

Knowledge of packaging waste among czech university students

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Abstract. The residential sector generates around 14% of the overall waste production in the Czech Republic. This essential share requires special attention to analyze with particular emphasis for citizen education, especially on young people. Thus, this research is dedicated to citizens' awareness about packaging waste to increase their knowledge. The experiment was conducted in the form of a survey, and students from a Czech university were asked to estimate the weight of the packaging waste presented to them in term to verify their knowledge about packaging waste. This experiment featured different groups of students over time. The result showed no difference in knowledge between these student groups over time. The long-term home study caused by COVID-19 did not appear to have affected students' knowledge of packaging waste. This study showed students' actual knowledge about packaging waste and highlighted the gap and importance of education in waste management.

Key words: education, packaging waste, residents, survey, waste sorting.

INTRODUCTION

The rapid growth of waste is a constant reminder to the European Union to manage it effectively to minimise its environmental impact. According to Kaza et al. (2018), waste generation around the world will have significantly outpaced population growth by more than doubling by 2025. It is commonly understood that waste consists of useful and valuable materials.

The residential sector significantly contributes to total waste production in the Czech Republic, generating up to 14% of the total waste production in 2021 (Czech Statistical Office (CSO, 2022)). This high percentage makes it imperative to focus on citizen education and awareness about responsible waste management. This study focused, in particular, on packaging waste, which makes up to 19% of total municipal waste generation and whose production is diverted by the behaviour of the citizens (CSO, 2022). Packaging waste generated by packaging material in EU Member States has shown an increasing trend since 2009 and the main compounds are paper and cardboard, plastic, glass, wood, and metal. The average production per capita was 177.2 kg in 2020. In comparison, the Czech production was about 50 kg lower than the EU average (124.2 kg capita⁻¹ yr⁻¹) and the recycling rate of 67% of the produced packaging was above average (Eurostat, 2021). Packaging waste is an emerging

environmental issue due to its volume, reusability, and recyclability. This problem results from the excessive use of packaging materials in consumer goods and contributes to the problem of plastic pollution. Addressing it requires the participation of citizens (Han et al., 2010). The issue of packaging waste is particularly acute in urban areas where the population density is high, and the waste management infrastructure is under pressure. Also, the fast growth of the e-commerce industry affected large production of packaging waste (Wang & Hu, 2016). Packaging waste types are highly variable and consist of a wide range of compounds. A good understanding of packaging waste can contribute to more effective sorting at the source. Education and increased awareness, among other factors, play a crucial role in influencing sorting and recycling rates (Suthar & Singh, 2015). People’s awareness and knowledge about waste sorting and recycling differ across income levels, geographical, cultural, and socio-economic impacts, reflecting varied patterns of consumption (Kreith, 1999; Dehghani et al., 2009; Diaz et al., 2020). Proper management of packaging waste, from primary waste collection through recycling and recovery, is needed and requires thoughtful inspection (Mimra et al., 2016; Chotovinský & Altmann, 2018; Kaza et al., 2018). Therefore, precious knowledge on packaging waste is essential to increase resource efficiency, target priority areas for the implementation of mitigation policies and subsequently achieve European recycling and circular economy goals (Lebreton & Andrady, 2019; Tallentire & Steubing, 2020).

The aim of this study was to analyse respondents’ awareness and knowledge of packaging waste generated at home over a medium-term period. Time was considered an important factor that can change people's views on waste generation at the source, and this study was conducted with repeated measurements.

During the experiment, the Coronavirus 2019 disease (COVID-19) emerged and affected people's way of living and working on a large scale for a short period. People were forced to stay at home and travel was reduced. At the same time, online shopping became prevalent during this period. The entire e-commerce industry reported multi-fold increase in orders. Thus, this aspect was included in this experiment as well.

MATERIALS AND METHODS

This experiment examined citizens’ understanding of various types of packaging waste and was conducted as a survey. Research participants involved were students from a university in Prague, Czech Republic, randomly selected across grades and regions of residence. Three independent groups with a total of 135 students were compared over an extended period. Students were given the survey, that included questions estimating the type and weight of prepared samples of packaging waste (Table 1).

Table 1. List of packaging waste used in the experiment

Packaging waste	PET 2 L	Plastic bottle 1.5 L	Plastic bottle 0.5 L	Can 0.5 L	Milk carton 1 L	Juice carton 1 L	Champagne 0.75 L	Wine 0.75 L	Beer PET 1.5 L
Weight (g)	56	37	24	15	30	38	611	420	47

Nine types of commonly used packaging waste were chosen in this experiment and presented to students for determination. This experiment was carried out several years

in a row to capture the changes in perception about packaging waste over time and as well to include the impact of the COVID-19 pandemic left on students, as during the pandemic in years 2020–2021, students were staying at home and having distance learning. Students were divided into three groups: before, during, and after the pandemic for better identification. Surveys from students were collected and analysed continuously, with comparisons made within and between groups as well as against actual values.

Software and statistical analysis

All the statistical analyses were conducted using the program IBM SPSS Statistics (IBM Corp., 2021). Since none of the collected data showed a normal distribution, the non-parametric method of statistics was applied to the experimental data. The Kruskal-Wallis Test (Kruskal & Wallis, 1952) was applied to assess the difference among three student groups over a time-span. The Student's *t*-test non-parametric equivalent, One-Sample Wilcoxon Signed Rank Test (Wilcoxon, 1945) were chosen for evaluating the difference between each students' group from the real value.

RESULTS AND DISCUSSION

This study aimed to evaluate the knowledge about packaging waste among university students from various degrees and regions. Additionally, the emergence of the COVID–19 pandemic presented unique challenges for students as education shifted to online learning and students spent more time at home. In order to capture the potential impact of the pandemic on students' perceptions and knowledge of packaging waste, data was collected during the pandemic without interruption. This data was then compared to data collected from groups of students prior to the pandemic. Furthermore, each group was evaluated separately, and their estimations were compared to the actual values.

Firstly, three groups of students were compared to each other over time, including before, during, and after the pandemic. The results of the Kruskal-Wallis Test showed that there was no statistically significant difference in the means of the assessed groups ($p\text{-value} > 0.05$, Fig. 1), indicating that the groups after the pandemic did not have a different understanding of the total packaging waste than the groups before or during the pandemic. This suggests that the distance learning and isolation caused by COVID–19 did not appear to have wide impacts on students' knowledge of packaging waste. This finding is in line with a study by Mao et al. (2022), which did not demonstrate a significant difference between the methods of conventional and video-based education in terms of teaching methods. Despite the statistical result showing no significant

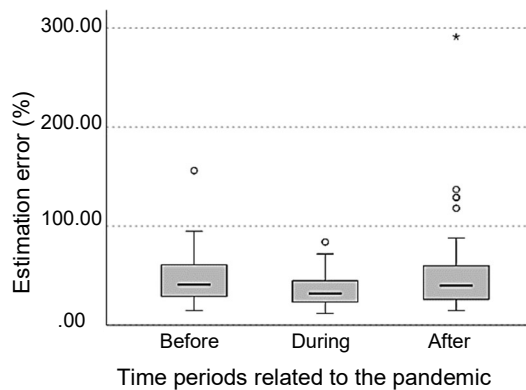


Figure 1. Comparison of 3 independent groups over time span has shown no differences among involved respondents.

difference, the COVID-19 pandemic did cause global disruption in all pupils and students' lives (Powell et al., 2021) due to the repeated ban on the personal presence of students in education and study processes (Snopek et al., 2021). All applied measures influenced the daily lifestyle and eating habits of all students (Powell et al., 2021). According to other studies, online distance instruction (ODI) has a great impact on education around the world.

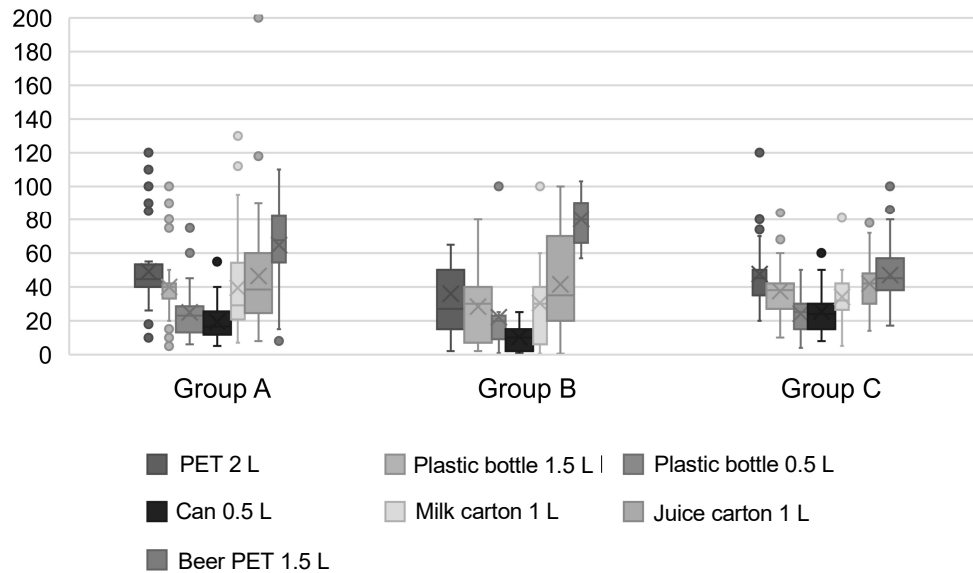


Figure 2. A more detailed look at the comparison between groups by type of packaging waste. Packaging waste Champagne and Wine glass are excluded and depicted separately.

When it comes to the concrete type of packaging, i.e. individual testing of packaging waste, few differences appear (Fig. 2 and 3). Particularly in plastic beer bottles, groups during and after showed distinct variations from the group before. This deviation may reflect a less satisfying fact, as it may be linked to the findings from other studies on COVID-19 that demonstrated elevated alcohol consumption during the pandemic. However, it is important to note that the initial months exhibited a declining trend in alcohol consumption (Neill et al., 2020; Sidor & Rzymiski, 2020; Murthy & Narasimha, 2021; Rossow et al., 2021).

The next part of the experiment was focused on the accuracy of the students' estimates, where each group

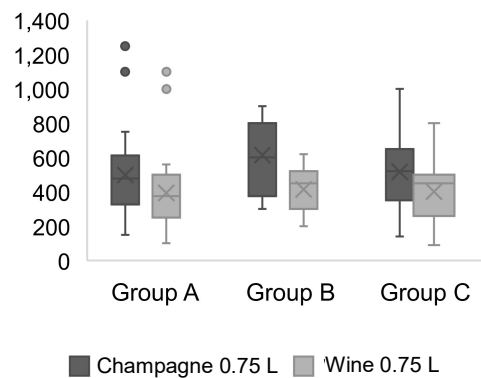


Figure 3. Comparison between groups with packaging wastes separated from the overall data due to their distinct values.

of students was compared to the actual value of the packaging weight (Fig. 4). According to the results, the most accurate students came from the third group after the pandemic, with six different types of packaging weight where their estimation was close to the real value. Groups before and during the pandemic had only about one correct estimate less, but they still had more than half of the accurate estimates. All three groups had a good estimate when guessing the weight of the 1.5-litre plastic bottle, as well as the juice box and the wine glass. The most challenging packaging type for students was 2-litre PET bottle and Champagne bottle, which did not meet success in any of the three groups. Across all groups, the average estimate was higher than the actual level. A similar situation occurred with champagne glasses when the average estimate was higher than the actual weight. On the other hand, students in three groups estimated plastic beer bottles to be lighter than they were. The possible reason might be that PET is a particular plastic type and has a different weight than other types of plastic bottles; therefore, even students were successful in both sizes of plastic bottles (0.5 L and 1.5 L) but failed in 2-litre PET. Also, the reason might be the unusual size of the PET bottle (2 L), which is not used by students very often for beverages. The same reason is suitable for cans with 0.5 L of volume; this type of packaging is very rarely used for beverages. These data could be useful for future design of the deposit refund system (DRS) as this topic has gained more attention in the Czech Republic. The types of packaging presented in the experiment are possible refundable beverage containers in DRS. Students during the survey were introduced to the beverage containers available for deposit refunding and the ways in which they can be refunded using data published by initiative Zalohujme.cz (Cordle et al., 2019).

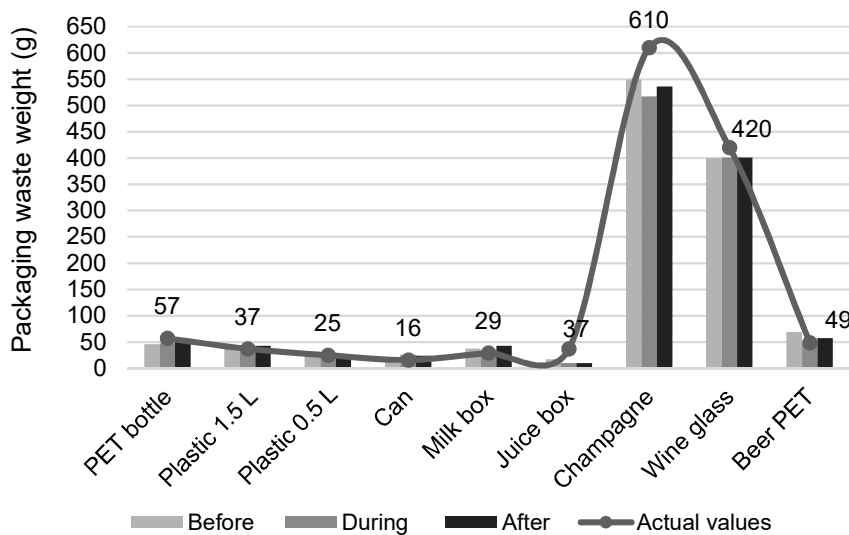


Figure 4. Result of respondents' estimations compared to the actual values.

It is important to note that the pandemic had both positive and negative impacts in many ways. The composition of waste changed during the pandemic according to a number of studies (Fan et al., 2021; Kasim et al., 2021; Laila et al., 2022). But people were pandemic motivated to initiate waste reduction, increase waste separation and

waste recovery (Requena-Sanchez et al., 2023). At the same time, environmental awareness rose around the pandemic and influenced sustainable consumption (Ali et al., 2021; Severo et al., 2021; Daryanto et al., 2022).

The summary demonstrates that students at the university have a common level of knowledge and do not differ by academic year. However, the university must continue to encourage and raise awareness about managing municipal waste, including packaging waste. This is important according to Zarębska (2014) who demonstrated a positive relationship between the environmental awareness of respondents and their level of effectiveness in the management of waste. Not only for students at universities, it is necessary to promote awareness and draw attention to the necessity of recycling materials among the younger generations (Licy et al., 2013).

CONCLUSIONS

In this study, an application of the knowledge testing method was presented. The experiment revealed that the actual knowledge of students about packaging waste did not vary over time and pointed out the importance of knowledge of waste management. Further, it was suggested to perform this experiment at different educational levels in order to obtain a more thorough and comprehensive evaluation across all age groups. Overall, this study highlighted the need for continued education and awareness-raising efforts in order to enhance public understanding of the growing amount of packaging waste in circulation and its impact on the environment.

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