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1	Short Communication - The COVID-19 pandemic and single-use plastic waste in						
2	households: a preliminary study						
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4	Leal Filho W, Salvia AL, Minhas A, Paço A, Dias-Ferreira C						
5	Science of the Total Environment 793 01 Nov 2021 DOI						
6	http://doi.org/10.1016/j.scitotenv.2021.148571						
7							
8	Highlights						
9	- The results of a worldwide survey with 202 respondents from 41 countries are						
10	presented						
11	- The COVID-19 pandemic led increased consumption of single-use plastics						
12	- The main reasons seem to be associated with food packaging and of single-						
13	use plastic bags						
14	- The results indicate promising opportunities for the packaging industry						
15							
16	Abstract						
17	The Coronavirus pandemic promoted an unprecedented change in consumption						
18	habits, especially as lockdowns contributed to the increase in online shopping and in						
19	delivery services. One of the consequences is the substantial amounts of plastic waste						
20	produced, which can undermine the efforts to reduce plastic pollution. In this context,						
21	this commentary explores, as a preliminary study, the impacts of the Coronavirus						
22	pandemic in relation to single-use plastic waste in households by means of an						
23	international survey with 202 participants distributed over 41 countries worldwide.						
24	Keywords: COVID-19; Waste generation; Waste management; Household waste,						
25	Plastic pollution						

27 Introduction: Plastic waste and its growth in the time of COVID-19

For many years, plastic waste has become a matter of great international concern, especially plastic debris in oceans (Leal Filho et al. 2019). This concern has been intensified during the COVID-19 pandemic, in the context of which the amount of plastic waste has increased substantially. This increase is associated with significant pressures and dangers to ecosystems and to the natural environment (Silva et al., 2021).

The levels of both macro (e.g. large particles) and micro plastic (e.g. plastic fragments less 33 than 5 mm in length) have increased significantly in connection with the consumption of plastic 34 based materials associated with the treatment of patients and general health care associated 35 36 with COVID-19. This was mainly attributed to the discarding of single use personal protective equipment (PPE) which are most made of plastic. This includes disposable gloves and masks. 37 It was found that the global plastic consumption of medical gloves and face masks worldwide 38 in 2020 was approximately 69 billion units per month (Kalina & Tilley, 2020). The increase in 39 40 plastic production has added a considerable pressure to the developing countries that already struggled with the handling of plastic waste prior to the pandemic (Parashar & Hait, 2020). This 41 42 was further increased by the amount of plastic used for packing in e-commerce and food 43 takeaways (Parashar & Hait, 2020), a phenomena partly related to the limited availability of 44 bio-based plastics, whose use is not as detrimental to the environment (Silva et al., 2021).

Another example of increased plastic usage can be provided from China, where plastic waste
increased from 40 tonnes per day before the pandemic, to around 240 tonnes per day during
the pandemic. Furthermore, the amount of medical waste generation containing significant
percentages of plastics showed a rise of 370% during the pandemic (Klemeš et al., 2020;
Parashar & Hait, 2020).

50 These examples, and other documented in the literature (e.g. ESDO 2020) illustrate how the 51 substantial amounts of plastic waste produced during the time of the pandemic have been 52 undermining the global efforts to curb plastic waste pollution. The lockdowns, the increase in online shopping and in delivery services have also contributed to change in consumption of
plastic products in households. In this context, this commentary focused on exploring the
impacts of pandemic in relation to single-use plastic waste in households.

56

57 Exploratory Study

In order to understand the impacts of the crisis caused by COVID-19 in relation to single-use 58 59 plastic waste in households, a quantitative approach is used. The data collection for the self-60 report study followed a structured questionnaire survey (see Appendix A), made available 61 through the online platform Google Forms between February and April 2021. The survey 62 consisted of a total of twelve closed-ended questions on demographic details and aspects of consumption of single-use plastic waste in households. The survey instrument was then 63 64 shared with a global audience via various scientific mailing lists, the networks of the European 65 School of Sustainability Science and Research (ESSSR), and the Inter-University Sustainable Development Research Programme (IUSDRP). 66

The sample was composed of 202 respondents from 41 countries (Australia, Austria, 67 Bangladesh, Belarus, Brazil, Cameroon, Canada, Chile, Côte d'Ivoire, Cyprus, Denmark, 68 69 Egypt, Finland, Germany, Ghana, Guatemala, India, Iran, Ireland, Italy, Japan, Lithuania, 70 Malaysia, Malta, Mexico, Nigeria, Peru, Philippines, Portugal, Romania, Serbia, Singapore, Slovenia, Spain, Sri Lanka, Sweden, Switzerland, Uganda, UK, USA, Vietnam). Around two 71 third of the sample is composed of women (67% female, 32% male, 1% other) and over 75% 72 of the respondents are postgraduates (high school 2%, graduate 21%, postgraduate 77%). 73 Regarding age group, more than half of the sample is divided into the groups of 30-39 gears 74 and 40-49 years (27% and 30%, respectively), followed by 22% with 50-59 years, 13% with 75 18-29 years and 8% with 60+ years. 76

When asked about a possible change in the consumption of single-use plastics during the lockdowns, 58% of the respondents indicated that the consumption increased. In general, the increase in the use of single-use plastic was not so expressive though, with more than 1/3 of respondents indicating an increase of 20% or less while only 10% of respondents reported an

increase over 30%. Other responses split up between no change in use (27%) and decreased
consumption (15%).

As can be observed in Figure 1, when asked to specify the changes in the consumption of 83 different materials, it can be noted that for most materials a substantial change in consumption 84 85 was not observed. The most remarkable results refer to the increase of food packaging in 50% of the households and of single-use plastic bags in 35% of the households. As expected, the 86 87 majority (66%) increased the consumption of single-use masks, given the mandatory use for 88 health protection. The respondents that indicated decreased or no change in use of these 89 products are probably supporting the use of other alternatives for health protection (reusable 90 cloth masks or reusable face shields).

91

Figure 1. Change in consumption of plastic materials during the lockdown (in percentage ofrespondents per category)



94 95

96 Probably because the general increase rate was not so expressive, the level of worry about 97 the amount of plastic produced in the household during the lockdown was not so high as one 98 could expect, as results from this survey indicate. Only 21% of the sample indicated to be 99 extremely worried, followed by 27% of respondents moderately worried. 15% of the sample 100 indicating not being worried at all. On the other hand, over 90% of the sample expressed

101 concern in terms of impact of plastic waste in the environment (69% extremely concerned and102 22% quite concerned).

103 The survey also investigated different efforts to separate plastic waste and to reduce the consumption of single-use plastics. Both indicated positive results: almost 85% of the 104 105 respondents said they already used to separate plastic waste and continued doing so during the lockdown and 90% indicated they intend to reduce the use of single-use plastic in their 106 107 day-to-day life after the pandemic. Regarding ways of reducing this consumption, the most 108 voted initiative was buying fewer packed food (selected by 65% of the respondents), which 109 indicates an interesting potential for the industry of alternative packaging products and for 110 brands to re-think their products' design. Around 59% of the respondents indicated both reusing plastic bags and using cloth/fabric bag for shopping, followed by 52% of responses 111 stating intention to avoid the use of plastic straws. Other responses included using stainless 112 113 stell cutlery (39%), buying drinks in glass bottles instead of plastic bottles (33%) and using glass or steel containers for shopping (33%). 114

115

116 Conclusion

117 The results of this preliminary and self-report study show that, as expected, the COVID-19 pandemic and its consequents lockdowns brought changes in consumers' behaviour, not only 118 regarding their buying patterns but also in the amount of waste produced. Here we intended 119 to analyse the production of household plastic waste, as well as single use products as the 120 disposable gloves and masks. In fact, more than half of the consumers inquired assumed that 121 its consumption augmented, emphasising the increase of food packaging and of single-use 122 plastic bags. Even so, a considerable number of individuals are making efforts to separate 123 plastic waste and to reduce the consumption of single-use plastics. 124

When thinking about ways of reducing this plastic consumption, one of the solutions proposed was buying fewer packed food. Thus, the food industry and the retailers could take advantage of this business opportunities by providing alternative packaging (e.g. bioplastics or allowing

to purchase in bulk). The reuse is also a strategy that can be implemented by some companies
since consumers show some predisposition to enter in the circular economy.

Communication professionals, and non-governmental environmental organizations, should make an effort to sell the idea of limiting the use of unnecessary single-use plastic during the pandemic, promoting other ways of consuming certain items (ex. reusable masks). It is necessary not to forget that the impact of the single-use plastic aggravated with this pandemic, will last for many years.

In future it would be useful to research more about green consumer buying behaviour in pandemic scenarios, relating it, not only with plastic waste, but also with other waste production in households.

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Appendix A. Survey - The COVID-19 pandemic and single-use plastic waste in households

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205 ZZb started doing so during the lockdown	204			226		started doing so during the lockdown			
205 8 How did the concumption of each plactic material	203	Q	How did the consumption of each plastic material	227					
200 c. The work of the consumption of each plastic material 200 c. The plastic materia	200	υ.	abongo during the lookdown?	228	11	After the pandemic, do you intend to re	educe	the I	ise of
207 change during the lockdown? 229 single-use plastic in your day- to-day life?	207			229	• • •	single-use plastic in your day- to-day l	ife?		
230 () Yes () No				230		() Yes () No			
231				231		()			
232 11.1 If yes, how do you intend to change it? (Multiple				232	11	.1. If ves, how do you intend to change	it? (Mi	ultiple	

233 answers are possible)

