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The impacts of Covid-19 on household behavior and household waste in Turkey

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Keywords: Covid-19; Household Behavior; Household Income; Household Size; Household Waste.

Abstract. *COVID-19 has caused many radical changes in our daily life. The main purpose of this study is to examine the impact of the pandemic on*

household behavior and waste changes in the largest city of Turkey, Istanbul. Research data were collected from 946 participants in the period May to December 2020 through an online survey, and frequency and logistic regression analyses were conducted. Frequency analysis of the data showed that mask, glove, disposable bag usage, cooking at home, online shopping, home delivery, dishwasher and washing machine usage increased, while ordering food from outside decreased. In line with these behavioral changes, we found that medical, food, disposable bag and plastic wastes generated by the sampled households increased as well. We then conducted logistic regression analysis to examine the correlation between changes in household behavior and waste disposal and the income and size of households during this pandemic period. The empirical findings highlight the importance of developing special management strategies for medical, food and plastic wastes and for households with different socio-economic backgrounds to reduce the unsustainable environmental impact of COVID-19.

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1. Introduction

The rapid spread of the COVID-19 pandemic (Clements, 2020; Di Renzo et al., 2020; Zhong et al., 2020; Somani et al., 2020) has meant that, as of January 21, 2022, 216 countries, areas, or territories have been affected, resulting in 340,543,962 confirmed cases and 5,570,163 total deaths globally (WHO, 2022). The protection of people's health and lives has become the most important priority for governments all over the world, and in many countries, including Turkey, drastic measures were taken to slow down or control the spread of the pandemic (Evren et al., 2020; Turgut et al. 2020). These measures focused on social distancing and personal safety measures, in the initial absence of an effective treatment or preventative vaccine (Nussbaumer-Streit et al., 2020). Such measures, together with lockdowns, closing schools and venues where people can gather (i.e., cinemas, shopping centers, restaurants, and bars), travel restrictions, encouraging working from home (Jribi et al., 2020; Somani et al., 2020), brought about significant changes in citizens' lifestyles and had substantial social, economic, and environmental impacts (Buzzi et al., 2020; Pérez-Fuentes et al., 2020; Shakil et al., 2020; Chakraborty and Maity, 2020).

A wide range of literature reports that COVID-19 has had both positive and negative impacts on the environment. The most apparent immediate positive impact was the improved air quality due to the reductions in the concentrations of air pollutants (Bao and Zhang, 2020; EEA, 2020a; Collivignarelli et al., 2020). It has also been suggested that there was an improvement in water quality and cleaner rivers, reduction in noise pollution and recovery in wildlife (Zambrano-Monserrate et al., 2020; Arora et al., 2020; EEA, 2020b). On the other hand, the pandemic has also had negative impacts on the environment by causing an increase in waste generation, especially in medical and household waste (Sarkis et al., 2020; Dente and Hashimoto, 2020; Naughton, 2020; Kulkarni and Anantharama, 2020).

Household waste has for some time been seen as a major environmental problem (Wang et al., 2020; Massawe et al., 2014; Omran et al., 2009) and it has been suggested that the effects of different consumption patterns on waste generation deserve special attention in terms of achieving sustainable development goals (EEA, 2020b), since the amount and composition of household waste is directly related to the lifestyles and socio-economic conditions of citizens which have changed significantly due to the COVID-19 pandemic control measures (Ouhsine et al., 2020; Cesaro and Pirozzi, 2020). In this sense, Kulkarni and Anantharama (2020) have suggested that investigating the impacts of the pandemic on the quantity and composition of household waste represents a prerequisite for developing effective waste management.

The waste management of both medical facilities and households waste must be studied. Although this may help to prevent the spread of the virus, the environment is exposed to various threats due to pollution caused by the unsustainable use of single-use plastics in this period. In addition, many mandatory provisions, such as the global use of personal protective equipment like face masks by every individual, have triggered unsustainable use (Sarkodie and Owusu, 2021). The consequent extra volume of medical waste in households causes great problems for waste management sectors (Das et al., 2021). In accordance with the United Nations Environment Program for sustainable waste management, the directive to control the spread of COVID-19 through waste management states that the virus can be destroyed only by processing waste at a temperature close to 1000 degrees in incinerators. For this reason, household waste should be disposed of and managed in a sustainable manner that does not harm human and environmental health (Elleuch et al., 2018).

This study mainly aims to analyze the impacts of COVID-19 on household behavior and waste in the context of Turkey. We also aim to investigate the effects

of household income (in local currency, *Turkish Lira* "₺") and household size on the behavior of household members and waste changes during COVID-19 pandemic. We focus on research data collected from May to December 2020, during a period while lockdowns continued across the country. Since a gradual "normalization" throughout the country started as of July 2021 (Interior Ministry of Turkey, 2021), the waste behavior of households was examined during the period when the effects of the COVID-19 virus could most clearly be detected.

The rest of the paper is structured as follows. The next section describes the materials and methods employed in the study. The third section reports and discusses the results of the study, and the last section presents the conclusions we have reached.

2. Materials and Methods

Our research aims to examine household behavior and waste changes during the COVID-19 pandemic period focused on, by collecting data to test the following hypotheses related to the influence of household income and size:

Hypothesis 1: During the pandemic period household income influences household behaviors (a. cooking at home, b. ordering food from outside, c. online shopping, d. dishwasher usage, e. washing machine usage, f. disposable bag usage, g. home delivery, h. mask usage, i. glove usage).

Hypothesis 2: During the pandemic period household size also influences the same range of household behaviors during the pandemic period.

Hypothesis 3: During the pandemic period household income influences waste changes (a. paper, b. food, c. plastic, d. glass, e. electronical equipment, f. garden, g. textile, h. disposable bag, i. antivirus protection equipment).

Hypothesis 4: During the pandemic period household size influences the same range of waste changes.

2.1 Sample and Measurement Instrument

Households in Turkey's largest city, Istanbul, were chosen for our research. According to Address Based Population Registration System Results published by the Turkish Statistical Institute in 2019, the number of people residing in Istanbul was 15.519.267, a number equivalent to 18,66 % of Turkey's population. While the total number of households in Istanbul was reported to be 4.521.402 in 2019, the average household size was reported as 3,33 members (Turkish Statistical Institute, 2019).

A survey of such a large population, in a crowded and chaotic metropolis, and during a very difficult period, poses problems in terms of time and cost. All components of the population were eligible to participate the research sample and research data were collected from the participants who volunteered. The sample was created using the convenience sampling method and we reached 946 participants. Table 1 reports the socio-economic characteristics of the participants, including age, gender, marital status, educational level, occupation, household size (in terms of the number of members within the household) and household income.

Demographics	*Characteristics of the household*	*Respondent's number and percentage*
Age	18-20 age range	146 (15.4%)
	21-30 age range	362 (38,3%)
	31-40 age range	208 (22,0%)
	51-59 age range	216 (22,8%)
	60-75 age range	14 (1.5%)
Gender	Women	719 (76.0%)
	Men	223 (23.6%)
	Does not want to indicate	4 (0.4%)
Marital Status	Single	573 (60.6%)
	Married	373 (39.4%)
Occupation	Public Sector	187 (19.8%)
	Private Sector	249 (26.3%)
	Own Business	61 (6.4%)
	Student	267 (28.2%)
	Retired	18 (1.9%)
	Does not work	164 (17.3%)
Educational Level	High School & Lower Degrees	160 (17.0%)
	Vocational School	41 (4.3%)
	Bachelor	534 (56.4%)
	Master	152 (16.1%)
	PhD	59 (6.2%)

	1 member	69 (7.3%)
Household Size	2-4 members	666 (70.4%)
	5-7 members	205 (21.7%)
	8-10 members	6 (0.6%)
	3000₺ (-)	150 (15.9%)
	3001-6000₺	262 (27.7%)
Household Income	6001-9000₺	217 (22.9%)
	9001-12000₺	137 (14.5%)
	12001-15000₺	71 (7.5%)
	15001 (+)	109 (11.5%)
	Total	**946 (100%)**

Table 1. Socio-economic characteristics of the participants.

From Table 1 we see that a large number of the respondents represent the younger age ranges. Like the rest of Turkey, Istanbul is a city whose inhabitants are mostly young people and also attracts many students. At the same time, the vast majority of the sample consists of women. This reflects an imbalance in gender distribution since housework is often attributed to one gender, as is common in communities that maintain a collectivist culture. An average household in Turkey consists of 3.3 members (mostly parents and their children) and the data on household size reflect this.

The questionnaire was created online and with an easy-to-use and simple design to facilitate compilation. The survey link was announced on various social media platforms to reach wider audiences. In order to not limit the sample only to social media users, the link was also disseminated by e-mail and telephone. In addition, volunteers who contacted the researchers to participate were also included in the study. The questionnaire form consists of three sections. In the first section, the demographic characteristics (*age, gender, educational level, marital status, occupation, household size and household income*) of the participants were requested (Umunnakwe et al., 2019). The remaining sections include items on household behavior and waste change during the pandemic period. Multiple-choice questions were prepared for the participants to compare their attitudes before and during the pandemic period considered. In the second and third part, the participants were asked to mark the appropriate choice (increasing/decreasing/no change) for the items according to their experience. In the second part, items related to daily

living habits (i.e., cooking at home) were listed, while in the third part, items related to waste and recycling behaviors (i.e., paper waste and recycling) were included.

To test the changes in household behavior and waste the participants were asked to answer questions in two different sections created after a detailed literature review. Household behaviors are considered as *Cooking at Home, Ordering Food from Outside, Online Shopping, Usage of Dishwasher, Usage of Washing Machine, Disposable Bag Consumption, Home Delivery, Usage of Masks* and *Usage of Gloves*. In addition, waste changes include *Paper, Food, Plastic, Glass, Electrical Equipment, Garden Waste, Textile Products, Disposable Bags,* and *Items for Antivirus Protection.* Data on household behavior and waste changes are given under separate headings as in the questionnaire form.

2.2 Data Analysis

The research designed involved using a cross-sectional and quantitative method for descriptive and explanatory purposes. Statistical analysis was performed using SPSS software (IBM SPSS Statistics for Windows, Version 25.0. Armonk, NY: IBM Corp.). The questionnaire items were analyzed using descriptive as well as applied statistics. Data were collected through an online survey, which is thought to be the fastest and healthiest way during the COVID-19 pandemic period considered. The data of 946 participants were analyzed by multivariate logistic regression after examining the frequency distribution.

3. Results and Discussion

3.1 Household behavior changes during the pandemic period

Various changes occurred in individuals' lifestyles. Almost all people wore masks outside their homes, washed their hands frequently, and worked remotely if it was possible (Rhee, 2020). As the lifestyle changed, household behavior changed correspondingly. Spending more time at home led to an increase in domestic activities. While this caused most household behaviors to increase, in some cases it had the opposite effect. Household behaviors that are reported to have increased the most during the pandemic period are *using a mask* (99%), *cooking at home* (71%), *shopping online* (70%), *home delivery* (70%), *usage of dishwasher* (70%).

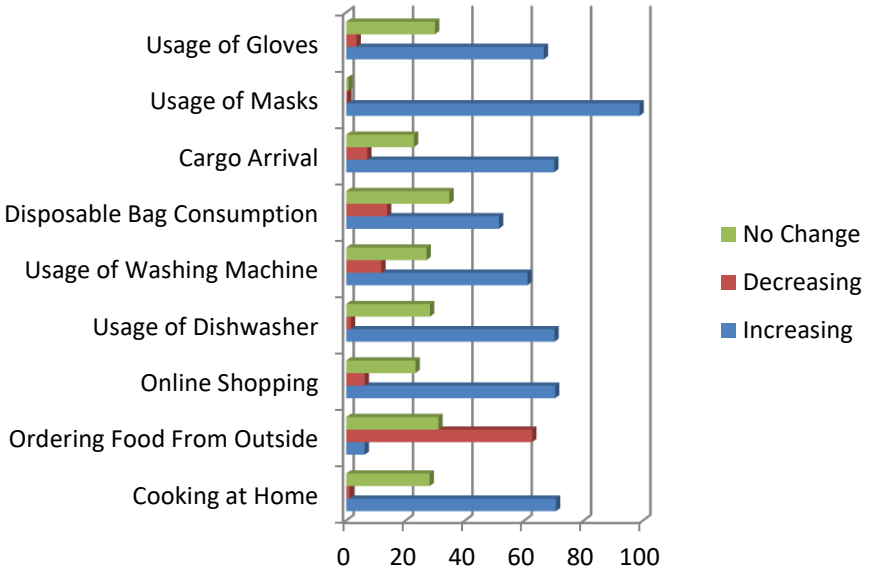

Figure 1. Household behavior changes during the pandemic period

Wearing a mask, a priority for public health concerns, came into effect rapidly (Ahmadian et al., 2020). Masks were increasingly used from the first day the virus started to spread. As found by Almandoz et al. (2020), our results show that there was an increase in cooking at home. The relative literature also reflects that most basic needs were satisfied through online shopping and delivered by courier in disposable plastic-based personal protective equipment (Singh et al., 2020; Rhee, 2020). This led to an acceleration of courier delivery and an increase in packaging waste in a very short period. The increase in home-made food consumption also caused an increase in organic waste and household dishes compared to the pre-pandemic period. In addition, dishwashers started being used not only for household dishes but also for oral hygiene equipment (e.g., toothbrush cleaning) (Bains and Bains, 2020).

On the other hand, most of the respondents (63 %) state that there was a decrease in ordering food from outside. As demonstrated by Rizou et al. (2020), particularly for high-risk populations, take-away, car service and food delivery are

among critical risk management practices to prevent the spread of the virus. Consequently, there was a decrease in the behavior of households regarding ordering from outside.

Based on the percentage changes of household behaviors, we aimed to investigate each change (increasing and decreasing) in detail. Examining the frequencies of behaviors, we saw that only "ordering food from outside" displayed a decreasing tendency while the others showed an increasing tendency. Therefore, we conducted analysis based on the emerging tendencies, using the "decreasing" and "no change" data to design a logistic model only for "ordering food from outside" behavior, and "increasing" and "no change" data to design logistic models for the other behaviors.

Household behaviors were studied as related to household income and household size. Each household behavior was measured with dichotomous variables either changing or not changing the related behavior. Response categories of only "ordering food from outside" behavior were determined as "decreasing" and "no change", whereas the other household behavior categories were determined as "increasing" and "no change" for the logistic model analysis. Response categories of household income were designed as an ordinal variable, as shown in Table 2. As a continuous variable, household size was taken to be the number of people living in the house. Multivariate logistic regression models were designed for each household behavior, so that ten distinct models were analyzed in this study, based on the Equation 1.

$$\ln\left(\frac{p}{1-p}\right) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + .. + \beta_k X_k \qquad \text{Equation 1}$$

$$\ln\left(\frac{\text{Changing household behavior}}{1-\text{household behavior}}\right) = \beta_0 + \beta_1(\text{h.income}) + \beta_2(\text{h.size}) \qquad \text{Equation 2}$$

In this context, equation 2 represents ten possible different models of household behaviors described in terms of income and size of households. Each household behavior, the dependent variable in ten separately designed models, was measured as a dichotomous variable "changing"/"not changing" of the related behaviors. This technique was used to reveal the most "change" regardless of the increase or decrease in household behavior changes. In addition, the category of "no change" was fixed as a reference category. The ordinal independent variable household income has six income levels. The minimum level (below 3000₺) was

determined to be the reference category and the other categories were compared with the reference group. Reference categories coding are represented in Table 2.

The results of the analysis showed that each of household behaviors of 'cooking at home', 'ordering food from outside', 'online shopping', 'dishwasher usage', 'washing machine usage', 'disposal bag usage' and 'home delivery' were significantly correlated with the income and size of households. However, household behaviors of "waste separation", "mask usage" and "glove usage" were not significantly correlated with these variables. Table 3 indicates only the significant models. Therefore, each model was designed separately, and the significance level of the models interpreted based on Chi-square, Wald statistics and Nagelkerke values. What emerges is the contribution of each independent variable (income and size of households) in influencing the dependent variables (household behaviors). In a logistic regression model, Wald test's level of significance represents independent variable's predictive ability of the dependent variable (Hilbe, 2016). The odds ratio [Exp(B)] represents "the change in odds of being in one of the categories of dependent variable when the value of independent variable increases by one unit" (Tabachnick and Fidell, 2007, p. 461). The odds heading in the Table 3 represents a ratio between a case happening and not happening (Pallant, 2013).

		Parameter Codes				
		(1)	(2)	(3)	(4)	(5)
Reference Group *(Household Behavior)*	,00 (no change)	.000				
	1,00 (increasing/decreasing)	1.000				
Reference Group *(Household Income)*	,00 (below 3000₺)	.000	.000	.000	.000	.000
	1,00 (3001-6000₺)	1.000				
	2,00 (6001-9000 ₺)		1.000			
	3,00 (9001-12000 ₺)			1.000		
	4,00 (12001-15000 ₺)				1.000	
	5,00 (above 15001₺)					1.000

Table 2. Reference categories of variables.

First, direct logistic regression was conducted to ascertain the likelihood that respondents would report increasing in cooking at home based on income and size of household. The overall model found significant $X^2(6, N=946) = 28,477$; $p< .05$; Wald=161,893. Given the significance level of each independent variable in explaining the dependent variable, it was confirmed that cooking at home was correlated with income and size of households.

	X^2/df	Nagelkerke R2		Beta	Wald	df	Sig.	Exp(B) (Odds)
Model 1			Income [Ref-Below 3000₺]		12,340	5	,030	
Cooking at	28,477/6	.043	Income 4 [12001-15000 ₺]	,936	6,642	1	,010	2,551
Home	p = .000		Income 5 (above 15001₺)	,892	8,675	1	,003	2,440
Ref: Inc			Household size	-,183	11,196	1	,001	,833
Model 2			Income [Ref-Below 3000₺]		14,172	5	,15	
Ordering Food			Income 2 [6001-9000 ₺]	,576	6,040	1	,014	1,779
From Outside	29.875/6	.046	Income 3 [9001-12000₺]	,572	4,886	1	,027	1,772
	p = .000		Income 4 [12001-15000 ₺]	1,009	8,371	1	,004	2,742
			Income 5 [above 15001₺]	,782	7,445	1	,006	2,185
Ref:Dec			Household size	-,165	9,235	1	,002	,848
Model 3			Income [Ref - Below 3000₺]		22,572	5	,000	
Online			Income 1 [3001-6000 ₺]	,463	4,044	1	,044	1,588
Shopping	23.621/6	.039	Income 2 [6001-9000 ₺]	,863	11,495	1	,001	2,370
	p = .000		Income 3 [9001-12000₺]	,536	3,877	1	,049	1,710
			Income 4 [12001-15000 ₺]	1,390	11,895	1	,001	4,017
Ref:Inc			Income 5 [above 15001₺]	1,126	12,629	1	,000	3,083
Model 4			Income [Ref - Below 3000₺]		21,170	5	,001	
Dishwasher	28.532/6	.044	Income 3 [9001-12000₺]	,509	3,693	1	,055	1,663
Usage	p = .000		Income 4 [12001-15000 ₺]	1,379	11,943	1	,001	3,969
Ref: Inc			Income 5 [above 15001₺]	1,087	12,083	1	,001	2,964
Model 5			Income [Ref - Below 3000₺]		10,957	5	,052	
Washing M.	13.695/6	.023	Income 4 [12001-15000 ₺]	,828	5,406	1	,020	2,290
Usage	p = .033		Income 5 [above 15001₺]	,820	6,544	1	,011	2,270
Ref:Inc								
Model 6			Income [Ref - Below 3000₺]		10,775	5	,056	
Disposal Bag	26.571/6	.044	Income 4 [12001-15000 ₺]	,741	4,418	1	,036	2,099
Usage	p = .000							
Ref:Inc.								
Model 7			Income [Ref-Below 3000₺]		16,924	5	,005	
Home	18.490/6	.031	Income 2 [6001-9000 ₺]	,588	5,449	1	,020	1,801
Delivery	p = .005		Income 4 [12001-15000 ₺]	1,372	10,577	1	,001	3,942
Ref: Inc			Income 5 [above 15001₺]	,993	9,695	1	,002	2,699

Table 3. Variables in the multivariate logistic regression models for household behaviors.

Nagelkerke R^2 indicated that the income and size of households explained 4.3% of cooking at home. Based on the multivariate logistic regression model, each category was compared with the reference category. As regards Model 1, by comparing household income with the reference category, it was seen that individuals who have between 12001₺ and 15000₺ household income were over 2.5 times more likely to cook at home than those who have 3000₺ and below household income. In addition, individuals who have more than 15000₺ household income would probably cook at home 2.4 times more than those who have less than 3000₺ income. The odds ratio of .83 of household size was less than 1, which indicated that for each additional person in a house it was .83 times less likely to increase cooking at home, controlling for other factors in the model.

Model 2 indicates the overall model concerning how ordering food from outside behavior was analyzed as related to income and size of household. Household income and size explained 4.6% of ordering food from outside. It was seen that individuals with more than 6000₺ household income were less likely to order food from outside than those with under 3000₺ household income. We found that individuals who have between 6001₺ and 9000₺ household income were over 1.7 times less likely to order food from outside than those who have 3000₺ and below household income. This result was the same for the 9001-12000₺ household income group who order from outside with 1.7 times lower probability than those who have 3000₺ and below. In addition, the household income group of '12001-15000' and '15000₺ above' were approximately 2 times less likely to order food from outside than those who have 3000₺ and below. The odds ratio of .84 of household size was less than 1, which indicated that for each additional person in a house it was .84 times less likely to decrease ordering food from outside, controlling for other factors in the model.

The results of the analysis showed a significant correlation between online shopping and household income, as seen in Model 3. However, household size produced a non-significant coefficient in this model. Household income explained 3.9% of online shopping behavior. All categories of household income ('3001-6000₺', '6001-9000₺', '9001–12000₺', '12001-15000₺', 'above 15001₺') would probably do online shopping more than the reference category ('under 3000₺' household income). Results indicate that individuals who have between 3001 and 6000₺ household income were 1.5 times, individuals who have between 6001 and 9000₺ were 2.3 times, individuals who have between 9001 and 12000₺ were 1.7 times, individuals who have between 12001 and 15000₺ were 4 times, and individuals who have more than 15001₺ were 3 times more likely to do online shopping than those who have 3000₺ and below.

Model 4 showed a significant correlation between dishwasher machine usage and household. At the same time, household size produced a non-significant value in this model. Household income explained 4.4% of dishwasher machine usage. It was seen that individuals who have between 9001₺ and 12000₺ household income were over 1.6 times more likely to use a dishwasher than those who have 3000₺ and below. In addition, individuals with 12001₺ and 15000₺ household income were over 3.9 times more likely to use a dishwasher than those with 3000₺ and below. Furthermore, individuals who have more than 15000₺ household income would probably use a dishwasher 2.9 times more than those who have 3000₺ and below.

Model 5 showed a significant correlation between washing machine usage on the basis of household income, while household size is non-significant in this model. Household income explained 2.3% of washing machine usage. It was seen that individuals with between 12001₺ and 15000₺ household income were over 2.2 times more likely to use washing machine than those with 3000₺ and below. Moreover, individuals who have more than 15000₺ household income would probably use washing machine 2.2 times more than those who have 3000₺ and below.

The results of the analysis showed that disposable bag usage could be significantly explained on the basis of household income, as seen in Model 6. At the same time, household size is non-significant in this model. Therefore, household income explained 4.4% of disposal bag usage. Comparing household income with the reference category, individuals who have more than 15000₺ household income would probably use disposable bags 2 times more than those who have 3000₺ and below.

Model 7 indicates that home delivery was significantly correlated with household income. However, household size proved non-significant in this model. Household income explained 3.1% of home delivery. It was seen that individuals with between 6001₺ and 9000₺ household income were over 1.8 times more likely to prefer home delivery service than those with 3000₺ and below household income. In addition, individuals who have between 12001₺ and 15000₺ household income were over 3.9 times more likely to prefer home delivery service than those who have 3000₺ and below. Moreover, individuals who have more than 15000₺ household income would probably prefer home delivery service 2.6 times more than those who have 3000₺.

Thus, through our logistic regression model and analysis we confirmed the H_{1a}, H_{2a}, H_{1b}, H_{2b}, H_{1c}, H_{1d}, H_{1e}, H_{1f}, H_{1g} hypotheses.

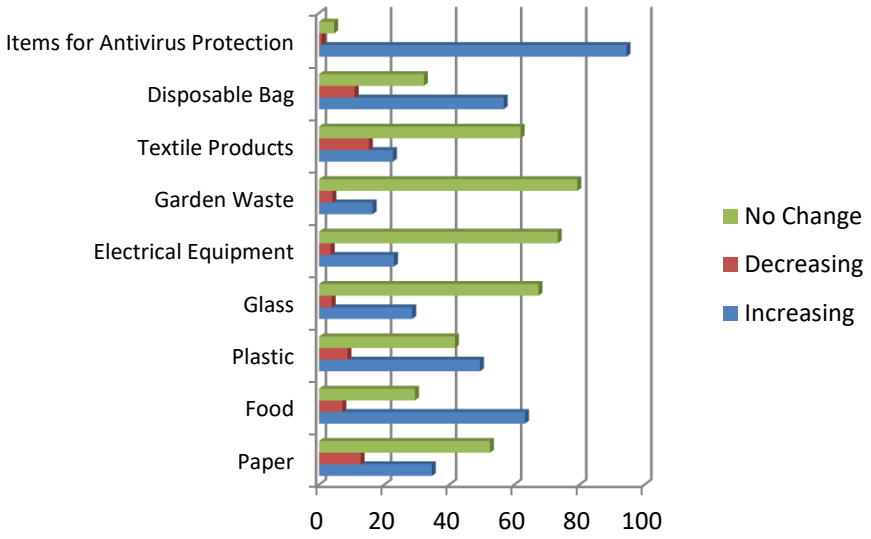

Figure 2. Household waste changes during the pandemic period.

3.2 Household Waste Changes During the Pandemic Period

Factors such as rapid increase in population and urbanization, socio-economic transformations and improvement of living standards lead to an increase in the amount of municipal solid waste generation (Wang et al., 2020; Omran et al., 2009). Istanbul is the most populous city of Turkey and is subject to an ongoing process of overcrowding in various ways, leading to an increase in the waste collected by the municipalities. According to the Turkish Statistical Institute data, in 2018 the amount of waste collected by municipalities in Istanbul was 7,042,585 tons (Turkish Statistical Institute, 2018). This equates to 1,28 kilograms of waste per person living in Istanbul. In addition to the overcrowding of the city, a decrease in recycling sensitivity has been recorded as one of the negative side effects of COVID-19 (Zambrano-Monserrate et al., 2020), significantly leading to an increase in waste in Istanbul. The main reasons for this decrease in recycling sensitivity can be cited as the increase in the use of disposable products, new products that have become a part of daily life, and the closure of the recycling centers necessary for the reuse of the wastes of these products. Like many sustainability

practices disrupted by the pandemic, recycling centers were temporarily closed in many countries, based on the belief that they could add to the risk of spreading COVID-19. Waste separation is another important issue concerning the efficiency of recycling centers. For example, since it was not possible for some municipalities to recycle masks and gloves that are separated as household waste, the increased waste volume caused further negative consequences for the environment, together with decreased recycling sensitivity (Bal and Ozturk, 2020).

Figure 2 represents the data we collected from the households of Istanbul regarding waste change. Household waste, which the households stated to be those that most increased, is listed as *items for antivirus protection* (95%), *food* (63%), *disposable bag* (57%) and plastic (49%).

Waste behavior can clearly be expected to change during a pandemic period. Hygiene products and various methods of virus protection, which are more integrated into individuals' lives than ever before, have also changed the solid waste production of households. Behaviors aimed at increasing individual hygiene standards have caused a large amount of medical waste in the environment (Saadat et al., 2020). Uncertainty about a possible stressful event and the fact that this uncertainty will persist for an indefinite period impairs the necessary self-control required to balance food consumption (Core et al., 2018). The active spread of the virus and the continuing uncertainty about the future have caused individuals to stay home. As a result, household waste has increased due to the increase in home-made meals and the demand for home delivery (Dente and Hashimoto, 2020). Additionally, the literature shows that the demand for and use of plastic packages and disposable plastic bags has increased during the pandemic period because of safety and hygiene concerns (Sharma et al., 2020; Klemeš et al., 2020; Singh et al., 2020). All these factors have played an inevitable role in the increase of household waste.

Concerns surrounding safety and hygiene during the pandemic have led to a substantial increase in plastic packaging, with likely implications on global sustainability efforts to curb plastic pollution. The reliance on online shopping for home delivery of commercial and essential products during lockdown has provoked a surge in demand for single-use plastic bags.

Based on the frequencies of waste shown in Figure 2, we aimed to investigate each type of waste change in detail. Investigating the frequency distribution of the waste changes, we observed an increasing trend in the data, so we conducted analysis on the basis of the existing increasing tendencies of each type of waste

change. In addition, we used "increasing" and "no change" data to develop logistic models for waste changes.

Waste changing was explained on household income and household size grounds. Multivariate logistic regression models were designed for each waste change, to analyze nine distinct models, proceeding as in Equation 2 above.

$$\ln\left(\frac{\text{Changing waste}}{1-\text{changing waste}}\right) = \beta_0 + \beta_1(\text{h. income}) + \beta_2(\text{h. size}) \qquad \text{Equation 3}$$

		Parameter Codes				
		(1)	(2)	(3)	(4)	(5)
Reference Group *(Waste changing in household)*	,00 (no change)	.000				
	1,00 (increasing/decreasing)	1.000				
Reference Group *(Household Income)*	,00 (below 3000₺)	.000	.000	.000	.000	.000
	1,00 (3001-6000₺)	1.000				
	2,00 (6001-9000 ₺)		1.000			
	3,00 (9001-12000 ₺)			1.000		
	4,00 (12001-15000 ₺)				1.000	
	5,00 (above 15001₺)					1.000

Table 4. Reference Categories of Variables.

In this way, nine different models of waste changing in household are examined on the basis of income and size of households. Each waste change, the dependent variable, was measured as a dichotomous variable "decreasing"/"increasing" of the relative waste change. The category of "no change" was fixed as a reference category. One of the ordinal independent variables, household income, has six income levels. The minimum level (below 3000₺) was determined to be the reference category and the other categories were compared with the reference group. Reference categories coding is represented in Table 4.

The results of the analysis showed that 'paper', 'glass', 'disposable bag' and 'anti-virus protection equipment' waste changes were significantly correlated with

income and size of household. On the other hand, 'food', 'plastic', 'textile', 'electronic equipment' and 'garden' waste changes were not correlated significantly with these variables. Table 5 represents only the significant models. Each model was designed separately, and the significance level of models analyzed based on Chi-square, Wald statistics and Nagelkerke values. This shows the contribution of each independent variable (income and size of households) to observe their influence on the dependent variables (waste change).

	X^2/df	Nagelkerke R2		Beta	Wald	df	Sig.	Exp(B) (Odds)
Model 1			Income [Ref-Below 3000₺]		16,973	5	,005	
Paper Waste	22,520/6	.039	Income 2 [6001-9000₺]	,589	5,498	1	,019	1,802
Change	*p* = .001		Income 3 [9001-12000₺]	,711	6,825	1	,009	2,036
			Income 4 [12001-15000₺]	,950	8,554	1	,003	2,585
Ref: Inc			Income 5 [above 15001₺]	,861	8,868	1	,003	2,366
Model 2			Income [Ref-Below 3000₺]		36,528	5	,000	
Glass waste	55.394/6	.084	Income 3 [9001-12000₺]	1,021	12,503	1	,000	2,777
change	*p* = .000		Income 4 [12001-15000₺]	1,467	19,361	1	,000	4,337
			Income 5 [above 15001₺]	1,230	16,804	1	,000	3,422
Ref: Inc			Household size	-,185	10,343	1	,001	,831
Model 3			Income [Ref-Below 3000₺]		14,258	5	,014	
Disposal Bag	22.632/6	.036	Income 3 [9001-12000₺]	,773	7,734	1	,005	2,167
Change	*p* = .001		Household size	-,117	4,827	1	,028	,889
Ref:Inc								
Model 4			Income [Ref-Below 3000₺]		10,080	5	,073	
Antivirus	16.689/6	.056	Income 1 [3001-6000₺]	1,161	7,088	1	,008	3,192
protection	*p = .010*		Income 2 [6001-9000₺]	1,148	6,302	1	,012	3,152
Ref:Inc								

Table 5. Variables in the multivariate logistic regression models for waste changes.

Multivariate logistic regression analysis was conducted to ascertain the likelihood that respondents would report an increase in paper waste based on income and size of household. The overall model found household income significant, but household size non-significant. Nagelkerke R^2 indicated that household income explained 3.9% of paper waste change.

On the basis of the multivariate logistic regression model, each variable was compared with the reference category. For Model 1, by comparing household income with the reference category, it was seen that individuals with than 6001₺ household income were more likely to produce paper waste than those with under 3000₺. Results indicated that individuals who have between 6001 and 9000₺ household income were 1.8 times, individuals who have between 9001 and

12000₺ were 2 times, individuals who have between 12001 and 15000₺ were 2.5 times, and individuals who have more than 15001₺ were 2.3 times more likely to produce paper waste than those who have 3000₺ and below.

Model 2 showed that the overall glass waste was correlated with income and size of household. Household income and size explained 8.4% of glass usage. Results showed that individuals with more than 9001₺ household income were more likely to produce glass waste than those with under 3000₺. We found that individuals who have between 9001₺ and 12000₺ household income were over 2.7 times, individuals who have between 12001₺ and 15000₺ household income were over 4.3 times, individuals who have more than 15000₺ household income were over 3.4 times more likely more likely to produce glass waste. The odds ratio of .83 of household size was less than 1, which indicated that for each additional person in a house it .83 times less likely to increase glass waste, controlling for other factors in the model.

Model 3 indicated that disposable bag waste correlated with household income and size. Household income and size explained 3.6% of disposable bag waste change. Individuals who have between 9001₺ and 12000₺ household income were 2.1 times more likely to produce disposable bag waste than those who have 3000₺ and below. The odds ratio of .88 of household size was less than 1, which indicated that for each additional person in a house it was .8 times less likely to increase disposable bag waste, controlling for other factors in the model.

Our results showed that antivirus protection waste change could be significantly correlated with household income, as seen in Model 4. However, household size produced a non-significant coefficient in this model. We found that household income explained 5.6% of antivirus production waste during pandemic period. The household income group of '12001-15000₺' and '15000₺ above' were approximately 3.1 times more likely to produce antivirus protection waste than those who have 3000₺ and below.

Thus, through our logistic regression model and analysis we confirmed the H_{3a}, H_{3d}, H_{4d}, H_{3i}, H_{4i}, H_{3h} hypotheses.

4. Conclusions

In the light of the impact of the COVID-19 pandemic on the lifestyles of citizens, this research aimed to empirically analyze how household behavior and waste changed in the period from May to December 2020 in the largest city of Turkey, Istanbul, by using an online questionnaire survey. Our results indicate that usage

of masks, cooking at home, online shopping, home delivery, and usage of dishwashers increased substantially. On the other hand, results of the study indicate that most of the respondents reduced ordering food from outside. In line with these behavioral changes, we have also detected important changes in the household waste of the respondents. Most of the respondents reported that there are increases in the quantities of medical waste, food waste, disposal bags and plastic waste. These results show that individual health precautions to avoid infection and decreased outdoor mobility led to increase in these types of household wastes.

We also attempted to analyze the effects of household income and household size on the behavioral and household waste changes during the pandemic period. The results of logistic regression analysis show that household income and size are related to the changes in the respondents' behaviors such as 'cooking at home', 'ordering food from outside', 'online shopping', 'dishwasher usage', 'washing machine usage', 'disposal bag usage' and 'home delivery'. 'Paper', 'glass', 'disposable bag' and 'antivirus protection equipment' waste changes during the pandemic period are also related to household income and size.

Our study highlights the need for developing special management strategies and action plans, especially for medical, food and plastic household waste to reduce the negative environmental impacts of such a pandemic. Examples of this could be sustainable industrialization (to support the huge amounts of unexpected material production), reusing (minimizing the unnecessary usage of raw material and waste generation), efficient food use (meal planning, freezing, and preserving), and behavioral change in daily life (optimum consumption and raising awareness towards recycling and reusing) (Babbitt et al., 2021; Rume and Islam, 2020). Furthermore, considering the effects of household income and size on the composition of household waste, it is possible to say that local and central authorities should seek ways of developing effective waste management strategies for citizens who have different socio-economic characteristics. In addition, dissemination of methods such as composting and waste separation by the authorities are necessary to increase the involvement of individuals in sustainable waste management (Khan et al., 2019).

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The contribution of each author to the manuscript is as follows:

Serap Yalçınyiğit: Preparing the research design, writing the draft. *Aygül Dönmez-Turan:* Analysis of the collected data, gathering the data. *Halil E. Akbaş:* Gathering the data, contributing the theoretical background. *Gamze Varank:* Contributing the theoretical background.

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