COVID-19 AND MUNICIPAL SOLID WASTE MANAGEMENT

ELENA CRISTINA RADA
Department of Theoretical and Applied Sciences, University of Insubria, Italy

ABSTRACT
The present work analyses the scientific literature available on the impact of the SARS-CoV-2 in the sector of municipal solid waste. After a bibliometric analysis based on data taken from Scopus®, the analysis deals with effects on waste composition, waste quantity, collection, and treatment. As expected, results show that the most productive authors on this topic belong to scientific bodies located in the countries more affected from COVID-19 in the world. Moreover, different strategies of international journals resulted in an unbalanced concentration of papers on this topic. Effects have been observed concerning municipal solid waste composition and amount (mostly for the role of masks and packaging). Impacts on management and circular economy are discussed too.
Keywords: COVID-19, circular economy, municipal solid waste, SARS-CoV-2, urban waste, waste management.

1 INTRODUCTION

During the first period of the COVID-19 pandemic, one of the criticalities to be faced with and to be solved quickly was the defence of the correct collection and treatment/disposal of municipal solid waste (MSW) to avoid risky side effects from unhealthy practices. A quick response went from the bodies responsible of health protection at national level through the issue of guidelines. In the same time an international activity evolved at research level. The present article zooms on this second aspect in order to understand which contribution came to fight SARS-CoV-2 in a short amount of time.

2 MATERIAL AND METHODS

The approach used in the present paper is based on four steps aimed to valorise the contents of the international scientific databases that significantly evolved in the latest decades. The steps are described as follows:

- Select an international scientific database suitable for a bibliometric analysis on relationships between COVID-19 and MSW management;
- Analyse the bibliometric data on the above-mentioned topic;
- Analyse the contents to find relevant issues to understand the impact of the pandemic on the sector of MSW, including sustainability and circular economy;
- Check if a qualified database can cover all the aspects of interest for MSW and pandemic.

3 RESULTS AND DISCUSSION

The chosen databased was Scopus® because of its wide coverage of peer review international journals and conferences. Indeed, the aim was to analyse the scientific response of researchers to the pandemic issues, specifically in the sector of municipal solid waste. This database was accessed in May 2022 to extract data referred to two queries: COVID-19 and "municipal solid waste" and COVID-19 and "urban waste", and the results are reported in Fig. 1.

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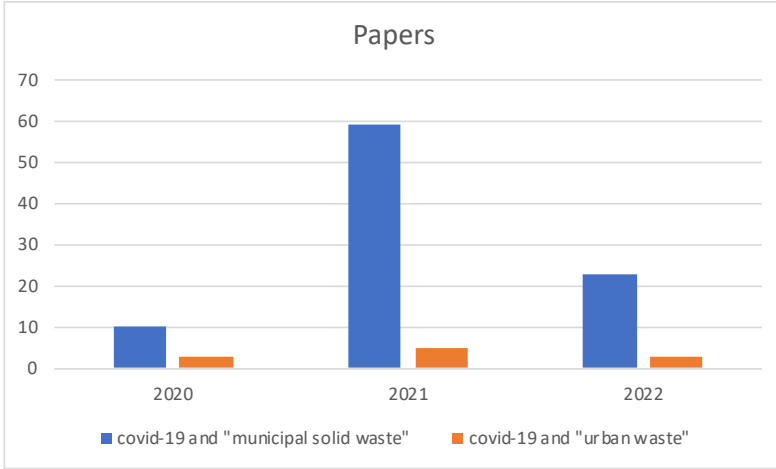


Figure 1: Papers published on the two queries in Scopus®.

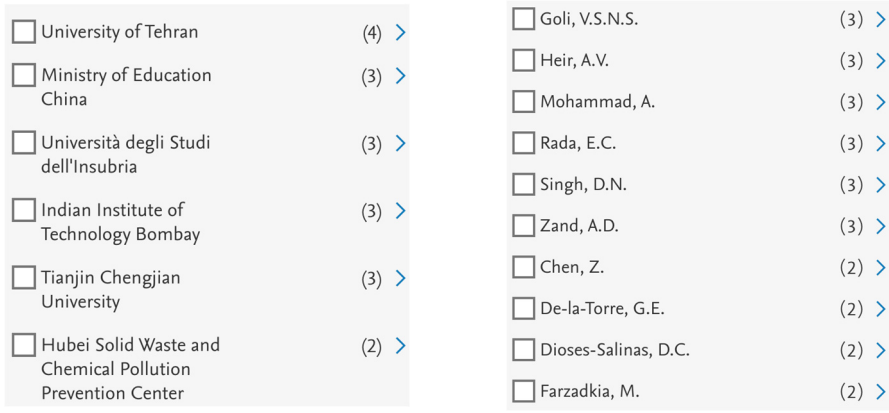
The results from the Scopus® databased showed 92 documents connected with the first query and 11 connected with the second one [1]–[103]. The expectation is towards a slight increase from 2021 to 2022 possibly as the main questions to manage MSW during the pandemic has found an answer. The papers on the second query were published in 11 different journals [93]–[103]. Some of the journals that published papers on the first query have more than one paper. Indeed, *Science of the Total Environment* dedicated a special issue on SARS-CoV-2 and collected 15 papers [1], [4], [5], [10], [16], [24], [25], [31]–[33], [36], [43], [63], [83], [84]. The other two journals that attracted papers connected with the first query are *Resources, Conservation and Recycling* [81], [82], [85], [86], [102] and *Environmental Science and Pollution Research* [14], [21], [27], [44], [48], each of them having five papers published. Four other journals, *Waste Management and Research* [8], [51], [57], *Journal of Hazardous Materials* [9], [11], [12], *Environmental Research* [23], [61], [89] and *Journal of Environmental Management* [53], [63], [78] published three papers each. Regarding the proceedings from different conferences, in the selected period only six papers were published [37], [64]–[66], [71], [92].

As an overview, it can be noticed that:

- 103 documents since June 2020, showing the typical delay from submission and acceptance of a papers and from these only five also considered the circular economy concepts [3], [25], [65], [72], [87];
- 79 were open access (a big part of the ones published on the first query and all published on the second one) showing the attention to guarantee a quick dissemination of the results of research around the world in order to help decision makers during the pandemic.

In order to understand the relevance of the scientific production, it must be underlined that in 2021 the papers in Scopus® on MSW or urban waste were 2,389. In practice the topic is belonging to a niche. May be the explanation can be done looking at Fig. 2(a), showing the affiliations of the corresponding authors of the articles in Scopus®: the presence of China (eight documents) and Italy (three documents) is visible as expected. In practice, the main production comes mostly from two countries that had to face the hardest impact of COVID-

19. Again, it is not surprising that an Italian author is present in Fig. 2(b) reporting the researchers with the highest production on the topic [65], [83], [91].



(a) (b)

Figure 2: (a) Affiliations of the corresponding authors who published on the topic in Scopus®; and (b) Main authors who published articles in Scopus® on the topic.

From another point of view, Table 1 is useful to see that articles on this topic were accepted in Scopus® indexed journals of high impact factor (Web of Science IF).

Table 1: Journals with the highest presence of papers on the topic and latest impact factor.

Science of the Total Environment	IF = 7.963 (WoS)
Environmental Science and Pollution Research	IF = 4.223 (WoS)
Resources, Conservation and Recycling	IF = 9.930 (WoS)
Waste Management and Research	IF = 3.549 (WoS)
Journal of Hazardous Materials	IF = 10.390 (WoS)
Environmental Research	IF = 6.498 (WoS)
Journal of Environmental Management	IF = 6.789 (WoS)

Zooming in on the contents of the articles, the target is different from the guidelines [104] (and their updates) that characterised the first period of pandemic: in practice the European Union issued quickly strategic guidelines in order to prevent a crisis in a sector (MSW collection and treatment) that can turn to be critical if the exposure of the operators went out of control. Looking to that period, the guidelines acted successfully.

The Scopus® literature followed a parallel pathway with time depending on the peer review lasting of the related journals. The uncertainty of the per review lasting pushed the authors to introduce in the text the concept that results will be useful for future pandemics. The presence of articles oriented to low–medium-income contexts is significant. Indeed, differently from EU and EU-like countries the MSW sector is far from to be optimised: EU guidelines could not be applied.

In Table 2 a resume of the most significant contents from the 103 documents extracted from Scopus® is presented.

Table 2: Indications for/from non-EU and EU like countries.

Indications referred to the pandemic period	Ref.
Attention must be exploited to set optimised MSW guidelines for the future	[15]
SARS-CoV-2 RNA detection in landfill leachate helps as surveillance strategy	[4]
Food delivery is contributing to a significant increase of plastic waste during the pandemic	[93]
Education and training were a significant predictor of health-protective behaviour	[22]
The presence of SARS-CoV-2 and other pathogenic microorganisms in sewage sludge, wastewater, and landfill leachate can hamper the possibility to ensure safe water and public health in economically marginalized countries	[23]
Compared to 2019, prolonged lockdowns caused larger decreases in the quantity of commercial and construction wastes versus household waste	[29]
Isolation measures greatly reduced the volume of commercial waste, especially for tourist cities, and part of this waste was transferred to household waste	[30]
With the increase in soap packaging waste production, soap packaging waste management and recycling become essential to reduce environmental impact	[31]
Face masks release microplastics, which are directly inhaled during use or transported through the environment. Additional research is needed on that topic	[38]
The extensive use of personal protective equipment (PPE) driven by the COVID-19 pandemic has become an important contributor to marine plastic pollution	[42]
Lockdowns have led to higher levels of consumption of packaged products, and of take-away food	[43]
The use of disinfectant prior to sorting waste, as well as storing waste for 9 days, may help to inactivate the COVID-19 virus, ensuring an appropriate safety level for MSW management	[48]
The codification of new policies for municipal waste management is necessary	[52]
Waste treatment facilities were overwhelmed, forcing emergency treatment and disposals (e.g., co-disposal in a municipal solid waste incinerator, cement kilns, industrial furnaces, and deep burial) to ramp up processing capacity	[53]
In countries with high recycling rates of MSW, the need to protect MSW employees' health has affected the supply stream of the recycling industry	[54]
The ban on the sale of tobacco products during the lockdown in South Africa did not greatly reduce the number of cigarette butts and associated packaging	[101]

The check of the completeness of Scopus® (or similar databases) is easy to do. Indeed, a recent work accepted in a non-Scopus® international conference [105] reported original data on the fluctuation of quantity and quality of MSW important to understand the effects of the pandemic in regions with a highly efficient source separation. Tables 3 and 4 are reported to see how the first impact of the pandemic acted on MSW in an Italian region where the MSW management is well organized [106], [107]. It can be noticed that:

- lockdown lowered MSW production for contraction of purchases but also for inactivation of eco-centres where to deliver household waste not compatible with curb side collection;
- lockdown lowered selective collection efficiency because of the inactivation of source separation at user level where householders have got COVID-19: there they had to deliver MSW fractions all together until the end of their illness.

These data and comments are not present in Scopus®, neither for similar cases, thus in case of emergency issues it is important to set wider criteria of searching to reach a comprehensive vision of the problem.

Table 3: MSW comparison during lockdown (9th–18th March 2020) and not lockdown (2019) periods in an Italian region [105].

Months	January	February	March	April	May	June
U.M.	(t)	(t)	(t)	(t)	(t)	(t)
2019	13883.58	11397.10	14666.10	14655.94	14866.11	13384.00
2020	14395.44 (+3.69%)	12540.52 (+10.03%)	12278.71 (–16.28%)	11172.56 (–23.77%)	13754.53 (–7.48%)	14510.36 (+8.42%)

Table 4: Percentage of selective collection, relative to the period between January and June of the years 2019 and 2020 for the Trento province [105].

Months	January	February	March	April	May	June
2019	79.82%	79.12%	82.70%	83.22%	83.28%	82.69%
2020	79.99%	80.86%	80.13%	79.93%	83.78%	82.76%

4 CONCLUSIONS

The present paper demonstrated that COVID-19 and MSW is a topic limited to a niche, in spite of the relevance in terms of health management. Moreover, it resulted that the more stimulated scientists belong to the regions with high criticalities during the pandemic. Depending on the short period available to develop deep research, a part of the articles underlines that future research is needed for a complete vision of the problem. International databases resulted important to find information on the topic but they cannot cover all the useful information produced during events as the present pandemic.

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