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Medical Waste after COVID-19 Pandemic, Management and Environmental Impacts

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Abstract: Since December 2019, the onset of COVID-19 disease has ranked first as the most important event worldwide. It is a contagious virus that starts as a respiratory system problem in general and causes many different symptoms depending on the human immune system in the body. It is tried to be protected from the contagious effect of the disease with the immunity system of the people and the individual protection rules. As of mid-June 2022, Corona-19 pandemic virus cases are estimated at 550 million worldwide, while deaths from the disease are estimated at 6.4 million. About 500 tons medical waste is produced every day in connected to COVID-19, where the first case was seen in the Chinese province of Wuhan. With the data obtained in Indonesia (Jakarta), approximately 13 thousand tons of medical waste was reached 60 days after the first infection in humans, with the medical waste scale. Recently, millions ton virus contaminated masks, gloves, and medical supplies are in the process of creating irreversible infectious waste, for testing to detect and detect Covid-19 and other human pathogens, and to treat infection. In the case of solid waste management, improper storage, transportation, and improper use cause environmental and health problems. In addition, due to the significant waste in healthcare services caused by the COVID-19 virus pandemic, it is thought that the unsafe disposal of hospital wastes will threaten to spread environmental pollution. As a result, one of the many environmental problems that will necessarily arise is infectious waste, which can cause serious diseases and environmental problems if not managed properly. One of the effects of the increase in Covid-19 cases on medical waste was to further increase the generation of such waste, which is 0.95 to 3.52 kg per day per bed in hospitals. Medical masks, gloves and protective clothing, which are the main defence tools in the fight and protection against Covid-19, are becoming an increasing problem of medical waste around the world. In addition, uncollected medical wastes enter the aquatic environment in the sewer or environment after being transported by wind and rain. To reduce the waste load and pollution, from municipal and industrial waste need to be recycled and reused. Again, infectious, and dangerous hospital wastes should be managed correctly by the municipality and other responsible persons. For this, appropriate methods should be put forward to control the environmental impact and waste. In this study, the applicability of thermochemical conversion technologies to dispose of COVID-19 medical wastes was evaluated. Moreover, Processes including heating, pyrolysis, carbonization, and gasification were evaluated. Among these incineration, thermo-chemical technologies, digestion is thought to facilitate variety of contaminated medical waste types, followed by gasification and pyrolysis.
Keywords: Environmental Impacts, Medical Waste, Covid-19 Pandemic, Waste Management

INTRODUCTION

From the start of Covid-19 problem in Wohan China and declared as a World pandemic from the World Health Organization, different measures for virus have been taken in all World countries to contain the further spread of the virus (Fadare & Okoffo, 2020). During March and September of year 2020, EU countries reported 3.5 million Covid-19 cases and about 200 thousand deaths infected by COVID-19 (ECDPC 2020a). COVID-19 case notification rates have increased steadily across the EU from August 2020 (ECDPC 2020b). Due to the coronavirus in Turkey, 288 more people died in the last 24 hours, the total loss of life rose to 35 thousand 608. With the detection of 250 new cases in the last day, many people infected with the Corona virus across the country has exceeded 15 million 200 thousand. Across the country, 2 thousand 973 people under the definition of "patient" were treated in hospitals, and the number of serious patients was recorded as 3 thousand 240 (URL-01).

The Total Number of Cases in Turkey has exceeded 15 million. While nearly 15 million of them were treated, around 100 thousand deaths were recorded. In total, around 150 thousand Corona-19 vaccines were administered (Figure 1).

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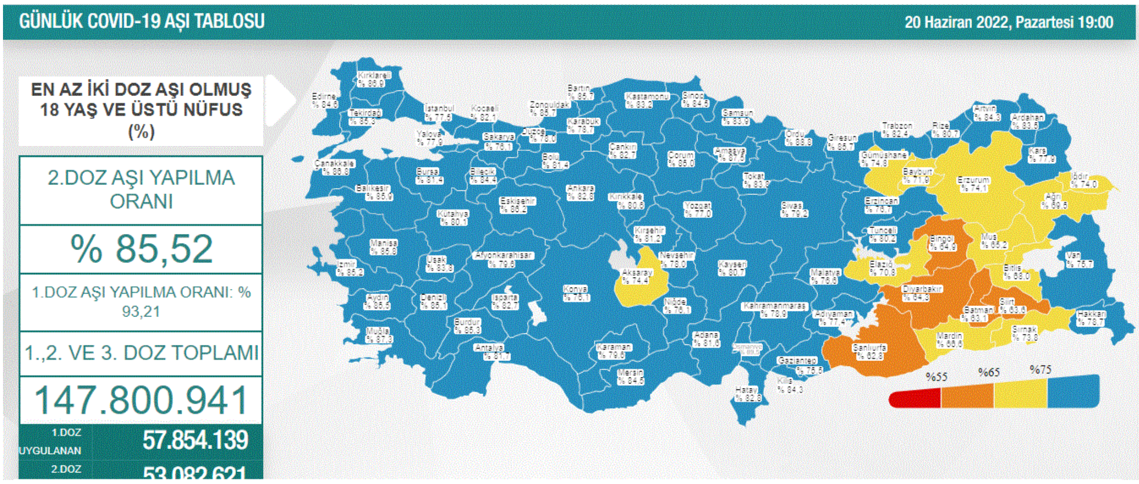

Figure 1. Vaccination numbers and risk map by provinces in Turkey (URL-02)

It is not possible to say that the covid-19 pandemic has completely ended worldwide. It continues with new mutations (Figure 2). Although, depending on the immune mechanism in humans, the depth disappears as much as in previous periods, but it is not exactly known what new mutations may cause.

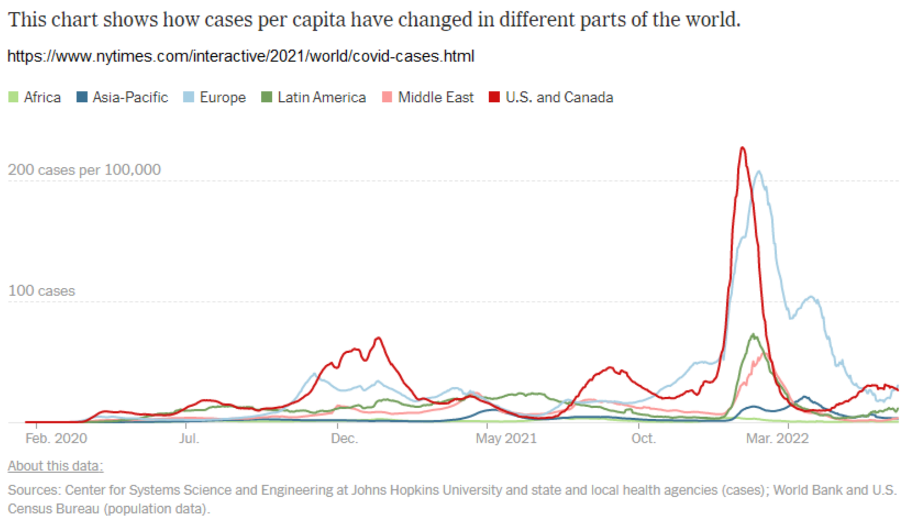

Figure 2. The chart of cases changed in different part of the world (URL-03)

In the first week of June 2022, more than 3.2 million infections were reported, like the number of infections reported in the previous week. increased. As of June 2022, there have been more than 550 million Covid cases worldwide and about 6.3 million deaths reported. The circulating COVID-19 infection case of alarming mutants requires an update on its geographic distribution. On the other hand, there is a need to focus on public transport incidents during the disease epidemic and the WHO's recommended risk-based approach to decision-making for public transport incidents (URL-04).

It is of concern that the epidemiological risk that still exists in many countries of the world poses an increased illness risk for susceptible individuals (individuals at risk for serious infectious disease, such as the elderly) and those working in the healthcare sector, especially in primary care. Different ideas have been put forward, including the measures taken in all countries, including the quarantine, which has hitherto been considered an adequate preventive measure. Other precautions include avoidance of contact, restriction of travel, isolation, hand hygiene, avoidance of public or crowded places, and the wearing of surgical face masks (Chintalapudi et al., 2020; Lin et al., 2020; Freedman, 2020). While masks were primarily made to protect healthcare workers to prevent occupational hazards, non-medical professionals adopted the use of face masks during the Covid epidemic in 2003 (Elachola et al., 2020; Yang et al., 2008). Moreso, authorities had advised the masses to do the same to curb the spread of Corona viruses. For current pandemic, researchers have advocated the use of face masks by the public until the mode of transmission of Covid-19 is really understood with cases (Leung et al., 2020). It has also been discussed that it may be helpful in reducing the number of touches to the nose, mouth, face with infected hands, which can significantly reduce the chance of infection. Many studies have shown that face masks retain their efficacy against ambient air infection for Religion visit (Tsukiji et al., 2020; Barasheed et al., 2016; Elachola et al., 2014).

In a study examining the change in food hygiene behaviours with the COVID-19 epidemic, when the COVID-19 epidemic was compared, it was found that the rate of individuals preferring home service from the markets increased from 22.8% to 55.7% (Sağlam et al. al. 2021). It is estimated that the amount of plastic waste produced per day worldwide since the beginning of the epidemic is 1.6 million tons, and approximately 3.4 billion disposable face masks or visors are thrown away every day due to COVID-19. (Benson et al. 2021).

According to the estimates, it is stated that there is a significant increase in the amount of health care waste by approximately 3.4 kg per person per day. Of the healthcare waste from COVID-19, approximately 2.2 kg per patient in Mexico and 2.9 kg in Indonesia, 2.5 kg of waste in Thailand was produced in developing countries. About 15% of solid wastes produced in health care facilities are hazardous and 85% are non-hazardous (Tsukiji et al., 2020).

There has been a significant increase in the amount of plastic waste with the use of protective equipment such as masks and gloves to prevent the transmission of the virus of Covid-19 (Rume and Islam, 2020; İkiz et al., 2021). The main reason for plastic-derived waste, which creates an environmental problem during the pandemic period; plastic packaging products originating from protective materials, pharmaceuticals, catering services. The duration of the covid-19 agent in plastic is specified as 3 days, 8 hours in gloves and 24 hours in cardboard. The perception that the risk of virus transmission from single-use plastics is low in humans has shown that the use of single-use plastics has increased significantly. Meeting the daily needs from the WEB has become widespread, and the preference of packaged ready-made products has led to an increase in plastic waste. The use of medical supplies to care for Covid-19 patients, the use of drugs during treatment, and the tendency of non-sick people to purchase illegally sold immuno-enhancing drugs to protect themselves have also increased the amount of medical plastic waste (Vanapalli et al., 2021). Standard waste management is also one of the sanitary measures that prevent the spread of disease (Somani et al., 2020). Due to the increased risk of pathogen contamination from municipal waste, proper waste management is of great importance during the pandemic. Local governments and relevant ministries are required to inform the public about waste reduction recommendations, protective measures and implementation procedures regarding collection frequency during the epidemic. In this context, a circular on "Covid-19 Precautions in the Management of Personal Hygiene Material Wastes such as Disposable Masks and Gloves" was published in April 2020 by the General Directorate of Environmental Management of the Ministry of Environment and Urbanization in Turkey (Anonymous, 2020). Thus, the minimum points to be considered during the collection, collection, transportation, temporary storage and transmission of disposable personal masks and gloves and other protection materials are explained (Figure 3).

Figure 3. Face mask and gloves and other protection materials.

In this study, the importance of medical waste produced in the treatment of the COVID-19 pandemic was investigated. Because in the pandemic, waste produces waste with quite unique properties, which is lower in mass and greater in volume compared to normal medical waste. This waste includes personal protective equipment these types of face mask, gloves, coveralls, shields, face, goggles, and other related wastes (disinfectant/disinfectant containers etc.). The use of standard medical protective equipment is a necessity for health workers (doctor, nurse, and caregiver), patients and healthy people who have close contact with patients. Almost all people in the world are forced to wear masks when they leave the house. Many disposable preservatives are produced and used, resulting in a large increase in potentially infectious waste, which poses more health of humans and living environmental threats. Purnomo et al (2021) and Kampf et al. (2020) suggested that the virus of COVID-19 can survive for approximately 9 days on material surfaces including steel, plastic, and glass. The threats risks are increasing in developing countries where medical solid waste management is limited. Today, contaminated humans, gloves and cleaning materials cannot be passed through irreversible cute animals to diagnose/detect other human pathogens of COVID-19. This would be inappropriately, in terms of health and condition (WHO, 2020). On the other hand, ECDPC hammer 2020b, which is being withdrawn from its cute kitchen unsuitable use due to increased healthcare due to the COVID-19 pandemic. This event is one of the problems that is useful in appearance, it is not properly designed and intended for use. One of the toys of one of those on Covid-19, 4 kg per patient. In Figure 4, mask usage in Asian countries is given.

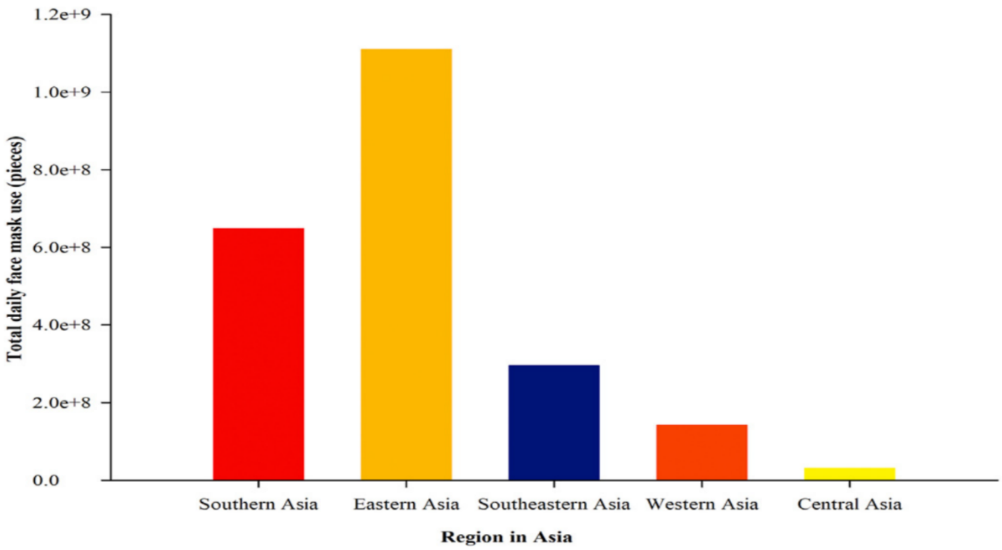

Figure 4. Face mask usage of general population in Asia region.

According to the WHO (2020) report, biohazardous solid wastes that threaten human and environmental health due to COVID-19 have revealed that there is a need for scientific studies to improve existing waste management practices and programs. It is necessary to carry out serious studies on the management systems of wastes from health services related to communicable diseases around the world. WHO's global analysis of health care waste from patients and contacts in the context of the COVID-19 pandemic: current status, environmental estimates and impacts and recommendations for the appropriate disposal of such wastes purchased between March 2020-November 2021 for protection and aid-supported It is based on approximately 87,000 tons of personal protective equipment shipped to these countries. Through a joint UN emergency initiative, urgent COVID-19 response needs are determined and supplied, as well as the elimination of wastes that will arise with appropriate methods. Most of this protective equipment should be planned to end up as biological waste. Today, 30% (additional 60% in developing countries) in healthcare facilities for Covid-19 treatment should determine the extra COVID-19 burden and have disposal equipment to handle the existing medical waste loads. Measures include environmentally friendly packaging, transportation, safe and reusable personal protective equipment (gloves and medical masks eg.), suitable recyclable and/or biodegradable materials; investment in non-combustible waste treatment technologies such as autoclaves; To ensure that materials such as plastic have a second life, studies are needed to support solid waste disposal centre operations and investments in the recycling sector.

Tens of thousands of tons of additional contaminated medical waste has been generated worldwide, resulting from the response to COVID-19 patients or as part of containment measures. It puts pressure on the issue in the management of wastes generated by healthcare services in hospitals around the world. It has emerged that serious measures are needed to improve the practices for the management of these wastes, which threaten human and environmental health. Global analysis of bio-contaminated waste of health services in the context of COVID-19 pandemic treatment and protection in the WHO's report: the situation, environmental impacts and waste estimates with the recommendations received result from approximately 87 thousand tons of personal protective equipment purchased or sent to their countries with donation supports during the pandemic period. Emergency COVID-19 response needs are provided through contribution to a joint UN emergency resolution. Most protective equipment is expected to end up as medical/contaminated waste. The researchers note that these only provide an important indication of the scale of the COVID-19 pandemic solid waste problem. Consider none of the COVID-19 commodities procured outside of contagion and public-generated waste such as disposable medical masks. They point out that more than 140 million COVID-19 test kits were shipped in the waste, with the potential to generate 2,600 tons of non-infectious solid waste (mostly plastic, etc.) and 731,000 litters of chemical waste (equivalent to one-third of an Olympic swimming pool). 1.6 billion doses of vaccine have been administered worldwide, generating 144,000 tons of additional waste in the form of syringes, needles and safes. As the UN and countries grapple with the urgent task of securing supply and quality assurance of containment equipment, less attention and resources have been devoted to the safe and sustainable management of COVID-19-related healthcare waste.

With COVID-19, sustainable healthcare medical waste management is more important than ever to protect communities, healthcare workers and the planet and prevent pollution. Of the 127.4 million tons of waste processed in waste disposal and recycling facilities in Turkey, 78.3 million tons are disposed of and 49.1 million tons are recovered solid wastes. The number of total wastes were processed increased by about 22% during the pandemic period compared to 2018. While protection materials should be disposed of, unfortunately, it is even seen that personal protection masks are hung in some historical areas for superstitions in a way that can be said ridiculous in Turkey (Figure 5).

Figure 5. They hung a mask on the ‘wish tree’ in Cappadocia and 'Wish trees' filled with fun masks at Zeus Altar

Contaminated medical wastes, which are difficult to separate in nature with the use of petroleum-derived materials, require new techniques that also require hazardous waste disposal. Therefore, this issue should be taken into consideration in the contaminated waste management system. In general, the personal protective equipment used against Covid-19 and the medical waste resulting from them are mainly made of plastic polymer-based materials, including PVC, PET, PP, PE, PEs and rubber latex analogues. Therefore, there is a need for appropriate recycling technologies that can economically and effectively dispose of such waste materials and provide the necessary adequate disinfection, outperforming other methods. Thermochemical Technology Applicability (CMW) has many advantages for the disposal of this type of waste. Table 1 summarizes the applicability of Thermochemical Technologies.

Table 1. Summary of Thermochemical Technologies applicability for medical waste

Waste types	Incineration	Combustion	pyrolysis	Gasification
Respirator equip.	h	l	a	a
Medical masks	h	a	h	h
Latex gloves	h	l	l	l
Poly nitrile gloves	h	n	l	l
Protection Glasses	a	n	l	a
hand sanitizer containers	a	n	a	a

Symbol meanings: h highly applicable; a applicable; l low applicable; n not possible.

Many alternative suitable infected waste disposal methods is suggested for the medical contaminated solid waste, which are these respond to the environmental problems which these came the in front with the pandemic Corona-19. These alternative methods include the waste derived fuel production, used medical contaminated wastes as the producing energy source to use later. this is homogeneous waste sources and to be used with many different systems. The amount was different quite big for energy usage. It has a low level of humidity. Sterilization and disinfection are required during the process procedure. Incineration methods may be possible to ignite to waste directly. The high temperature incineration method (may called combustion) process that was the widely adopted technology for wastes to the effective disposal of various medical wastes and sterilization infectious pathogens. Combustion poses relatively high environmental concerns due to high CO_2 emissions and high additional fuel consumption to reach and stabilize at a temperature above 800 °C. All these possible emissions from the combustion of medical wastes must be controlled with appropriate flue gas treatment. Almost half of the operating cost of the incinerator is used for air pollution treatment. Thermal degradation of PE (HDPE and low density polyethylene (LDPE)) begins when the temperature approaches 430 °C and ends at 500 °C. PP basically has a similar decomposition temperature to PE but slightly lower, ranging from 420 to 480 °C. PS has the lowest decomposition temperature of 380-440 °C. PET begins to degrade when the temperature approaches 400 °C and stops at around 500 °C, producing CO, CO_2 , methane and light hydrocarbons. PVC degrades in two continuous steps. Carbonization results in the release of volatile matter producing homogeneous solid carbonized (coal-like, charcoal) products. The solid product has higher energy density due to increased carbon content and decreased oxygen content, excellent grindability, hydrophobicity and stability (stable and long storage possibility). A smaller oxygen/carbon ratio is achieved due to the release of volatile matter, resulting in reduced auto-ignition during grinding. Carbonization is divided into 2 different processes as dry and wet carbonization. It is called dry carbonization (Torrefaction), Dry roasting, light pyrolysis and slow pyrolysis. It is a thermochemical process performed in an almost inert atmosphere, and materials are slowly heated under ambient pressure and a temperature of 200–300 °C. Torrefaction requires raw materials with a low moisture content (such as less than 15% by weight). Therefore, general medical wastes, especially the wastes mentioned above, can be incinerated directly without the need for drying, as they are basically dry.

Wet Carbonization (Hydrothermal Carbonization) is one of the hydrothermal processes adopted to produce homogeneously carbonized material at high temperature (typically ranging from 180 to 280 °C) and a saturated pressure of 2-10 MPa. It is suitable for materials with a relatively high moisture content, as the drying step can be skipped. Subcritical water accelerates the reaction by acting as a solvent and reagent during the reaction. The solid product of hydrothermal carbonization is often referred to as hydrochar. Pyrolysis is the thermal degradation of long chain polymeric molecules into shorter and less complex molecules under an inert or oxygen-deprived atmosphere, in the presence or absence of Catalysts. The pyrolysis products can be a mixture of solid, liquid and gas. It can produce a high amount of liquid product over a wide temperature range. According to their properties, the obtained products are not only suitable for use as fuel but can also be used as chemical raw materials. It has low carbon emissions due to lower carbon monoxide (0.8–3.9%) and carbon dioxide (1.0–9.1 vol) formation compared to combustion. There are two types: thermal and catalytic pyrolysis. Thermal Pyrolysis, Thermal pyrolysis is a pyrolysis that utilizes the material without a catalyst using thermal energy. Since the process is endothermic, energy must be supplied to the process. Thermal pyrolysis is a complex process consisting of polymer chain breaking, crosslink formation, side chain elimination and side chain crystallization. Catalytic Pyrolysis is basically like thermal pyrolysis in terms of process and conditions. The main difference is in the presence of the catalyst. The catalyst is used to increase the reaction rate by lowering the activation energy of the reaction. Therefore, by using the catalyst, a high reaction rate can be achieved at a lower temperature, ultimately reducing the energy requirement and operating cost of the process. Gasification, Gasification is a process that heats materials at high temperature under a controlled atmosphere, converting carbon materials into a mixture of carbon monoxide, hydrogen, carbon dioxide, methane, and a longer hydrocarbon gas chain. The catalyst can be used to reduce energy and increase product yield. Gasification products can be used as fuel or chemical raw materials (syngas) depending on their composition. It is classified in 2 ways as Air Gasification and Vapor Gasification. Gasification in Air, Gasification in air is the process of gasification using air as the atmosphere or a mixture between oxygen and inert gas (usually nitrogen). Vapor Gasification, Vapor gasification contains steam in the gasification atmosphere, thus making it possible to produce hydrogen rich gas. Due to this feature, the products of this process are more suitable to be used as chemical raw materials. Comparison the disposal methods of contaminated medical waste have given in Table 2.

Table 2. Comparison the disposal methods of contaminated medical waste (Mofijur et al., 2021.).

Treatment method	Advantages	Disadvantages	Difficulties
RDF (without further processing)	High recovery and low rejection rate (due to CMW's high plastic and paper content); Low drying cost (due to low moisture content of CMW)	Risk of infection for the operator; Requirement for disinfection stage	Appropriate disinfection method
Incineration	Simple process and mature technology; High material flexibility; No need for disinfection step; ow fuel requirement (due to high calorific value of CMW)	High carbon emission: Possibility to produce harmful or corrosive gases; It can only recover heat	Flue gas treatment technology; CO_2 capture and storage technology
Dry-carbonization	Higher energy density product; No need for disinfection step; Moisture content suitable for CMW; Low ash and sulphur content; Low carbon emission	Inadequate operating conditions to facilitate further deterioration; Possibility to produce harmful or corrosive gases	Gas purification technology
Wet-carbonization	Low carbon emission; Higher energy density product; No need for disinfection step; Low ash product; Can efficiently PVC remove from chlorine content	Requires adding water to CMW; Requires washing and drying of the product; Pressure and heating energy is considered high; requires a high-pressure reactor; Difficulty for continuous process	Continuous process improvement to increase efficiency
Dry-carbonization	Higher energy density product; No need for disinfection step; Moisture content suitable for CMW; Low ash and sulphur	Inadequate operating conditions to facilitate further deterioration; Possibility to produce harmful or corrosive gases	Gas purification technology

	content; Low carbon emission		
Wet-carbonization	Higher energy density product; No need for disinfection step; Low carbon emission; Low ash product; Can efficiently remove chlorine content from PVC	Requires adding water to CMW; Requires washing and drying of the product; Pressure and heating energy is considered high; Requires a high-pressure reactor; Difficulty for continuous process	Continuous process improvement to increase efficiency
Air-gasification	simple process; Suitable for PE and PP, the main component of CMW; No need for disinfection step	Not suitable for PVC, PET and rubber	tar removal technology
Gasification-with steam	PE and PP, the main component of CMW Suitable; High hydrogen yield suitable for synthesis gas production; Can process PVC (recover chlorine from PVC); No need for disinfection step	Not be enough suitable for PET and rubber; Requires a high amount of energy; High tar formation	Heat integration system to increase the energy efficiency of the process; tar removal technology

RESULTS

Waste recycling aims to generate more profit and reduce the amount of waste (Kulkarni and Anantharama, 2020). Recycling of plastic packaging, which is one of the most used packaging types in daily life, causes less environmental pollution (Rajmohan et al., 2019). However, recycling projects in various countries have been suspended in the beginning of the pandemic, as the possibility of Covid-19 spreading to recycling centres raises concerns (Mofijur et al., 2021). In this process, throughout the countries where recycling activities have stopped, the personnel working in waste processing have faced risks in terms of their livelihoods. However, in some countries, recycling activities have continued since the beginning of the pandemic. In these countries, waste treatment personnel should be careful about virus protection and all precautions should be taken during recycling to minimize the risk of contamination. For this reason, waste recycling activity procedures should also be evaluated and taken into account within the framework of the epidemic (Kulkarni and Anantharama, 2020).

Establishing a medical waste system that can provide capacity and resistance in the future and in case of need in urban medical waste management can only be possible with the right inventory and tracking system. In this context, the change in the amount of medical waste collected from all health institutions within the borders of Tekirdağ province and sent to the medical waste sterilization facility during the January 2018-March 2021 period was determined according to the time, health institution type and waste codes. According to the results obtained, 959,071 kg of waste was collected in 2018, 937,929 kg in 2019, 1,272,478 kg in 2020 and 354,378 kg in the first three months of 2021. Generally, the highest amount of waste is collected in December-January. The percentage of waste collected from public hospitals in total medical waste was 68% in 2018, 2019, 2020 and 2021, respectively; 69%; 74% and 76%. Considering the distribution of collected wastes according to waste codes, 180103 "hazardous wastes whose collection and disposal are subject to special procedures in order to prevent infection" constitutes 98.6% of all wastes on average. According to the calculation results, the amount of medical waste generated per capita in the province; The amount of medical waste generated per bed varied between 0.89-1.28 kg/person-year and between 1.06-1.35 (Zafer, 2021). The amount of medical waste per capita has increased over the years and has reached high amounts especially during the Covid-19 pandemic process. In the province of Tekirdag, population projections were made and future medical waste estimations were made, and according to the calculation results, an increase of around 50% is expected in the amount of medical waste in the province in 2050. Within the scope of the study, the average monthly waste amount in Tekirdağ was calculated as 111,039 kg between 01 April 2020 and 31 March 2021, covering the pandemic process, to evaluate the amount of medical waste in the province during the Covid-19 process. The amount of medical waste collected and sterilized in the province during the process is approximately 3.7 tons/day during the specified period. As a result of the calculations, it was determined that a total of 1,960 tons/year extra waste load was realized in the province between April 01, 2020 and March 31, 2021, and 43% of this was due to the use of masks, 39% to isolated patients and 18% to Covid-19 treatment in hospitals (URL-05).

Turkish Statistical Institute, within the scope of waste statistics; from all municipalities, manufacturing industry establishments with 50 or more employees, all active thermal power plants with an installed power of 100 MW or more, all organized industrial regional directorates with completed infrastructures, mining enterprises that declared production for the reference year to the General Directorate of Mining and Petroleum Affairs, licensed It compiles data from all waste disposal and recovery facilities with temporary or temporary activity certificates and from sanitary landfills, incineration and compost facilities operated by or on behalf of municipalities, although they are not licensed. Medical waste data related to health institutions include universities, general purpose and maternity hospitals and clinics that generate large amounts of waste in Annex-1 of the Medical Waste Control Regulation and are obtained from the administrative records of the Ministry of Environment, Urbanization and Climate Change (URL-06).

It is estimated that more than 100 million tons of bio contaminated waste was produced during the three-year COVID-19 pandemic (ECDPC, 2020a). In addition, 110 million tons of which are dangerous, in industrial manufacturing industry workplaces, mining enterprises, thermal power plants, organized industrial facilities in Turkey. million tons of contaminated waste was produced. Within the scope of the research, it is seen that the total amount of waste generated from industrial zones, health institutions and houses increased by 10.5% compared to 2018. About 110 thousand tons of contaminated medical waste was collected from only health institutions. 23.7% of total medical wastes 23% of the collected medical wastes were collected from health institutions located in these three metropolitan cities, 23.7% in Istanbul, 7.8% in Ankara and 5.8% in İzmir. 90.6% of the collected medical wastes were sterilized and sent to landfills, 9.4 of them were sent to solid waste incineration plants (URL-07).

Masks, gloves and protective clothing, which are known as the basic protection tool in the fight against the corona virus and protection measures, are turning into an increasing environmental problem around the world. In addition, uncollected wastes can enter the water by entering the sewer after being dragged by wind and rain. Both industrial and municipal waste should be recycled and reused to reduce the waste load and environmental pollution. In addition, hazardous and infectious medical waste should be properly managed by the municipality and hospitals. Therefore, appropriate strategies should be adopted to consider environmental degradation and to control contaminated waste.

The effects of plastic and plastic component wastes on environmental pollution have been emphasized by scientists on the subject in many scientific studies and their effects have been shown in detail (Browne et al., 2008; Cole et al., 2014; Galloway et al., 2017; Rist et al., 2018; Wright et al., 2013). Some of the results that show the important negative aspects include threats to aquatic life, which is important in the food system, which constitutes another part of it and affects human life. Plastic products and the particles resulting from them enter the food intended for human food consumption, increasing concerns about the impact of global food security (Fadare et al., 2020). It causes significant damage to the aesthetic and entertainment value, which is of vital importance for the stability of people's social lives and health conditions. The presence of plastic wastes in the living environment of people creates a significant risk in the global food chain by contributing to many significant environmental pollutions, especially climate change, due to carbon-based emissions, and these have been reported from studies (Reid et al., 2019; Shen et al., 2019).

It is evaluated in research that the number/amount of medical waste used for prevention/treatment in the COVID right, which originates significantly from the personal protective equipment used in the current COVID epidemic period, is quite high, and that such wastes have the potential to be an important energy source. Many options have been described for the safest management of the COVID pandemic medical waste, converting it into a usable fuel walk or heat. Since such wastes are known to be contagious, it is necessary to add the disinfection/sterilization step first or to integrate the selected disposal technology with them. In this current study, considering the options that have been made and can be made, thermochemical technological transformation applications are examined, especially considering the economic aspects and environmental characteristics, and the options that can be suitable for the disposal of COVID pandemic medical wastes are reviewed. Among them, efficiency includes combustion, carbonization/heating, pyrolysis and gasification methods. Among these new thermochemical conversion technologies, it is thought that incineration can be applied to a wide variety of medical waste types, and then facilitate gasification and pyrolysis methods. Due to the enormous volume of COVID pandemic medical waste, its very high caloric content, and the possibility of rapid conversion, it is urgently necessary to focus on thermochemical technology methods.

From the time Covid-19 was first detected in Turkey until June 2022, around 160 million Covid-19 tests were carried out across Turkey, and it is estimated that around 500 tons of contaminated waste will be generated due to these test kits. Until June 2022, 150 million tests were carried out and 200 tons of solid horses could be formed from the materials used in vaccination from these tests. The total number of Covid-19 cases is around 15 million, and the number of hospitalizations for positive patients is 45 thousand tons, and the number of hospitalizations is estimated over 3 million, and it is likely that 150 thousand tons of waste will be generated from them. The total number of deaths is around 100 thousand and there will be 250 thousand tons of waste. The total of all contaminated wastes will reach 1 million tons from first Covid-19 cases to end of June 2022.

DISCUSSION

The use of surgical masks is a barrier to help healthcare workers protect themselves from the effects of droplet airborne viruses to protect them from COVID-19. However, its effectiveness only requires the use of masks depending on their properties and correct application recommendations. FFP2 or N95 face masks, called surgical face masks, are produced for single use. Used and discarded should not be kept around the neck or on the crown during treatment. Pictures of some of the misuses, some of which are posted on official websites, and some of the uses classified as incompatible, have shown that wearing the wrong mask is a significant incompatibility. Raising awareness about the prevention of the Covid pandemic is important around the world. It will be important that we try to protect and raise awareness of our environment and those around us by reducing, eliminating (where possible) and properly managing disposable masks. Perhaps plastic solid waste pollution may become an epidemic of the world in the future. WHO continues to recommend measures for airborne factors for the environment where aerosol-generating procedures and therapy are applied to avoid contact and droplet and assess risks for caregivers of COVID patients (WHO, 2020). The correct implementation of this prevention strategy will need to reduce the contagion and deaths due to the infectious nature of Covid and the importance of its clinical impact.

CONCLUSION

Medical waste management is a very important task in preventing the risk of transmission of the Corona-19 virus to humans and in controlling the spread of the disease. Because while the disease can travel with people in many ways and survive under various environmental conditions, the virus can also have the feature of staying alive for a long time in the environment where it is transmitted without a host. As a result, the virus should be handled at the source of the medical wastes generated during the treatment of covid patients and with an appropriate and rapid method. If the wastes containing contagious factors are disposed of with appropriate methods on site, the risk of transmission of covid-19 will be reduced. Ideally, a medical waste management approach should always have options for reusing and/or recycling valuable material, with waste minimization or reduction. However, some of the contaminated biological waste may not be directly related to hospital waste. COVID-19 pandemic wastes are hazardous biological wastes, posing a very important risk to human life and needing to be disposed of with special methods. Such infectious wastes are generally subjected to appropriate disinfection/sterilization (chlorination, incineration, incineration, etc.) procedures. However, careful handling of these processes unintentionally releases hazardous chemicals into the environment and poses a risk to employees handling biological waste. Modern waste technologies such as incineration, pyrolysis and plasma waste technology must be used to properly treat biocontaminated wastes. Further efforts will not only help with the careful recycling of hazardous waste, but also prevent the spread of COVID-19 transmission to the public through its disposal.

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