equipment**

| <b>Item</b> | <b>Regularly<br/>(%)</b> | <b>Sometimes<br/>(%)</b> | <b>Never<br/>(%)</b> |
|-------------|--------------------------|--------------------------|----------------------|
| Face mask   | 91.1                     | 8.9                      | 0                    |
| Gloves      | 87.8                     | 8.9                      | 3.3                  |
| Gown        | 60.0                     | 30.0                     | 10.0                 |
| Cap         | 35.6                     | 37.8                     | 26.7                 |
| Boots       | 25.6                     | 35.6                     | 38.9                 |
| Goggles     | 37.8                     | 43.3                     | 18.9                 |
| Apron       | 42.2                     | 36.7                     | 21.1                 |

Table (4.24) showed that 91.1% of study participants stated that face masks are available regularly, 42.2% stated that apron is available regularly, 37.8% said that goggles are available regularly, 60% mentioned that gowns are available regularly, 25.6% reported that boots are available regularly, 35.6% said that caps are available regularly, and 87.8% reported that gloves are available regularly. These results are inconsistent with a study which was conducted in Pakistan which showed that there is a reuse of PPE mainly due to adearth of PPE and lack of training. There is sharing of gowns between healthcare personnel in the health facilities for many times (Chughtai, A. A., & Khan, W., 2020).

In our study regarding the table number (4.24), most of the respondents revealed that the availability of PPE in the governmental dental clinics in the GS is the least challenge they are facing during disposal of the hazardous dental wastes especially when there is an emergency situation due to spread of the COVID-19 pandemic.

All the healthcare systems around the world were facing challenges in obtaining the PPE for their healthcare workers during the spread of the COVID-19 pandemic, therefore the American Medical Association (AMA) and the World Health Organization (WHO) called on medical warehouses and factories to increase the number of PPE components manufacturing by 40% to meet the ascending global demands (Bhargava, S. et al., 2021).

**Table (4.25): Ranking of challenges that face dentists and nurses during disposal of the hazardous dental wastes**

| Challenge   | Mean score |
|---|------------|
| Shortage of the plastic bags needed for dental waste management.  | 5.00       |
| Shortage of the colored bins in the clinic.   | 4.51       |
| Shortage of sterilization solutions.  | 4.45       |
| Dental research is a challenge due to the lack of the financial resources needed to improve waste management. | 4.18       |
| Defective equipment maintenance in the clinic.  | 4.01       |
| Shortage of the number of the staff (dentists and nurses) in the clinic.                                      | 3.83       |
| Improper infection control practices in the clinic.   | 3.70       |
| Insufficient personal protective equipment such as gloves, masks and safety glasses.                          | 3.68       |

Table (4.25) presented the challenges that face the study participants during the disposal of hazardous dental wastes. The highest challenge was a shortage of the plastic bags needed for dental waste management (m= 5.000), followed by a shortage of the colored bins in the clinic (m= 4.511), and a shortage of sterilization solutions (m= 4.455). This interferes with

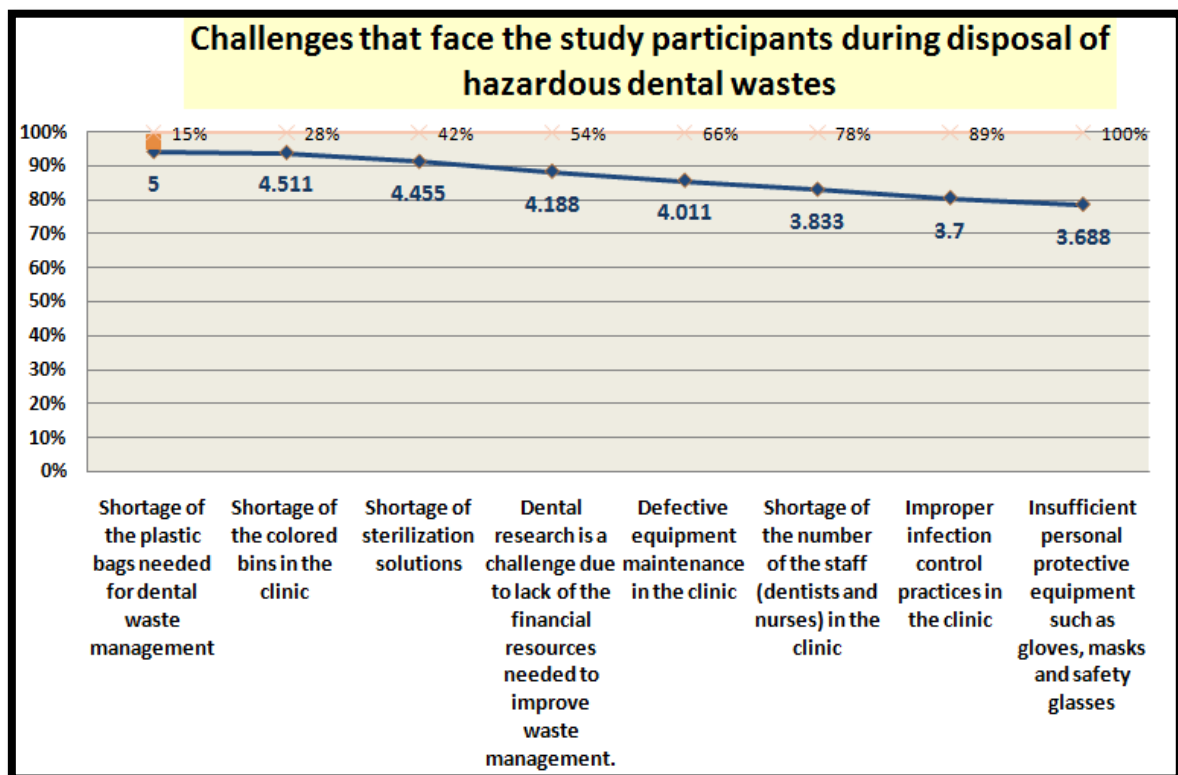
a study conducted in Egypt which revealed that all wastes generated from the different departments were collected twice daily in a quarter and thrice daily in only one of the selected hospitals. A two-wheeled trolley with a lid for transporting sealed waste bags into central storage rooms was used in only three of the surveyed hospitals and also be used for the temporary storage of sealed waste bags within or near to the medical areas in only one of them. Additionally, another one of these hospitals used fixed, large, and covered plastic containers for the temporary storage of waste to avoid filled waste bags being piled on the floor where they could be knocked and split open (Abd El-Salam, M. M., 2010).

Regarding the fourth challenge in the table (4.24) which is “dental research is a challenge due to lack of the financial resources needed to improve waste management”, the mean score is (4.188). This result is consistent with a study conducted in the Eastern Cape which showed that there is a dearth of literature and research conducted on MWM particularly in the social sciences. The issue of healthcare waste management is inadequately studied, a factor common in most developing countries. Research is required to establish a database, information, and statistics on medical waste generation, collection, storage, transportation, treatment, and disposal. This will form the basis of the planning and design of a MWM plan. Research on MWM informs policymakers on waste management issues (Maseko, Q., 2014).

On the other hand, the lowest challenges were improper infection control practices in the clinic ( $m = 3.700$ ) and insufficient personal protective equipment such as gloves, masks, and safety glasses ( $m = 3.688$ ). These results mean that there is compliance with the proper infection control practices among dentists and nurses, and these findings are in line with a study conducted in Jordan which showed that Jordanian dentists were aware of COVID-19 symptoms, mode of transmission, and infection controls and measures in dental clinics. However, dentists had limited comprehension of the extra precautionary measures that

protect the dental staff and other patients from COVID-19. National and international guidelines should be sent by the regional and national dental associations to all registered dentists during a crisis, including the COVID-19 pandemic, to make sure that dentists are well informed and aware of best practices and recommended disease management approaches (Khader, Y. et al., 2020).

This is a good indicator for the availability of PPE in the governmental dental clinics in the GS because the majority of the respondents revealed that it is the least challenge they are facing during disposal of the hazardous dental wastes especially when there is an emergency situation due to spread of the COVID-19 pandemic.



**Figure (4.3): Pareto chart to know the vital few**

Pareto Principle (also known as the 80/20 rule) is used to know the few causes (20%) which produce most of the problems (80%).

According to figure (4.3), the highest percentages of challenges are shortage of plastic bags needed for dental waste management, followed by shortage of colored bins in the clinic and the most third challenge is the shortage of the sterilization solutions, which lead to 80 percent of the problems related to hazardous dental waste management in the GS.

Challenges faced in both waste collection and disposal in health institutions in Nakawa division Waste management in Health institutions in developing country Uganda in particular cannot be discussed with precision because of factors that can undermine it. During the research, there was an attempt to examine factors that could the process of waste collection and disposal in Health institutions; Limited financial resources have been put as one of the major challenges in waste collection and disposal. Methods like recycling of waste like gloves need machines to operate the function which is limited in Health institutions that function at a tight budget and loans. This has made it difficult for Health care institutions to practice appropriate waste collection and disposal. 32 Lack of appropriate technology has been a big obstacle in waste management in Health institutions. Many of the institutions still use rudimentary methods like open burning which is not environmentally friendly, very few health institutions has the capacity to acquire the required technology to use incineration method to dispose of waste materials. This has often encouraged institutions to practice the most available methods like disposal into water and sewerage. This is a great setback in terms of environmental protection and lack of uniform laws governing waste collection and disposal. A great deal of agreement has been put by all the health institutions that there is no clear uniform law in Uganda targeting waste management. The one that exists like Water Waste management Act, Environment management Act and Health Care Act are far faced and not clear. This makes Health care practitioners take advantage and provide waste collection and disposal strategies that are not friendly to both environment and human habitat. Many of these Hospitals operate

within town centers where land is limited. Life Link Ntinda operates within a 45\*60 feet land which is all covered with building and outside the building contains private settlement of other people. This limits them from practicing proper waste collection or disposal like landfill method of waste disposal. Lack of enough protective gear like gloves during the collection of waste materials. Broken glasses have often injured staff during the process of collecting the used materials. In some cases, workers are not provided with safety boots and goggles to protect them from broken materials which have often been a source of occupation hazard to many workers (Twesige, I., 2017).

From the researcher's point of view, I recommended that to achieve the best management of hazardous dental waste, the waste reduction must be carried out using less hazardous and toxic materials with a smaller amount of packaging. For instance, the installation of amalgam traps and the application of small size capsules can minimize amalgam waste. Waste reuse can be achieved using reusable materials and equipment instead of disposable ones. On the other hand, the first priority in dental offices is the health and safety of the patients. Therefore, it is very important that using reusable material would not threaten patients' health.

## **Chapter 5**

### **Conclusion and recommendations:**

#### **5.1 Conclusion**

This study aimed to assess the status of dental waste management at governmental dental clinics in GS. The results indicated that management of infectious wastes was above moderate, management of non-infectious wastes was moderate, management of biomedical wastes was above moderate, and the overall management of dental wastes was at moderate level.

The findings reflected statistically insignificant differences in the overall management of hazardous dental wastes related to gender, age, governorate, specialty, qualification, and experience.

In addition, there were insignificant differences in knowledge and practice of hazardous dental waste management related to gender, and specialty. Significant differences in knowledge about hazardous waste management existed in relation to age, and experience.

The results also showed that 16.7% of study participants said that safety box was the most common equipment needed for hazardous dental waste management, followed by 6.7% who stated that they need a special company for waste treatment and transportation containers. Finally, the study revealed that the highest challenge was a shortage of the plastic bags needed for dental waste management (Mean= 5.00), followed by shortage of the colored bins in the clinic (Mean= 4.51), and shortage of sterilization solutions (Mean= 4.45).

## **5.2 Recommendations**

In the light of the results, the researcher recommends the following:

### **For decision-makers:**

- Development of clear plans and policies for safe management and disposal of dental wastes.
- Provide adequate supply of safety and personal protection equipment for all the healthcare providers at dental clinics.
- Enforcing rules and regulations to all the governmental dental clinics.
- Establishment of collective teamwork with committed government support in terms of finance and infrastructure development.

### **For dentists and nurses:**

- Education and training programs about the appropriate ways of disposing hazardous dental wastes.
- Continuing education and short courses on cross-infection and biomedical waste management are suitable means of improving the knowledge of dentists and other staff employed in various dental clinics to increase their level of understanding and associated risks.
- Training aspects of health-care waste management should be strengthened.
- Periodic evaluation and assessment should become routine to enforce adherence to waste management.

## **5.3 Suggestions for further research**

- To carry out a study to examine the status of dental waste management at UNRWA health centers and at private sector.
- To conduct a study to explore the potential threats of hazardous dental wastes to public health.



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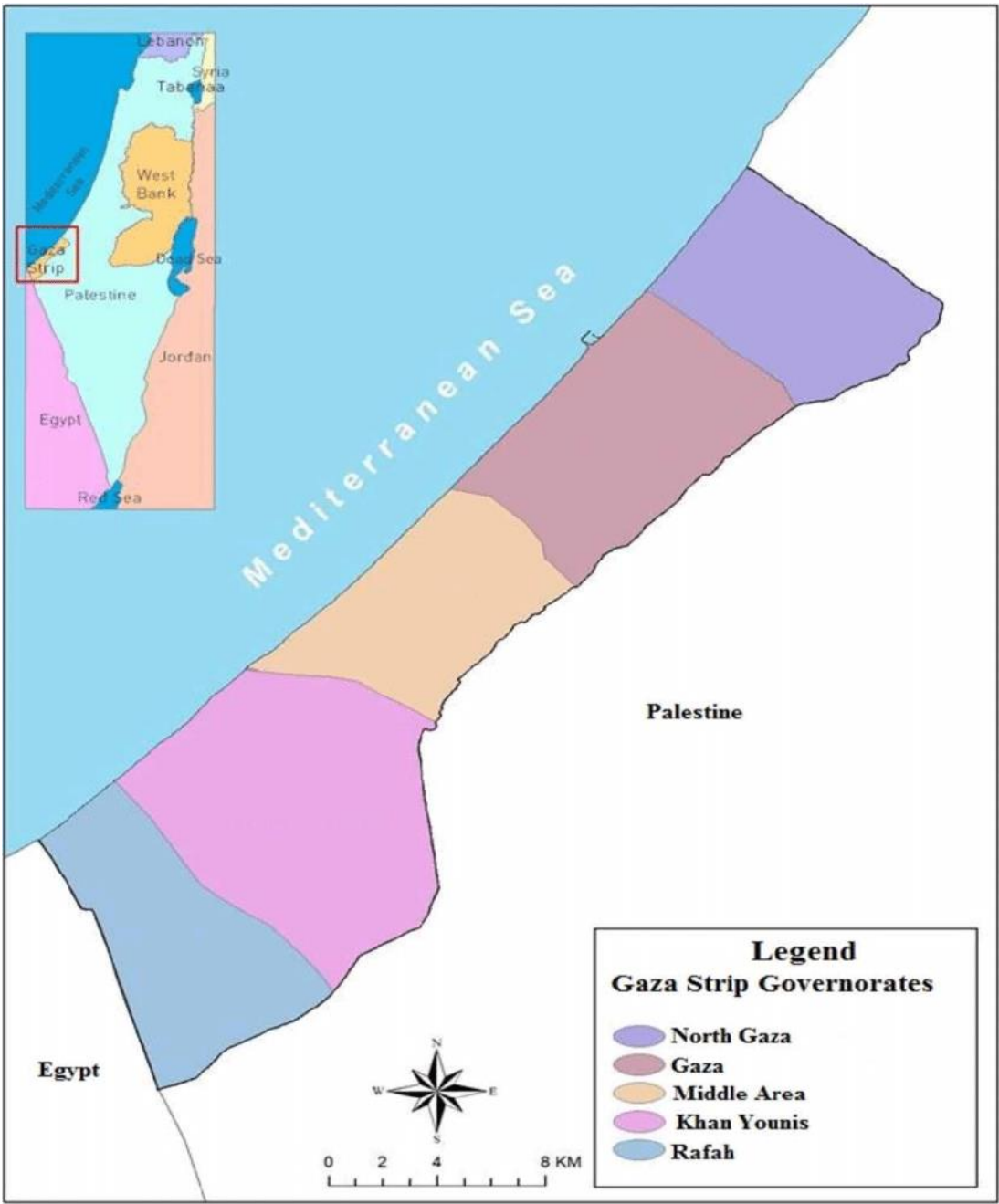
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Annexes

Annex (1) Gaza Governorates distribution map



(Abuzerr, S. 2019)

## **Annex (2): The study instrument (Questionnaire)**

|                      |  |
|----------------------|--|
| <b>Serial number</b> |  |
| <b>Date</b>          |  |

### **Dear Participant:**

My name is Roba Atef Alagha and I am a post-graduate student at Al-Quds University. For my final project, I am examining the dental hazardous waste management at the governmental dental clinics in the Gaza Strip. As a dental health care provider, I am inviting you to participate in this research study by completing the attached questionnaire.

The following questionnaire will require approximately 15 minutes to be completed. There is no compensation for responding or risk. In order to ensure that all information will remain confidential, please do not include your name. Copies of the project will be provided to my Al-Quds University instructor and to the director of the public health master program. If you choose to participate in this project, please answer all questions as honestly as possible. Participation is voluntary and you may refuse to participate at any time.

*Thank you for taking the time to assist me in my educational endeavors.*

**Sincerely,  
RobaAtefAlagha  
Mobile phone / 0599920004**

**Demographic characteristics:**

Name of clinic: \_\_\_\_\_

**Age:** \_\_\_\_\_ year

**Gender:**

☐ Male

☐ Female

**Location- governorate:**

☐ North Gaza

☐ Gaza

☐ Mid- zone

☐ Khan Yunis

☐ Rafah

**Graduation country and name of University:**

\_\_\_\_\_

**Specialization/ Profession:**

☐ Dentist

☐ Dental assistant

☐ Nurse

☐ Other / \_\_\_\_\_

**Qualification:**

☐ Bachelor degree in Dentistry

☐ Bachelor degree in Nursing

☐ Diploma degree in Dental assisting

☐ Diploma degree in Nursing

☐ Other/ \_\_\_\_\_

Total years of experience in the governmental clinic: \_\_\_\_\_ years.

**Domain 1: Infectious waste management:**

| No. | Item  | Never | Rare | Sometimes | Often | Always |
|-----|---|-------|------|-----------|-------|--------|
| 1   | You wear personnel protective equipment PPE (gloves, face shields, goggles and facemasks) when handling the infectious dental wastes. |       |      |           |       |        |
| 2   | Your clinic produces pathological wastes as body parts (tissue or surgical specimen).   |       |      |           |       |        |
| 3   | You dispose the extracted teeth in the regular dustbin.   |       |      |           |       |        |
| 4   | You collect amalgam scraps and hand them over to waste management service for recycling purpose.                                      |       |      |           |       |        |
| 5   | You dispose excess amalgam restoration in the regular dustbin.  |       |      |           |       |        |
| 6   | During removal of old amalgam restoration, you use a copious amount of coolant.   |       |      |           |       |        |
| 7   | You throw the non-contact amalgam in a separate bottle.   |       |      |           |       |        |
| 8   | Color coded bags are used to segregate the waste.   |       |      |           |       |        |
| 9   | Infectious waste management is done according to the rules and regulations in the clinic.   |       |      |           |       |        |
| 10  | Collection of the infectious dental waste is done daily.  |       |      |           |       |        |
| 11  | The bags or containers are replaced immediately with new ones at the same time.   |       |      |           |       |        |
| 12  | The infectious dental waste is usually stored in a separate area appropriate to the quantities of wastes.                             |       |      |           |       |        |

**Domain 2: Non- infectious waste management:**

| No. | Item  | Never | Rare | Sometimes | Often | Always |
|-----|---|-------|------|-----------|-------|--------|
| 1   | The x-ray machine in the clinic is used for diagnostic purposes.  |       |      |           |       |        |
| 2   | You collect the lead foils of the used x-ray films separately and dispose to local waste collection body. |       |      |           |       |        |
| 3   | Liquid hazardous waste as processing developer discharge is settled to the sanitary sewer.                |       |      |           |       |        |
| 4   | Sterilization solutions and the disinfectants waste are disposed in the waste water.                      |       |      |           |       |        |
| 5   | Preparing for replacement of conventional radiograph with digital x-ray system is present.                |       |      |           |       |        |
| 6   | Plastic bags or containers are usually filled to three quarters of its size.                              |       |      |           |       |        |
| 7   | The containers of the non- infectious wastes are labeled properly.  |       |      |           |       |        |
| 8   | Sodium hypochlorite is being used for sterilization in your clinic.                                       |       |      |           |       |        |
| 9   | The used fixer solution hand is disposed to recycling companies.  |       |      |           |       |        |
| 10  | The disposed developer solution hand is sent to recycling companies.                                      |       |      |           |       |        |



**Domain 3: Biomedical waste management:**

| No. | Item  | Never | Rare | Sometimes | Often | Always |
|-----|---|-------|------|-----------|-------|--------|
| 1   | Biomedical dental wastes are being disposed in yellow containers.                             |       |      |           |       |        |
| 2   | You use puncture proof containers for the disposal of used sharps as needles and blades.      |       |      |           |       |        |
| 3   | Scalpels are disposed in the regular garbage.   |       |      |           |       |        |
| 4   | Disposal of used glass carpules is mainly in the puncture proof containers.                   |       |      |           |       |        |
| 5   | The current methods of biomedical dental waste management in your department are appropriate. |       |      |           |       |        |
| 6   | Separation for the dental biomedical wastes from other wastes is performed before disposal.   |       |      |           |       |        |
| 7   | The containers of the biomedical wastes are labeled properly.                                 |       |      |           |       |        |
| 8   | Needle stick injury during biomedical waste management is an extra burden on work.            |       |      |           |       |        |
| 9   | Containment of sharps does not help in safe management of the clinic waste.                   |       |      |           |       |        |

#### Domain 4: Knowledge of the dental health care providers:

| No. | Item  | Yes | No | Don't know |
|-----|---|-----|----|------------|
| 1   | Is the dental waste hazardous to the human health?  |     |    |            |
| 2   | Is the dental waste hazardous to the environment?   |     |    |            |
| 3   | Should a color- coded container be available for different type of dental waste inside the clinic?  |     |    |            |
| 4   | Should waste management responsibility be included in the job description of all dental care providers?   |     |    |            |
| 5   | Have you received formal training courses about dental waste management in the last year?   |     |    |            |
| 6   | Are training given to newly hired staff hazardous dental waste management?  |     |    |            |
| 7   | Should dental colleges organize a continuing dental education program to upgrade existing knowledge about biomedical waste management?                                  |     |    |            |
| 8   | Is there a supervision process for dental waste management in your work place?  |     |    |            |
| 9   | Is there coordination at the process of dental waste management between all relevant departments (pharmacy, nursing, infection control, environmental health, etc ...)? |     |    |            |
| 10  | Does your clinic coordinate with other organizations in relation to the waste concern?  |     |    |            |
| 11  | Is there a protocol for the dental hazardous waste management in your organization?   |     |    |            |
| 12  | Are there rules and regulations about dental hazardous waste management in your organization  |     |    |            |

**Domain 5: Practice of the dental health care providers:**

| No. | Item   | Yes | No | Don't know |
|-----|--|-----|----|------------|
| 1   | Do you use any personal protective equipment (gloves, mask, and lab coat) during waste disposal?   |     |    |            |
| 2   | Is the infectious waste should be segregated from the main waste stream?   |     |    |            |
| 3   | Are all the dental care practitioners in the clinic vaccinated against HBV?  |     |    |            |
| 4   | Have you studied hazardous waste management methods in college or university?  |     |    |            |
| 5   | Do you feel the need to setup an organizing authority to provide guidelines and management of the proper disposal of dental radiographic waste?    |     |    |            |
| 6   | Do you use a sponge type Mercontainer to store the scrap amalgam   |     |    |            |
| 7   | Do you collect lead foil packets in a marked container?  |     |    |            |
| 8   | Is the waste management plan applied and compliance by dental care providers?  |     |    |            |
| 9   | Are dental materials properly stored in a protected area to prevent premature damage?  |     |    |            |
| 10  | Are dentists and nurses applying rules and regulations during dealing with safe treatment and disposal of hazardous dental waste?                  |     |    |            |
| 11  | Is transfer of the dental hazardous waste according to the governmental dental clinic protocol being done properly?                                |     |    |            |
| 12  | Is hazardous waste properly separated and conveniently stored off the ground in suitable containers that are clearly labeled and kept under cover? |     |    |            |
| 13  | Do you use a yellow biomedical waste bag to collect the blood-soaked wastes?   |     |    |            |
| 14  | Do you categories your waste into hazardous waste?   |     |    |            |
| 15  | Is the clinic wastewater discharged into municipal sewage pour?  |     |    |            |

**What are the necessary equipments and facilities needed to implement hazardous dental waste management? (You can choose more than one answer)**

|                                       |  |                                      |  |
|---------------------------------------|--|--------------------------------------|--|
| Colored bags                          |  | Safety box                           |  |
| Special Savers for chemicals          |  | Transportation containers            |  |
| Storage room                          |  | Treatment methods                    |  |
| A special company for waste treatment |  | A special company for waste disposal |  |

**Indicate personal protective equipment that available in your hospital?**

| <b>Personal Protective Equipment</b> | <b>Regularly</b> | <b>Sometime</b> | <b>Not absolutely</b> |
|--------------------------------------|------------------|-----------------|-----------------------|
| Face mask                            |                  |                 |                       |
| Apron                                |                  |                 |                       |
| Goggles                              |                  |                 |                       |
| Gown                                 |                  |                 |                       |
| Boots                                |                  |                 |                       |
| Cap                                  |                  |                 |                       |
| Gloves                               |                  |                 |                       |

**From your point of view please arrange in descending order (from highest to lowest) the most important challenges which face dentists and nurses during dispose of the hazardous dental waste at the governmental dental clinics in the Gaza Strip**

|   | <b>Challenges facing dentists and nurses</b>  | <b>Arrangement</b> |
|---|---|--------------------|
| 1 | Shortage of the number of the staff (dentists and nurses) in the clinic.                                  | _____              |
| 2 | Improper infection control practices in the clinic.   | _____              |
| 3 | Insufficient personal protective equipment such as gloves, masks and safety glasses.                      | _____              |
| 4 | Dental research is a challenge due to lack of the financial resources needed to improve waste management. | _____              |
| 5 | Defective equipment maintenance in the clinic.  | _____              |
| 6 | Shortage of Sterilization solutions.  | _____              |
| 7 | Shortage of the color -bins in the clinic/  | _____              |
| 8 | Shortage of the plastic bags needed for dental waste management.  | _____              |

Please feel free to write down any suggestions for improvement of dental hazardous waste management at the governmental dental clinics in the Gaza Strip.

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Thank you for your cooperation

### Annex (3): Helsinki Committee Approval Letter



## المجلس الفلسطيني للبحوث الصحي Palestinian Health Research Council

تعزيز النظام الصحي الفلسطيني من خلال مأسسة استخدام المعلومات البحثية في صنع القرار

Developing the Palestinian health system through institutionalizing the use of information in decision making

### Helsinki Committee For Ethical Approval

Date: 10\08\2020

Number: PHRC/HC/762/20

Name: Ruba Atef Othman Alagha

الاسم:

We would like to inform you that the committee had discussed the proposal of your study about:

نفيدكم علماً بأن اللجنة قد ناقشت مقترح دراستكم  
حول:

#### Dental hazardous waste management at the governmental dental clinics in the Gaza Strip

The committee has decided to approve the above mentioned research. Approval number PHRC/HC/762/20 in its meeting on 10\08\2020

وقد قررت الموافقة على البحث المذكور عاليه  
بالتاريخ والتاريخ المذكوران عاليه

#### Signature

Member  
10/8/2020

Chairman  
2020

Member  
10/8/2020

#### Genral Conditions:-

1. Valid for 2 years from the date of approval.
2. It is necessary to notify the committee of any change in the approved study protocol.
3. The committee appreciates receiving a copy of your final research when completed.

#### Specific Conditions:-



Waqar R. Al-Shukh  
10/8/2020

E-Mail: pal.phrc@gmail.com

Gaza - Palestine

غزة - فلسطين  
شارع النصر - مفترق العيون

## Annex (4): Manpower Development - Ministry of Health Approval

**Al-Quds University**  
Jerusalem  
School of Public Health



**جامعة القدس**  
القدس  
كلية الصحة العامة

التاريخ: 2020/10/13

حضرة الدكتور/ رامي العبادلة  
المحترم  
مدير عام تنمية القوى البشرية-وزارة الصحة

تحية طيبة وبعد،،،

الموضوع: مساعدة الطالبة ربا الأغا

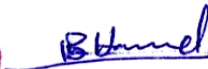
نشكر لكم دعمكم الدائم لمسيرة العلم والتعليم وخصوصاً دعم كلية الصحة العامة وطلابها، ونود إعلامكم بأن الطالبة المذكورة أعلاه تقوم بعمل بحث كمنطلب للحصول على درجة الماجستير في الصحة العامة-مسار إدارة صحية بعنوان:

***“Dental hazardous wastes management at governmental dental clinics in the Gaza Strip”***

وعليه نرجو من سيادتكم التكرم بالموافقة على تسهيل مهمة الطالبة في إنجاز هذا البحث حيث أن الفئة المستهدفة هم أطباء أسنان و تمريض أسنان و مساعدتي أطباء الأسنان العاملين في مراكز الرعاية الأولية بالإضافة إلى عيادتي جراحة الوجه والفكين بجمع ناصر الطبي وجمع الشفاء الطبي التابعة لوزارةكم الموقرة.

و اقبلوا فائق التحية و الاحترام،،،



  
د. بسام أبو حمد  
منسق عام برامج الصحة العامة  
فرع غزة

نسخة:

- الملف

Jerusalem Branch/Telefax 02-2799234  
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فرع غزة / تلفاكس 08-2644220-2644210  
ص.ب. 51000 القدس

**Annex (5) Study activities time table:**

| Month<br>Activity                                  | Durati<br>on | 2/<br>2020 | 3/<br>2020 | 4/<br>2020 | 5/<br>2020 | 6/<br>2020 | 7/<br>2020 | 8/<br>2020 | 9/<br>2020 | 10/<br>2020 | 11/<br>2020 | 12/<br>2020 | 1/<br>2021 | 2/<br>2021 | 3/<br>2021 | 4/<br>2021 |
|--|--------------|------------|------------|------------|------------|------------|------------|------------|------------|-------------|-------------|-------------|------------|------------|------------|------------|
| Identify research area                             | 2 weeks      |            |            |            |            |            |            |            |            |             |             |             |            |            |            |            |
| Proposal defense and approval                      | 2 weeks      |            |            |            |            |            |            |            |            |             |             |             |            |            |            |            |
| Literature review                                  | 6 weeks      |            |            |            |            |            |            |            |            |             |             |             |            |            |            |            |
| Writing up a full project proposal                 | 2 weeks      |            |            |            |            |            |            |            |            |             |             |             |            |            |            |            |
| Expert committee check for validity of instruments | 1 month      |            |            |            |            |            |            |            |            |             |             |             |            |            |            |            |
| Pilot study  | 1 month      |            |            |            |            |            |            |            |            |             |             |             |            |            |            |            |
| Modifications                                      | 1 month      |            |            |            |            |            |            |            |            |             |             |             |            |            |            |            |
| Data collection                                    | 4 months     |            |            |            |            |            |            |            |            |             |             |             |            |            |            |            |
| Data Entry   | 1 month      |            |            |            |            |            |            |            |            |             |             |             |            |            |            |            |
| Data Analysis                                      | 2 months     |            |            |            |            |            |            |            |            |             |             |             |            |            |            |            |
| Research Writing                                   | 2 months     |            |            |            |            |            |            |            |            |             |             |             |            |            |            |            |



**Annex (6): List of adjudicators**

|   | <b>Name</b>              | <b>Work place</b>       |
|---|--------------------------|-------------------------|
| 1 | Dr.Bassam Abu Hamad      | Al-Quds University      |
| 2 | Dr.Yehia Abed            | Al-Quds University      |
| 3 | Dr.Mahmoud Almoghany     | University of Palestine |
| 4 | Dr.Yasser Baroud         | Nasser Medical Complex  |
| 5 | Dr.Abd Allah Abu Moammar | University of Palestine |
| 6 | Dr.Shady AlYazji         | Al-AzharUniversity      |
| 7 | Dr.Tareq Othman          | Khartoum University     |
| 8 | Dr.Mohammed Tabash       | Al-AzharUniversity      |

**Annex (7) Estimated budget:**

| <b>Activity</b>                | <b>Total</b> |
|--------------------------------|--------------|
| Transportation & communication | 1000 \$      |
| Ethical administration         | 160 \$       |
| Questionnaire design           | 180 \$       |
| Data collection                | 1000 \$      |
| Data entry                     | 800 \$       |
| Final report                   | 600 \$       |
| Total                          | 3740 \$      |

## عنوان الدراسة: إدارة نفايات الأسنان الخطرة في عيادات الأسنان الحكومية في قطاع غزة.

الطالبة: ربا عاطف الأغا

إشراف: أ.د. يوسف الجيش

### ملخص الدراسة:

تتطلب طرق تشخيص وعلاج الأسنان مواد كيميائية مختلفة ومواد إشعاعية مختلفة مثل الملغم الفضي والإبر. تشكل بعض هذه المواد خطر التسبب في ضرر للأفراد المعرضين لها. هدفت الدراسة إلى تقييم واقع إدارة مخلفات الأسنان الخطرة في عيادات الأسنان الحكومية في قطاع غزة. تم استخدام التصميم الوصفي والتحليلي والمقطعي في الدراسة. تكونت عينة الدراسة من 90 مشاركاً (58 ذكراً و 32 أنثى) بمعدل استجابة 92%. تم استخدام استبانة معدة ذاتياً بواسطة الباحثة. تم تقديم الاستبيان إلى مجموعة من الخبراء لتقييم الصدق الظاهري والمحتوى. أجرت الباحثة دراسة استطلاعية على 20 مشاركاً تم اختيارهم عشوائياً ، وكان معامل كرونباخ ألفا 0.880. وأظهرت النتائج أن 84.4% من المشاركين في الدراسة هم أطباء أسنان حاصلون على بكالوريوس ، و 33.3% لديهم خبرة 20 - 30 سنة. أشارت النتائج أيضاً إلى أن إدارة نفايات الأسنان المعدية كانت أعلى من المتوسط (71.52%) ، وأن إدارة نفايات الأسنان غير المعدية كانت معتدلة (59.54%) ، وأن إدارة النفايات الطبية الحيوية كانت أعلى من المتوسط (70.22%) ، والإدارة لنفايات طب الأسنان الخطرة. النفايات متوسطة (67.10%). عكست النتائج أن المشاركين في الدراسة لديهم معرفة عالية (86.2%) ، وفوق الممارسة المعتدلة لإدارة نفايات الأسنان الخطرة (83.7%). كانت هناك فروق ذات دلالة إحصائية في المعرفة حول إدارة نفايات الأسنان الخطرة المتعلقة بالعمر ( $P = 0.003$ ) و سنوات الخبرة ( $P = 0.001$ ). توجد فروق ذات دلالة إحصائية في ممارسة إدارة مخلفات الأسنان الخطرة مرتبطة بالمحافظة ( $P = 0.034$ ) والمؤهل العلمي ( $P = 0.047$ ) وسنوات الخبرة (0.009). كما أشارت النتائج إلى أن معظم معدات الوقاية الشخصية متوفرة في العيادات. من بين التحديات الشائعة التي تواجه أطباء الأسنان والممرضات أثناء التخلص من مخلفات الأسنان الخطرة نقص الأكياس البلاستيكية لإدارة مخلفات الأسنان ، ونقص الصناديق الملونة ، ونقص محاليل التعقيم. خلصت الدراسة إلى أن إدارة مخلفات الأسنان الخطرة كانت معتدلة. كانت هناك معرفة عالية وما فوق الممارسات المعتدلة لإدارة نفايات الأسنان الخطرة. أوصت الدراسة بضرورة زيادة الوعي بالمخاطر المحتملة لمخلفات الأسنان ، وتحسين إجراءات السلامة في بيئة العمل لحماية الموظفين من مخاطر مخلفات الأسنان.