



SEINÄJOEN AMMATTIKORKEAKOULU
SEINÄJOKI UNIVERSITY OF APPLIED SCIENCES

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The amount of food waste and food packages generated in various-sized households with university students

Margit Närvä, Jarmo Alarinta and Gun Wirtanen
Seinäjoki University of Applied Sciences, Seinäjoki, Finland

Abstract

Purpose – The purpose of this study was to investigate amount of food waste and the number of food packages used in Finnish households with university students. The aim of the paper is to answer the following research questions: How much avoidable food waste is generated in the participating various sized households? How much unavoidable food waste is generated in the participating various sized households? How many food packages are classified as deposit, municipal waste or recycled in the participating various sized households?

Design/methodology/approach – The data was collected among the students in Seinäjoki University of Applied Sciences. A total of results from 432 households with 890 persons are presented. The participating households weighed their unavoidable and avoidable food waste and calculated the food packages during one week. The results were analysed in Excel and the statistical significance assessed using a *t*-test.

Findings – The average avoidable and unavoidable food wastages were 498 g/week/person, i.e. 25.9 kg/year/person and 543 g/week/person, i.e. 28.3 kg/year/person, respectively. Single-person households generate more avoidable and unavoidable food waste as well as packages per person than other sized households. The results show that there is no correlation between the amount of avoidable food waste/person, unavoidable food waste/person or packages/person.

Originality/value – This kind of research has sparsely been reported. The food and package wastage definitions vary, and thus it is difficult to compare these results with other reported results.

Keywords Avoidable food waste, Unavoidable food waste, University student, Food packages, Households

Paper type Research paper

1. Introduction

1.1 *Definitions of avoidable and unavoidable food wastes*

Several studies about food waste in households have been carried out in recent years (Barker *et al.*, 2023; Herzberg *et al.*, 2020; Aitsidou *et al.*, 2019; Cantaragiu, 2019; Landry and Smith, 2019; Pellegrini *et al.*, 2019; Delley and Brunner, 2018; Szabó-Bódi, *et al.*, 2018; Lanfranchi *et al.*, 2016). In the literature, food waste definition varies. This means that it is difficult to compare research on food waste directly.



European meta-analyses use terminology containing avoidable or edible food waste, which means that food is thrown away prior to disposal, e.g. bread slices, fruit and cold cuts (European Commission, 2011). According to the article written by Silvennoinen *et al.* (2014), food waste in households can be divided into avoidable waste, which includes leftovers due to too much production, and bio-waste, which includes bones, skin, tea leaves, coffee ground and fruit peels. Possibly avoidable food waste is described in the preparatory study across EU 27 as food, which can either be eaten or not. The non-edible food waste contains, e.g. fruit and potato peels. In the same report, unavoidable food waste was defined as “waste arising from food preparation e.g. fish bones and eggshells” (European Commission, 2011).

In this research, food waste is divided into avoidable, i.e. edible and unavoidable, i.e. non-edible food waste. The respondents taking part in this study decided themselves whether the food waste should be categorized as avoidable or unavoidable waste.

1.2 The amount of food waste in households

Barker *et al.* (2023) found out that the amount of food waste was 48.6 kg/person annually. In this study, 51% of total food waste was either avoidable or potentially avoidable. In the Hungarian results compiled by Szabó-Bódi *et al.* (2018), the annual amount of avoidable food waste was 33 kg/person. According to Silvennoinen *et al.* (2014), the annual average food waste was 23 kg/person in Finland. Närvä *et al.* (2023) found out that the average annual amount of food waste in Finnish households with at least one university student was 25.2 kg/person. The annual food waste per person depended on the size of households and was 36.6 kg in one-person households, 25.2 kg in two-person households, 25.7 kg in three-person households and 23.7 kg in four-person households. The variation in same sized households varied; the results showed that the waste varied from none to large amounts of avoidable food waste. This revealed that there are households in all sizes that produce lots of food waste; these households affect the green transition negatively and are due to both attitudes and behavioural habits. Barker *et al.* (2023) presented similar results. According to them, avoidable annual food waste per person was 35.8 kg in one-person households, 10.0 kg in two-person households, 25.4 kg in three-person households and 19.7 kg in four-person households. Furthermore, in their study unavoidable and potentially avoidable food waste per person was all together 34.6 kg in one-person households, 29.7 kg in two-person households, 19.6 kg in three-person households and 27.7 kg in four-person households. Williams *et al.* (2020) also noticed that the food waste amounts per person were reduced when the number of persons in household increase. They reported that the participating household removed on average 1.9 kg of food during the reporting week. The waste in small households (1–2 persons) was on an average 920 g/person (\pm 720 g/person) over a week and in bigger households (3–8 persons) 640 g/person (\pm 500 g/person). The food waste was on average 780 g/person/week. Converted to annual level, this gives approximately 40 kg/person.

Silvennoinen *et al.* (2022) found out in their research performed in Finnish urban areas that the total annual amount of food waste varied between 53.0 and 62.1 kg/person, and it contained 23.0–28.4 kg edible food/person and 28.2–33.7 kg non-edible food/person.

Many studies have not showed any significant correlation between the education level and the amount of food waste (Herzberg *et al.*, 2020). Barker *et al.* (2023) found statistically significant differences for potentially unavoidable food waste when comparing results of graduated persons and persons with no degree. More educated persons produced more potentially avoidable food waste. The studies by Marangon *et al.* (2014) and Secondi *et al.* (2015) indicate that food waste increased with higher education. Noticeably, there are effective policies and programmes developed to reduce food waste in households (Schanes *et al.*, 2018;

Hebrok, 2020). Thus, it is important to affect the behaviour of young people through information and training, especially in higher education.

1.3 The role and amount of food packages

There is not much research relating to the amount of food packages generated in households in Europe. The research relating to the daily package waste generated in households is mainly from Nordic countries. There is also some research available from India (Suthar and Singh, 2015) and from Nigeria (Ogwueleka, 2013). Different methods have been used to study the amount of municipal waste. Thus, it is not possible to generalize this outcome. The study by Ogwueleka (2013) about quantities and composition of household solid waste in Abuja originated from different socio-economic groups. The average amount of non-organic household waste was 233 g/person/day. In the study performed by Suthar and Singh (2015), both family size and socio-economic status were considered. The estimated generation of packaging waste (plastic, paper, cardboard and glass) was 43 g/person/day. In the study by Boer *et al.* (2010), an average quantity of package waste in Polish households was 54.7 kg/person/year, i.e. 150 g/person/day. The altogether municipal waste produced annually was 94.2 kg/person. Larsen *et al.* (2010) estimated the amount of plastic packages and cans as waste in Denmark to 9.0 kg/person/year. In the Eurostat report from 2022, the generated package waste was estimated to 177.2 kg/person in the EU (Eurostat, 2022). The annual variation between EU member states is high and differs from 226 kg/person in Germany to 66 kg/person in Croatia. In Finland, the generated package waste/person is over 130 kg. This amount includes paper and cardboard (41.1%), plastic (19.4%), glass (19.1%), wood (15.2%) and metal (5.0%). The recycling rate in EU Member States was on average 64.4% and in Finland slightly higher, i.e. 68.5%.

Poças *et al.* (2009, 2010) collected data during a 30-day period from 34 households with 105 consumers. The weight of food package material was 76 g/person/day in households with children. Williams *et al.* (2020) studied the impact of packaging, including its design and functions, on food loss. Food packaging is often considered guilty in destroying the environment. However, incorrect use can lead to loss of food instead of potential waste reduction. Wohner *et al.* (2019) estimated the link between food loss and packaging in developed countries, where food is usually wasted due to wasteful behaviour at home level. Their packaging can be a key source due to inappropriate packaging and packaging that is difficult to clear.

In this paper, the focus was on finding out the amount of both avoidable and unavoidable food as well as the number of generated food packages in various sized households with at least one student at Seinäjoki University of Applied Sciences. The aim was also to compare food waste and packaging wastage in various sized households.

2. Material and methods

In this study, the data collection was performed during 2021–2022. The respondents in this study were students in Seinäjoki University of Applied Sciences. These students participated in two courses related to sustainable food systems; both courses were arranged twice during 2021–2022. The courses included data collection of: avoidable food waste, unavoidable food waste and generated food packages in the students' own households. The students in the participating households quantified all their avoidable food waste and unavoidable food waste through weighing it using their own kitchen scales. They also counted the pieces of food packages. Furthermore, the packages were divided into the following categories: material depositing, recycling and municipal waste. The students were allowed to choose the data collection week. The study lasted one week – from Monday to

Sunday. These students participating in this study are either living alone or together with their family members, e.g. spouse, children, siblings and/or parents. Due to the fact that many students are living with family members, there are representatives in many age groups. In Finland, the other common way of living for university students is to live in apartments with kitchen or kitchenette.

The data collection was carried out for one week using an Excel sheet, in which the students marked the figures for the above given three classes (avoidable food waste, unavoidable food waste and food packages). In the Excel sheet, there were similar tables for each day for both avoidable and unavoidable food waste. The guidance was that the food originally aimed to eat was avoidable food waste. Unavoidable food waste was food originally aim as non-edible.

The students were introduced to the data collection by using an introductory video. In the video, the authors told how to monitor and report the various wastes in the households. There was also the possibility for students to check facts from the video concerning sorting and follow-up. Guidance was also given by the teachers, i.e. authors. Furthermore, the students had also the possibility to ask questions related to the study during the monitoring period. The respondents did not get any further instructions to omit any products in the beginning of the monitoring period. Thus, the monitoring period was as normal as possible.

After the submission of the collected data, all Excel sheets were checked by the authors. Those Excel sheets, which were not filled accurately, were rejected. The reasons for rejection were incomplete background information and/or weighing data. Those that reported zero food waste in the study with an explanation of/reasons for the outcome were included in the study. Note that none of responses with zero waste without explanations were approved. Furthermore, data from households with more than five persons were not included, due to the fact that there were too few observations in this category. In total, 432 data sheets provided by 890 persons were approved in this study (Table 1). Approximately 75% of participated households were one or two persons. In Finland, these households counted for 77% in year 2019 (Statistics Finland, 2019). More respondents belonged to younger groups in the study than in average in Finland. In this study, 47.5% were 24 years or younger, in 2022 corresponding value for inhabitants in Finland was 26.1% (Statistics Finland, 2023).

The approved data sheets were thereafter merged into one big Excel file. The merged results were then analysed. The amount of food waste was divided based on the household size. Excel was used in analysing the data. The statistical significance of the average samples obtained from the background variables was assessed using a *t*-test. The *t*-test has been performed using the incoherent variance (heteroscedastic) of two samples.

Size of households	No. of households	% of households	Persons in the households	Age <12 (%)	Age 12–18 (%)	Age 19–24 (%)	Age 25–30 (%)	Age 31–40 (%)	Age 41–50 (%)	Age 51–60 (%)	Age 61–70 (%)	Age >70 (%)
1 person	165	38.2	165	0.0	0.6	63.6	19.4	13.9	0.0	2.4	0.0	0.0
2 persons	160	37.0	320	0.6	0.9	34.7	32.8	17.8	7.2	4.7	0.6	0.6
3 persons	43	10.0	129	23.3	6.2	14.0	12.4	20.2	8.5	12.4	3.1	0.0
4 persons	44	10.2	176	37.5	4.0	8.5	9.1	24.4	10.2	3.4	2.8	0.0
5 persons	20	4.6	100	25.0	19.0	13.0	6.0	16.0	12.0	7.0	2.0	0.0
Together	432	100.0	890	13.8	4.3	29.4	19.7	18.5	7.2	5.4	1.5	0.2

Source: Authors' own work

Table 1. Background information about participants

3. Results

The results show that the average food waste was 498 g/person/week, and the unavoidable food waste was 543 g/person/week (Table 2). This gives an annual amount of 25.9 kg food waste per person. Furthermore, there was 28.3 kg unavoidable food waste per person. Single-person households produced more avoidable and unavoidable food waste per person than households with several persons. When comparing avoidable food waste in single-person households to households with two and four persons, the *t*-test indicated a probability less than 0.001. The comparison with three persons gave a probability, which was less than 0.05. Thus, the results show that three-person households generate more avoidable food waste/person in relation to households with several persons. When comparing unavoidable food waste in single-person households to four person households and two-person households, the *t*-test indicated probabilities less than 0.001 and less than 0.05, respectively.

Correlations of avoidable and unavoidable food waste as well as food packages were analysed through data correlation analysis. These analyses showed no correlations.

The average number of generated food packages/person/week was 22 pieces. Single-person households produce more packages per person than other sized households (Table 3). The average number of packages was highest for single-person households (30.4 pieces) and at lowest for four-person households (15.6 pieces). Based on the *t*-test, the statistically significant difference ($P < 0.001$) was between food package waste per person between single-person household size and the other household sizes.

Table 2.
The amount of avoidable and unavoidable food waste in the households of the respondents

Size of households	No. of households	Persons in the households	Avoidable food waste, average g/person ^a	Avoidable food waste, standard deviation	Avoidable food waste, mean error margin	Unavoidable food waste, average g/person ^b	Unavoidable food waste, standard deviation	Unavoidable waste, mean error margin
1 person	165	165	746.7	876.4	-112.9	700.2	661.8	-85.2
2 persons	160	320	437.7	898.7	-117.5	573.6	898.1	-117.5
3 persons	43	129	508.1	1,466.3	-376.1	538.3	1,278.7	-328.0
4 persons	44	176	417.6	1,229.6	-311.6	422.3	1,355.6	-343.6
5 persons	20	100	404.8	1,547.0	-598.1	408.0	1,094.9	-423.3
Together	432	890	498			543		

Notes: The statistical significance when comparing: ^aAvoidable food waste: one-person households to the two- and four-person households $P < 0.001$ and $P < 0.01$ to three-person households; ^bunavoidable food waste: one-person households to the two-person households $P < 0.05$, three-person households $P < 0.05$, and $P < 0.011$ to four-person households

Source: Authors' own work

Table 3.
The number of food packages generated during one week in various sized households

Size of households	Packages/person, average	SD	Mean error margin
1 person ^a	30.4	28.5	-3.7
2 persons	23.9	19.7	-2.6
3 persons	18.2	23.2	-6.0
4 persons	15.6	23.7	-6.0
5 persons	18.2	56.1	-21.7

Note: ^aStatistical significance between single-person (one-person) households and other households was $p < 0.001$

Source: Authors' own work

During the follow-up week the total amount of food packages was 19,600 pieces, from which 23.8% was deposited, 46.4% was recycled and 29.8% ended in municipal waste. Figure 1 shows that single-person households generate more packages for deposit and material recycling per person than bigger households. The impact of the household size did not appear to have any statistical significance in municipal waste when considering the number of packages per person. The average sorting by households was given with a 95% confidence interval (deposit, municipal waste and recycling). In single-person households, 27% of package waste ended up in municipal waste; corresponding value for five-person households was 41%.

4. Discussion

The results showed that the total average food waste was annually 54.1 kg/person, which is divided into avoidable food waste 25.9 kg/person and unavoidable food waste 28.3 kg/person. The results of this study are consistent with the results of [Silvennoinen et al. \(2022\)](#), who found out that the total annual food waste varied between 53.0 and 62.1 kg/person. The avoidable food waste was 23–28.4 kg/person and unavoidable food waste 28.2–33.7 kg/person.

Single-person households produced more avoidable and unavoidable food waste per person than other sized households in this study. The significance was less than 0.001 comparing single-person households to two- and four-persons households. The significance for three-person households compared to single-person households was less than 0.05. In total, the produced waste in single-person households was 75.2 kg/person, which included 38.8 kg avoidable and 36.4 kg unavoidable food waste. [Barker et al. \(2023\)](#) obtained similar results, i.e. the results for single-person households were 70.4, 35.8 and 34.6 kg. The rest of their results were similar except for the amount of avoidable food waste in two-person households, which was much lower than in this study, i.e. 10 kg/person. The avoidable food waste results were

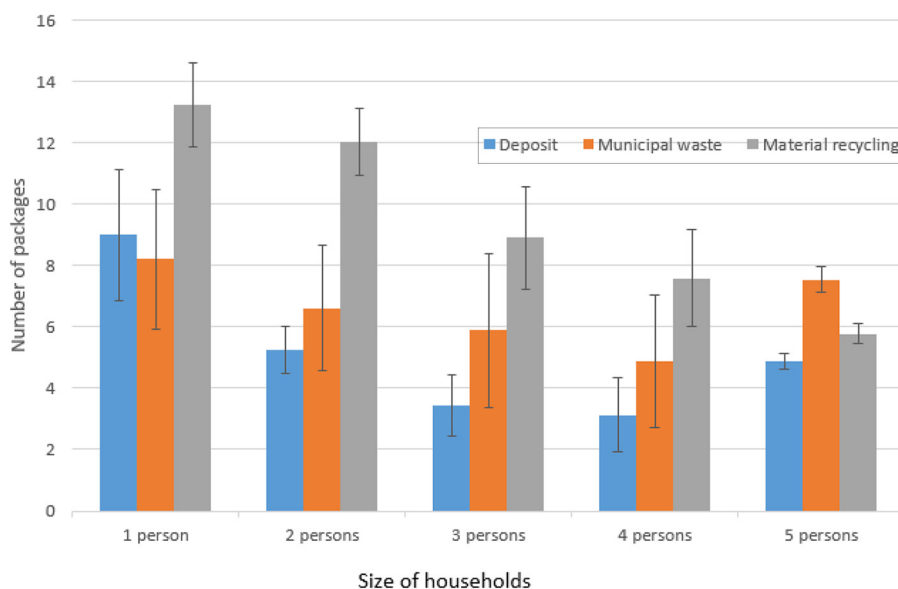


Figure 1. Number of packages per person produced by households for different recycling fractions

Source: Authors' own work

also similar to earlier results reported by Närvä *et al.* (2023). This earlier research revealed that single-person households generated more food waste than other sized households. The amount of unavoidable food waste was not studied in the earlier published article.

The average number of generated food packages/person/week was 22 pieces. The average number of food packages/person was at highest for single-person households (30.4 pieces/week) and at lowest for four-person households (15.6 pieces/week).

5. Conclusions

In this study, the average avoidable food waste was 25.9kg/person and unavoidable food waste was 28.3kg/person. This study revealed that the total food waste per person was biggest in single-person households. The results show that there is no correlation between the amount of avoidable food waste/person and unavoidable food waste/person. This means that the households, which generate a lot of avoidable and unavoidable food waste, are not the same. The results also show that the amount of avoidable and unavoidable food waste vary among the same sized households. There are households which do not generate food waste at all, and households which generate a lot of food waste. In this research, the total amount of food packages was 19,600 pieces/week. These packages were categorized as follows: deposited 23.8%, recycled 46.4% and municipal waste 29.8%. Single-person households generate more packages/person than other sized households. Small households with one or two persons generate more package material to recycling than bigger households.

The results revealed that the importance of education is needed relating to both avoidable and unavoidable food waste. The differences between households show that some students have good habits relating to the minimizing food and package waste. Furthermore, there are students with good habits who are actively recycling packages. The feedback of the students was that the follow-up of both avoidable and unavoidable food waste as well as the amount of food packages really functioned as an eye-opener. The study also revealed to the students how and why food waste and used packages were generated in their households.

Good results can be achieved using correct pedagogical methods, which motivate information sharing and peer learning among students. This type of follow-up study should be implicated in education of students at higher level. It is related to learning by doing. And these results also improve the benchmarking within the group of students performing the course. Those students, who generate no or little food wastages, should share their knowledge to those who generate lots of waste. Furthermore, the higher education should contain more information on, e.g. food waste effects on the environment, the importance of healthy food and processing of various food raw materials. In the future, it would be interesting to investigate how different pedagogical means affect the minimizing of food and package waste.

There are some limitations in this study. Thus, it should be stated that the participating households is not equal to the average population in Finland. Students were instructed to behave normally during the follow-up week. But despite this, it is possible that the students gave more attention to food and package waste than normally, which may affect the results.

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Corresponding author

Margit Närvä can be contacted at: margit.narva@seamk.fi