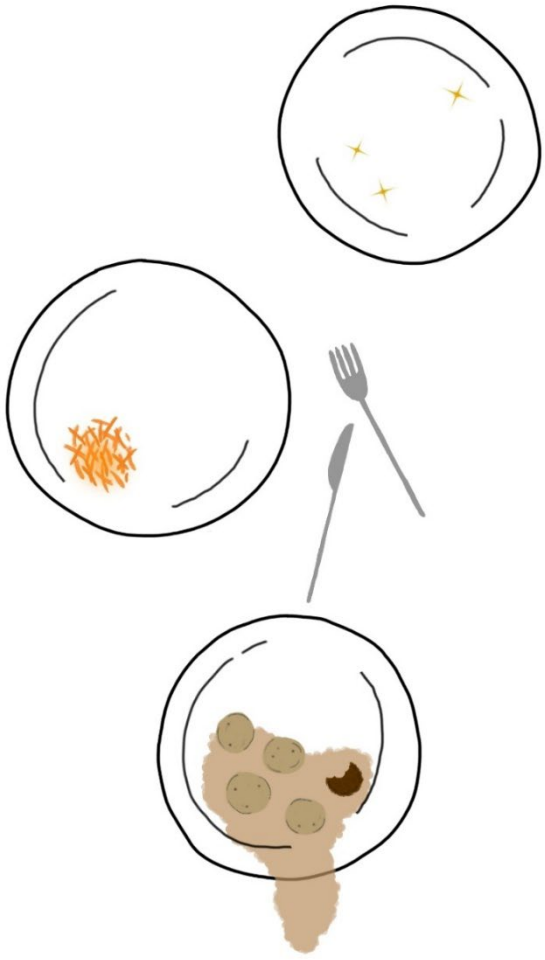
Reducing School Plate Waste: Stakeholder Views, Student Behaviour, and Future Action in Uppsala

Runa Halvarsson



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Reducing School Plate Waste: Stakeholder Views, Student Behaviour, and Future Action in Uppsala

Minskat tallrikssvinn i skolor: Intressenters synpunkter, elevbeteende och framtida åtgärder i Uppsala

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Abstract

Food waste has significant implications for the planet, contributing to climate change and biodiversity loss. In 2022, an estimated 1,052 million tonnes of food waste were generated globally. In Sweden, around 1.42 million tonnes were wasted the same year, with approximately 3,500 tonnes generated in upper secondary schools. Plate waste, the fraction of food left on consumers' plates, impacts not only the environment but also nutrition. Previous research has shown that plate waste increases with student age and that a minority of students often generate a majority of the waste. Therefore, this study investigates plate waste in two upper secondary schools in Uppsala municipality, Sweden, with the aim of exploring how to reduce it.

A mixed-methods approach was used to examine what measures the schools have taken, what causes relevant stakeholders perceive behind plate waste, what challenges and opportunities exist for reducing it, and whether high-waste students can be identified. Stakeholders included kitchen personnel, school staff, and students. Semi-structured interviews were conducted to gather information on interventions and to identify challenges and opportunities for plate waste reduction. Thematic analysis was applied to interview data, resulting in five identified themes. A student survey looked into student perspectives on reasons for food waste and potential school-level improvements. Lunchroom observations were used to investigate whether male students waste more than female students, and whether larger student groups contribute to increased waste.

Findings showed a variety of interventions implemented by the schools, many which align with previous research, such as educational campaigns and reduced plate size. The schools were observed to have lower plate waste than the national average during the study period. A key challenge was capturing students' attention and achieving long lasting behavioural change. Interviews revealed routines for approaching high-wasting students and efforts to educate them, however the effects from such efforts have not been evaluated. It was also revealed that peer pressure and trends in society might have a substantial impact on plate waste behaviour. Other key findings were that plate waste increases at the start of the school year, indicating a window for when to concentrate efforts. Survey and interview data had contradictory results as to why students waste food, highlighting the limitations of self-reported data. Observations showed no significant gender difference in waste levels but did indicate that plate waste may increase with group size. The study concludes that further research is needed to study effects and implications of targeting high-waste students and for developing interventions with long-term impact in school settings.

Keywords: Food waste, interventions, upper secondary schools, interviews, thematic analysis, meal observations

Table of contents

List of tables **6**

List of figures **7**

1. Introduction **8**

1.1 Background 8

1.1.1 School meals in Sweden 9

1.1.2 Food waste definition 10

1.1.3 Previous research 10

1.2 Aim and research questions 11

2. Method **13**

2.1 Description of the schools 13

2.2 Interviews 14

2.2.1 Sampling and recruitment 14

2.2.2 Interviews and interview guide 14

2.2.3 Thematic Analysis 16

2.3 Survey 17

2.4 Observations 17

2.4.1 Design 17

2.4.2 Visual estimations of plate waste 18

2.4.3 School A: Students per table and plate waste 18

2.4.4 School B: Gender-based differences in plate waste 19

2.4.5 Analysis 20

3. Results **21**

3.1 Interviews 21

3.1.1 Measures to reduce food waste 21

3.1.2 Thematic Analysis 24

3.2 Survey 33

3.3 Observations 35

3.3.1 School A: Students per table and plate waste 35

3.3.1 School B: Gender-based differences in plate waste 38

4. Discussion **40**

4.1 Future efforts for plate waste reduction 40

4.1.1 High-wasting students 41

4.1.2 Carbohydrate sources 44

4.1.3 Popular meals 45

4.1.4 Informing students 45

4.1.5 Could efforts be concentrated to improve efficiency? 48

4.2 Study limitations 48

4.3 Future research 50

5. Conclusions 52

References 53

Popular science summary 58

Acknowledgements 59

Appendix 1 – Sample of interview questions 60

Appendix 2 – Survey questions 61

Appendix 3 – Menus & tables from lunchroom observations 62

Appendix 4 – Excerpts from the portion guide by the Swedish Food Agency 63

Appendix 5 – Original Swedish quotes from the interview transcripts 64

List of tables

Table 1. Interview respondents from the participating schools. 16

Table 2. Total plate waste in kilograms at School A and B from three observation days. The calculated average plate waste and standard deviations are presented in the table. 35

Table 3. Results from logistic regression 38

Table 4. The total amount of observations at school B divided into gender and visual estimation of plate waste. 38

Table 5. Results from the Mann-Whitney U test and the Two-sample Kolmogorov-Smirnov test on the observational data from school B. The abbreviation n/a (not applicable) is used when the value is irrelevant to the statistical test. 39

Table 6. Dates and the menus served during lunchroom observations at school A and B. Both schools also has a salad bar which varies from day to day with a wide assortment of vegetables. The schools usually serve at least two dishes. 62

Table 7. Observational data from School A, showing the number of students per table and how many tables with that number of students that was observed. 62

List of figures

Figure 1. Themes and sub-themes identified with thematic analysis. 25

Figure 2. Share of answers to the question “How often do you throw away food at school?”. 33

Figure 3. Share of answers to the question “How much do you usually throw away if you throw away food?”..... 34

Figure 4. Share of answers to the question “What is the most common reason for you to throw away food?”..... 34

Figure 5. Flowchart with the amount of student observations at school A including missed observations and visual estimations of plate waste..... 36

Figure 6. Proportion of students who generated plate waste per table, including a linear trendline with equation y and the R2-value. 36

Figure 7. Scatter plot demonstrating the probability that there is a high-wasting student (plate waste between 4-6) at the table, and if the probability increases with the group size, or number of students, at the table. 37

Figure 8. Share of student plate waste, divided by gender, showing % of observations which were categorised between 0-6 on an estimated visual scale of plate waste..... 39

Figure 9. Screenshot showing portion sizes of salad with a Swedish description of when the guide should be used (Swedish Food Agency 2010:12). 63

Figure 10. Screenshot showing portion sizes of stew/casserole with a Swedish description of when the guide should be used (Swedish Food Agency 2010:19). 63

1. Introduction

Due to an interest in reducing food waste within public catering in Sweden, this thesis focuses on plate waste from two upper secondary schools located in Uppsala municipality. The study is explorative in nature, investigating stakeholder perceptions and student behaviour using mixed methods.

In the introduction, a background is presented to familiarize the reader with consequences of food waste and targets to reduce it. This is followed by a short description of school meals in Sweden and the definitions for food waste used in the study. Previous research is then introduced, including the rationale behind the study, before aim and research questions are presented.

1.1 Background

In 2022, the United Nations Environment Programme (UNEP) (2024) estimated that 1,052 million tonnes of food waste were generated were generated globally at the retail, food service, and household levels. This number amounts to 132 kg/capita/year, with 36 kgs estimated to come from the food services sector. Scherhaufer et al. (2018) found that the environmental impacts from food waste are primarily attributed to the production stages, and food production has been identified as a primary driver of biodiversity loss globally (Benton et al. 2021; Boakes et al. 2024). WWF-UK (2021) estimates that food waste contributes to 10% of all GHG emissions, and suggests that up to 40% of all food produced is wasted, meaning we could decrease the impacts of food production if we stopped wasting food and produced less. Not only will preventing food waste significantly contribute with reducing the food systems environmental footprint, but also with achieving healthy diets for all (IPCC 2019).

With regard to the impacts of food waste, there are several goals in place towards decreasing it. Perhaps the most prominent is Sustainable Development Goal (SDG) 12.3, established in 2015 by the United Nations as part of Agenda 2030 (2015). The goal states to halve per capita food waste at retail and consumer level by 2030 (SDG 12 Hub 2024) and is accepted by all member states. In the latest Food Waste and Index Report, UNEP (2024) writes that the first indices for measuring progress towards SDG 12.3 will be published in their subsequent report, showcasing that UNEP does not have a clear indication, yet, as to whether SDG 12.3 will be achieved in time. Some experts, however, believe that the goal will not be reached by all member states by 2030 (Lipinski 2024).

In the European Union (EU) it is estimated that 59 million tonnes of food waste in fresh mass were generated in 2022, amounting to 132 kg per inhabitant (Eurostat 2024). Around 11% of the total food waste came from restaurants and food services,

however food losses[1] are not part of the statistic. Scherhaufer et al. (2018) state that approximately 73% of climate impact from food waste in the EU comes from production, and that about 94% of acidification and 96% of eutrophication caused by food waste are estimated to be caused by production. This shows, once again, that decreasing food waste and thereby food production is necessary. The European Commission (Directorate-General for Environment 2023) have also proposed to set reduction targets that are legally binding for member states, as a way to accelerate progress towards SDG 12.3. This means that member states would have to reduce food waste at retail and consumption level, including households, by 30% by the end of 2030.

Measurements from Sweden estimate that circa 1.42 million tonnes of food waste were accumulated in 2022 (Hultén et al. 2024). Roughly 37,000 tonnes (or 2.6%) were generated in the public catering sector. The majority of that food waste came from preschools and elementary schools, which is also where most meals in public catering are served, and 9% (3,500 tonnes) were generated by upper secondary schools the same year. According to SCB (2022), Sweden has had positive developments towards some of the targets in SDG 12: Responsible Production and Consumption (The Global Goals 2015). SCB (2022) also writes that food waste in Sweden is decreasing from households and the food industry, but that the pattern is not observed in other parts of the food chain. Sweden has also failed to reach an interim target set to advance progress towards SDG 12.3, to reduce food waste by 20% by mass per capita between 2020-2025 (Swedish environmental objectives 2025).

Uppsala municipality, Sweden's fourth most populous municipality (SCB 2025), included food waste in their Environment- and Climate program released earlier this year (Uppsala municipality 2025b). The document states that food waste produced by establishments which are financed by the municipality should be reduced as much as possible, including food waste from kitchens, service, and attending guests' plates. Uppsala is a good place to investigate food waste since the municipality's meal services (*Måltidsservice* in Swedish) are striving to uphold sustainable meals, including several efforts to reduce food waste (Uppsala municipality 2023).

1.1.1 School meals in Sweden

Sweden is one of few countries that offer tax-funded, universally free school lunches. Swedish law states that every child has the right to a balanced and nutritious meal (Riksdagsförvaltningen 2010), and schools are responsible for 30% of students' daily energy intake (Swedish Food Agency 2019). Due to this,

[1] Defined by Eurostat (2024) as *"food not harvested or food not authorised to be marketed for safety reasons"*.

decreasing production is not a simple solution or the way forward for decreasing food waste in schools. Most Swedish schools operate a self-serve and all-you-care-to-eat system in their restaurants. Upper secondary schools offer three-year programmes which you can attend between the ages of 16-20 (Utbildningsguiden n.d.a, n.d.b).

The meal services in Uppsala municipality produce around 45,000 meals every day (Måltidsservice n.d.), including for six of the municipal upper secondary schools. Uppsala municipality has a goal for secondary and upper secondary schools, as well as for elderly care, to reach a total food waste of 45 g/guest, with 20 g made up of plate waste and 25 g from kitchen and serving waste (Uppsala municipality 2025a). The upper secondary schools in the municipal meal services share a rotating weekly menu.

1.1.2 Food waste definition

This study assumes the definition of plate waste as used by Malefors et al. (2019), meaning all of the waste that comes from the plates of guests. This includes napkins and inedible food waste such as bones when sorted with other plate waste. However, in schools napkins are often separated by guests themselves into combustibles rather than food waste bins.

1.1.3 Previous research

Many factors have been found to affect plate waste in schools and educational settings (Eriksson et al. 2025). Amongst them are the menu (Bustamente et al. 2018; Martins et al. 2020; Sundin et al. 2023), portion size (McCrickerd et al. 2017), lunch scheduling (Strohbehn et al. 2016) and seated lunch time (Burg et al. 2021), food waste and nutritional education (Antón-Peset et al. 2021; Junkkari et al. 2024), and awareness campaigns (Malefors et al. 2022b). Food waste in Swedish schools has decreased over time, as shown by Malefors et al. (2022a). The authors found that food waste in primary schools decreased by 40% between 2013-2020, with a similar pattern observed for secondary schools. However, it is estimated that plate waste increases with age in schools (Steen et al. 2018; Gerstbrein 2024; Fritz & Jonsson 2025), not accounting for preschools which often report higher plate waste (Fritz & Jonsson 2025). Intervention studies looking to decrease food waste in schools have mostly concentrated on younger ages (Eriksson et al. 2025), not including university canteens, and it is therefore of interest to explore how food waste reducing measures affect older students.

A mapping done by the Swedish Food Agency (Fritz & Jonsson 2025) showed that plate waste in upper secondary schools in Sweden had a median value of 30 g/person in 2022 and 2024. Gerstbrein (2024) observed lunches at five schools in Uppsala municipality and found that the average plate waste ranged between 44-64 g/person, with the highest value at 64 g/person coming from the only observed

upper secondary school. Also in Uppsala, Sundin et al. (2024) found average plate waste to be 27 g/person after conducting a waste composition analysis at two elementary schools. Results from Malefors et al. (2022a) point to 42 g/portion (peak median) of food waste in primary school canteens and 53 g/portion in preschools. Eriksson et al. (2017) found that food waste in schools was 79 g/portion in the municipality of Sala, and that in total for all of the public catering establishments in the study around 33% of food waste were represented by plate waste. In a study by Engström & Carlsson-Kanyama (2004), 9-11% of delivered food to two schools ended up as plate waste, at 33-35 g/portion.

There are several studies which have found serving waste to be the highest fraction of food waste in schools (Silvennoinen et al. 2015; Eriksson et al. 2017; Malefors et al. 2022a; Persson Osowski et al. 2022). However, as mentioned previously schools are responsible for 30% of students' daily intake (Swedish Food Agency 2019) which means that plate waste not only affects the environment, it also affects the nutritional intake of students. Sundin et al. (2024) found plate waste in schools to be nutrient-dense, containing 4.8 MJ energy/kg and significant amounts of protein and fiber as well. The study also assessed the climate impact of plate waste, showing that there is potential in reducing climate impact from the plate waste fraction in schools.

A study by Malefors et al. (2024), using an automated quantification tool to study plate waste at 16 Swedish primary schools, found that around 20% of guests generated 60% of plate waste. These results indicate that not all guests waste the same amounts, with many students generating very low waste or zero waste. Results also showed that 31% of overall plate waste could be reduced if the 20% with the highest plate waste were able to halve their waste. Malefors et al. (2024) conclude that targeting these "high-profile" wasters could be the next step to reducing plate waste in school lunch services. Due to many students generating zero waste in the study, one may also suggest that targeting all students might not be an effective way of using resources when implementing food waste interventions in schools.

Given that plate waste increases with age, that it is a fraction of food waste with both environmental and nutritional consequences, and that few students might be responsible for the majority of it, this study formulated the following aim and research questions.

1.2 Aim and research questions

This thesis investigates plate waste in upper secondary schools in Uppsala municipality, Sweden, and what can be done to reduce it further. In order to do so, the following research questions will be answered:

1) Which measures have the schools taken to reduce food waste?

2) What causes do relevant stakeholders perceive to generate plate waste?

3) Which challenges and opportunities exist for reducing plate waste in upper secondary schools going forward?

4) Can high-wasting students be identified to ascertain where efforts should be concentrated in the future?

2. Method

This is a mixed method study, including both quantitative and qualitative data. Interviews, a survey, and lunchroom observations were used to investigate the research questions. Stakeholders are defined as kitchen personnel, teachers, principals, and students in this study. Interviews were utilized to gain insight into current practices to reduce food waste in the schools and to investigate the perceptions of kitchen staff, teachers, and principals, on why food waste is generated and how it could be reduced. Interviews were also used to assess possible challenges and opportunities towards reducing plate waste in the schools. A survey was distributed to students to get their perspective on food waste generation and prevention. Lastly, observations of student lunches were performed to try and identify students who generate a high amount of plate waste, based on hypotheses formed during the interview-phase of the study. The method starts with a description of the participating schools, followed by methodology for the interviews, the survey, and lastly for the observations.

2.1 Description of the schools

Two upper secondary schools agreed to participate in the project, and are referred to as School A and School B throughout this report. Schools were chosen based on convenience sampling, and the municipal meal services provided contact details to the head chefs at each school. Both schools are sub-urban and are attended by 900-1000 students. In addition to preparing lunches for their own school, the school restaurants deliver lunches to other schools each morning. Staff at the schools measure food waste every day, and the schools have similar set ups for students to leave their dishes and plate waste. Dishes are left at a designated station where there is also a waste bin with two openings, one for food waste (plate waste) and one for other waste, such as napkins, named combustibles. Beneath the plate waste opening is a scale that registers food waste so that the students can see how many kilos of total food waste has accumulated throughout the day.

According to the head chef at school A, there is an average plate waste of around 25-30 g/portion, which sometimes reaches the municipal goal of 20 g/portion. The school serves roughly 800 portions per day, though it can vary between 500 to 1000 portions depending on factors such as if classes are away on field trips or if students have exams and go home without attending the lunch service. Lunch is served between 10:50 and 13:30. The dining hall is split in two, with one bigger hall where students take their food and leave their dishes, and then there is a wall that can be retracted during opening times to increase the amount of seats, with more tables outside of the wall. The students can access these tables even when the dining hall

is closed. There are two serving lines where students can take their food and a third smaller set up with a sign showing that it is for taking a second portion.

At school B, the head chef relayed that they produce around 700-900 portions each day and that they receive around 700-800 guests during lunch. The daily plate waste ranges between 25-26 kg on average and represents about 70-75% of the total food waste according to the head chef. Lunch is served between 10:30 to 13:00. The dining hall is integrated into the school environment and is also used for other purposes when necessary. Food is served in a separate room, with two serving lines. The station where students' leave their food waste and dishes is also in a separate room. Both the room where students take their food and the room where they leave their dishes have open doors to the dining hall during opening times. Since the dining hall is integrated into the school, the tables are frequently used by students when studying or during break times.

2.2 Interviews

Interviews were utilized to acquire information and thoughts from staff working at the schools, both from the meal services and school personnel. The idea was to gain insight from personnel who have more contact with the students, as well as the staff who are responsible for producing the school meals. The interviews were used to investigate current efforts to reduce food waste in the schools and to identify which challenges and possibilities exist for reducing plate waste further.

2.2.1 Sampling and recruitment

The head chefs were contacted for consent to conduct interviews and perform lunchroom observations at the schools. At each school, head chefs asked their personnel if they would like to participate in interviews based on who they thought were suitable after explaining the purpose of the study. Some guiding questions were provided before the interviews, with the notion that questions could change between respondents but that the overall theme of food waste and measures against food waste would remain the same. While the head chefs had access to the guiding questions at the start, the remaining respondents had not read through any questions before the interviews but most were aware of the topic beforehand, with one exception. At School A, the headmaster was able to set up contact with a teacher for an interview, while at School B the head chef provided contact details to a teacher, who after their interview recommended another teacher as well. Principals were contacted using details provided by the school's websites.

2.2.2 Interviews and interview guide

Semi-structured interviews (Kvale & Brinkmann 2014) were used as the method for performing interviews. Semi-structured interviews allow for a conversation

between the respondent and interviewee, and are an interview style where mainly open-ended questions are prepared beforehand and where new queries and follow-up questions can be formed during the interview (Brinkmann & Kvale 2018). Semi-structured interviews were used since they are flexible, giving the researcher freedom to explore unexpected subjects and letting the respondents express their thoughts freely (KnowFife 2018).

All interviews were performed by one researcher. An interview guide was prepared before the first interview, which was then changed and adapted to suit the coming respondent depending on their position at the school and knowledge gained from the previous interview. Questions such as *"Could you tell me about your work towards reducing food waste?"* and "*What do you believe could reduce food waste further?"* were asked. Appendix 1 presents more examples of interview questions which were used. Though the focus of this study was on plate waste, many interventions might affect different fractions of food waste and therefore all food waste reducing efforts were investigated. All interviews were audiotaped with consent, and all but one took place in person, which was conducted digitally via Microsoft Teams. Interviews lasted between 20-50 minutes with 31 minutes on average. In total 13 interviews were conducted, 7 at school A and 6 at school B. For information on interview length and which position each respondent held at the corresponding school, see Table 1. The table provides information on how long respondents have worked at the studied schools' though most have worked in public catering even longer. To protect their anonymity, the respondents were coded in order of when the interviews were held. For example, R1 is an abbreviation of Respondent 1 and represents the first respondent that was interviewed in the study. All interviews were held in Swedish and were conducted between February and April of 2025.

Table 1. Interview respondents from the participating schools.

Respondent	Position	Years respondent has worked at school	School	Duration of interview
R1	Chef	17	B	23 min
R2	Kitchener	6	B	20 min
R3	Head chef	6	B	50 min
R4	Teacher	11	B	43 min
R5	Chef	3	A	31 min
R6	Teacher	20	B	32 min
R7	Chef	<1	A	31 min
R8	Kitchener	<1	A	32 min
R9	Kitchener	10	A	24 min
R10	Principal	6	B	20 min
R11	Principal*	14	A	28 min
R12	Teacher	7	A	26 min
R13	Head chef	6	A	43 min

* Digital interview

2.2.3 Thematic Analysis

Thematic analysis was used to analyse the interviews due to its flexibility (Braun & Clarke 2006). The method is used to identify and analyse repeated patterns, or themes, within qualitative data, and is not bound to a pre-existing theoretical framework (Braun & Clarke 2006). In this study, a theoretic thematic analysis was conducted to provide a detailed analysis in relation to the research questions. The analysis applies a semantic approach, analysing explicit meanings of the data, and a realist perspective. In this study, prevalence in the data is described as the amount of data items, or interview transcripts, which contain a certain theme. The thematic analysis closely followed the six steps explained by Braun & Clarke (2006).

First, interviews were transcribed by hand and then corrected while re-listening to the audio files to ascertain accuracy. Square brackets were used in the transcripts to explain gestures or add meanings which were not clear from reading spoken words without real-life context. During this step, ideas for themes that started to form were noted down. When all interviews had been transcribed, they were joined into one document, the data corpus, which was re-read once before coding. This was followed by an initial coding process, where words and sentences were colour coded into different categories depending on patterns that were observed in the data. After initial coding, the data corpus was read in its completeness once again to ascertain whether more data fitted amongst the codes. When all data had been coded, the codes were combined and divided into themes and sub-themes. Once all codes fit into one theme, which did not overlap with another, the data corpus was

read through a final time to make sure that no data extracts had been missed in the coding process.

2.3 Survey

A survey about student food waste habits was created in Netigate, see Appendix 2 for a complete list of survey questions. The survey was created to gather students' opinions on how to reduce food waste and to get an approximation of why they generate plate waste. No questions were set as mandatory and students could choose for themselves which questions to answer. The survey was given in Swedish and was distributed to one class at school A and one at school B in March and April of 2025. To reduce negative connotation to the questions, throw away (Swedish *kasta*) was used instead of food waste (Swedish *matsvinn*). The Swedish Ethical Review Authority approved of the survey, and due to responses being anonymous there was no necessity to collect consent from respondents.

2.4 Observations

Lunchroom observations were performed by one researcher. The aim was to observe certain behaviours from students during school lunches to try and ascertain whether those behaviours influence plate waste. The studied behaviours were decided alongside kitchen personnel at each school and were based on subjects brought up during the interview-phase of the study. The hypotheses concerning the behaviours were reviewed to see that they fit within the aim and scope of the study before observations were conducted.

The schools have distinct layouts for their dining halls which limited what observations were possible. Due to this factor, it was decided to observe different behaviours at school A and B. At school A, the purpose was to observe whether larger friend groups could lead to increased plate waste. At school B, the aim was to observe whether male students wasted more food than female students.

2.4.1 Design

Three days of observations were dedicated to each behaviour, as it was found to be enough time to observe a behavioural pattern during lunches according to Gerstbrein (2024) and due to the limited time of the study. The days were chosen after convenience for the school restaurants and with the menu in mind. A goal was to conduct observations with differing menus as they were believed to have an impact on student attendance and plate waste. Previous research has shown the impacts menus can have on plate waste in schools and other establishments, see Connors & Rozell (2004) and Sundin et al. (2023) for examples, which also motivated this decision. Dates and menus from all lunch observations are presented in Table 6 in Appendix 3. Due to public holidays and ordering difficulties one

school had to deviate from the set menu and swap days for two meals, explaining why the same menu appears twice in the six observation days, albeit not at the same date or school.

After evaluating ideas for lunchroom observations, it was decided to do a pilot observation at one of the schools (School A). The pilot observation was performed on 2025-04-08 and resulted in several adjustments to the original plan for observations, with regards to the large amount of students at each school. It was decided to use a visual method for estimating plate waste since the scale beneath the waste bin was difficult to read while performing observations at the same time. To appear less out of place to the students a chef's jacket was borrowed during the observations. If a student approached to ask questions, however, it was explained that research on food waste was being conducted. The total plate waste was recorded every half hour throughout the observations. Observations were approved by The Swedish Ethical Review Authority.

2.4.2 Visual estimations of plate waste

Visual estimations were based on a portion guide published by the Swedish Food Agency (2010). The guide is usually used for dietary surveys and is developed for assessing adult food intake. The guide provides images for a variety of meals and food stuffs, where portion sizes are labelled from 1-6 with 1 being the smallest, see Appendix 4 for two examples from the guide. Images from the guide was used during observations to estimate plate waste instead of portion size. Empty plates were labelled 0 during observations and then 1-6 was used for non-empty plates, corresponding to increasing amounts of plate waste in line with the portion sizes from the guide. Observations were noted down in Excel on a smart pad, where images from the portion guide were made available beforehand, using images that corresponded best with the day's menu. For example, if a stew was served then a reference image from the guide with a stew was used, and if pasta was served a reference image for pasta was applied instead. The same images of vegetables and salads were used on all days. The images were studied thoroughly before the first observation. Other than that, there was no prior training.

2.4.3 School A: Students per table and plate waste

At school A, observations were performed to observe whether the number of students at a table, the group size, had any impact on plate waste. The hypothesis was, as brought up in interviews, that larger groups of students may result in more plate waste due to social pressure, with students wanting to leave the dining hall at the same time as their friends. To observe this hypothesis, the number of students per table combined with a visual estimation of their plate waste was made.

The pilot observation cemented that the number of students was too high to observe all tables during the lunch service, and it was decided to observe a sample.

To complete as many observations as possible it was decided to choose tables which housed students rather than randomising which tables to observe. It was also decided to only observe tables within the larger part of the dining hall, where students take food and leave their dishes. An effort was made during the first day of observations to include tables from the outer part of the dining hall, however, it was deemed too difficult to perform visual estimations of plate waste when the distance to the food waste bin was too large. A map of the dining hall was sketched to keep track of the tables, which were assigned letters from A to N. Observations were performed during the restaurants opening times (10:50-13:30) and a bit after, since students always linger past the opening times according to kitchen personnel. The following parameters were recorded in Excel: Students per table, which table (signified by a letter), observed gender of the students at the table, and visual estimates of plate waste for each student when they left the table to leave their dishes. Any missed observations were noted down as well.

2.4.4 School B: Gender-based differences in plate waste

During the interviews, several respondents expressed their perception that male students generate more plate waste compared to female students. It was decided to test this hypothesis during the three observation days at school B. Observations were made from behind the dish-leaving station, where kitchen personnel operate. From that point, the waste bin was clearly visible and visual estimations of plate waste could be made. Different columns were used in Excel to note down observations of plate waste from male and female students. Observed school staff were noted amongst the observations so that they could be excluded from the final analysis. All observations of gender were based on visual appearance and thereby affected by gender norms.

One observation day was completed with a meat dish, one with a vegetarian dish, and one lunch when fish was served as the main option, to observe an array of dishes. Observations were made throughout the full lunch service (10:30-13:00) on all observation days, and a bit after. Since the dining hall is integrated into the school and used for more purposes, it is not closed in the same way as the dining hall in School A may close after the last student has finished eating. Personnel at school B explained that students can sit at their tables for quite a while after the lunch service has finished, and are instructed to leave their plates before leaving. Therefore, observations were terminated before the last students had left on all observation days. The amount of students that were missed from observations were not quantified. It was presumed that the observed plate waste occasions would be enough to answer the question of interest.

2.4.5 Analysis

To answer the hypothesis that group size affects plate waste, two questions were formulated when analysing the data from school A. First, if group size affect how many students waste food at the table, and second, if there are any common traits between tables where someone is a high-wasting student (here defined as student's generating plate waste between 4-6 from visual estimations). The first question was investigated by creating a plot in Excel.

To answer the second question, probabilities were first calculated in Excel for the presence of a high-wasting student in relation to number of students at a table. Then, logistic regression was used to find the impact of different parameters on the presence of high wasting students at the tables where such observations were made. Logistic regression was performed in RStudio using the `glm` function. The presence of "high wasting students" was chosen as the dependent variable, and *time of day, table, gender*, and *students per table* were assigned as independent variables. Another logistic regression was conducted using only *gender* and *students per table* as independent variables. The variable *students per table* was weighted since the goal was to find out the effect group size has on the presence of a high-wasting student and not simply whether the presence of more students increases the probability. Since the response variable is binomial, i.e. presence of a high-wasting student = 1 and no high-wasting student = 0, family was set as "binomial" in the `glm` function.

For the data at school B, a Mann-Whitney U test was used to determine if there was a statistically significant difference between how much plate waste was generated by male versus female students. Alpha was set at 0.05 and calculations were performed in RStudio. The `shapiro.test` function was used to check for normality in the data, and then the `wilcox.test` function was used to perform a Mann-Whitney U test on the dataset.

An exact two-sample Kolmogorov-Smirnov test was then performed to test if the values came from the same distribution, meaning if plate waste from male students and plate waste from female students came from the same distribution or not. The `ks.test` function was used in RStudio, with exact set as TRUE in the function due to the small data set (<5000 data points).

3. Results

This chapter presents the study's main findings. The interviews provided information on previous and current efforts the schools have applied to reduce food waste. Thematic analysis revealed five themes, including plate waste hot-spots, challenges towards food waste reduction, and opportunities, social influences on plate waste generation, and the emotional response respondents and students have in relation to food waste. The survey was able to provide an insight into student perspective, showing their main reasons for wasting food, that students' waste different amounts, and some examples for possible plate waste reduction. The lunchroom observations indicated that group size and gender affect high-wasting students but also contradicted the hypothesis that male and female students waste unequal amounts. Interview results are presented first, followed by the survey, and ending with the observations.

3.1 Interviews

The interview results are divided in two parts, first presenting a list of responses to the question *"How do you work towards reducing food waste?"* and the second part showing the results from the thematic analysis. Note that all interviews were conducted in Swedish and that quotes from the respondents have been translated into English for this report by the author. The original Swedish transcriptions can be found in Appendix 5. All quotes are followed by a letter, in alphabetical order, and the respondents interview code for easy identification.

3.1.1 Measures to reduce food waste

After interviewing 7 respondents at school A and 6 at school B, it became clear that both schools have implemented a lot of measures to combat food waste. Below are three lists which present, summarized, which measures these are. A majority of the interventions were mentioned by more than one respondent, however there are a few exceptions, meaning that the following measures may not be performed by all personnel working in the school kitchens. The lists are divided to show which interventions have been implemented by both schools and which are exclusive to school A and B, as identified via interviews. Note that the implementations of an intervention may differ between the schools, and that some interventions are done in periods (such as information campaigns) while others are always present (such as signage in the dining hall).

Food waste interventions: Implemented at school A and school B

- Kitchen personnel weigh and record the food waste every day, divided into the categories plate waste, kitchen waste, and serving waste. The data is registered digitally and shared with the meal services. At the schools, the kitchen personnel use the data to assess how close they are to the municipality's' goal and reflect on the amounts during meetings.

- Signage in the school dining halls, provided by the meal services. The information on the signs differs, for example stating information such as "You may take as much as you want, but not more than you can eat", or climate impact related to food waste.

- A food waste board provided by the meal services, where kitchen personnel write the total food waste from the previous day. There are smileys showing happy or sad expressions depending on how close the food waste amount was compared to the municipality's goal. At school A, the board is posted above the station where students leave their dishes and plate waste. At school B, the board is displayed above the stations where students take their food

- Students get to skip in line when they go for their second portion. At school A, they have created a serving station especially for "re-takes". At school B, they inform that it is okey to get ahead in line when taking ones second portion.

- A scale placed below the station where students scrape their plate waste, which shows the total plate waste accumulated so far that day.

- Rewards such as ice-cream or other desserts when the students manage to decrease the food waste.

- Competitions with other schools to reduce food waste.

- Several different information campaigns, highlighting different consequences of food waste, such as environmental impact or costs.

- Cooperation with the student council when running campaigns to inform on food waste.

- Communication with the schools regarding the schedules around lunchtime, making efforts to reduce crowding.

- Try to only serve one popular carbohydrate source, such as pasta and rice, at a time to reduce plate waste of those.
- The head chefs talk to students one-on-one if it is identified that the same student wastes a lot of food many times.
- Personnel in the serving line reminds students that they can come and get food several times, and to not take more than they can eat.
- Kitchen personnel regularly ask students why they waste food in order to better adapt the meal services efforts towards reducing food waste. They mostly pose such questions to students when they are leaving their dishes.
- Halving potatoes when they receive potatoes on the bigger side.
- Reusing leftovers as much as possible when it is safe to do so.

Food waste interventions: Implemented at school A

- Updates to the staff during regular meetings on how much food waste is generated and how it changes.
- The principal asks teachers to mention food waste during class councils.
- Signage with recommendations on how much food to start with when taking your first plate, used for some foods such as how many meatballs for example.
- Teachers regularly eat in the dining hall at the start of new semesters to provide a safe space for new students.
- Changed the kinds of snacks that are served in the school cafeteria to be more filling, to encourage students to buy those instead of taking lunch several times a day.
- When plate waste increases a lot in periods, personnel will stand more by the dish leaving station and ask students why they waste, and give them looks meant to make them ashamed of wasting food (referred to as “giving the evil eye”).
- Offer smaller taste-portions when introducing new dishes to the menu.
- Stopped serving oat rice since the students refused to eat it.

- Have put signs with information about food waste on the tables in the dining hall.
- Internal surveys to ask the students why they waste food, with feedback provided to both kitchen staff and teachers.
- The head chef attends the teachers Monday meetings when they feel that it is time to remind the teachers of communicating with the kitchen when students will not attend lunch for different reasons.

Food waste interventions: Implemented at school B

- The head chef speaks to new students for 5-10 minutes every year in their classrooms, explaining how the lunches work and also informing about food waste.
- Special permission to eat in smaller rooms, such as study rooms or classrooms, are given to students who, for different reasons, do not feel comfortable eating in the dining hall.
- Students, from one of the schools programmes, get to come into the school kitchen to observe and learn how the meal services work.
- Head chef decreased plate size when they started working at the school.
- Some programmes include education on food waste, in connection to education on the food system.

3.1.2 Thematic Analysis

Five themes were identified from the interview data using thematic analysis, see Figure 1. The first theme presented is plate waste hot-spots, which describes different occasions where the respondents relayed that large quantities of food waste occur. The second theme then presents challenges that will need to be overcome in order for the schools to continue reducing food waste. The third theme explores opportunities to, hopefully, reduce food waste further. The fourth theme then explores societal influences on plate waste, ending with the fifth theme which concerns emotional responses to food waste.

Figure 1. Themes and sub-themes identified with thematic analysis.

3.1.2.1 Plate waste hot-spots

One theme identified from the interviews was plate waste hot-spots, i.e. foods or situations which usually lead to a lot of plate waste. Regarding food stuffs, all of the eight respondents who worked for the meal services mentioned that potatoes and rice were the main components of the plate waste. Most also mentioned pasta, but three respondents said that pasta is very popular amongst the students and does not result in a lot of plate waste. Other foods that were thought to cause a lot of plate waste were unpopular fish options, such as fish gratin or stew. However, the respondents who mentioned this also pointed out that a lot of the waste on those days were from potatoes, and that potatoes weigh a lot. Vegetarian prefabricated products were also mentioned as a cause for food waste by respondent 12, however, it is worth mentioning that many of the respondents referred to vegetarian nuggets as being one of the more popular food options. Four of the respondents from the meal services mentioned that popular foods cause more plate waste than unpopular dishes, but once again this was mostly tied to the carbohydrate source on the plate. Both head chefs expressed similar accounts of why carbs such as potatoes, rice and pasta generate a lot of plate waste:

> ”But they [the students] have their blinders on, so they go and get rice, they love rice, they fill their plates with rice, and then they see ‘Oh there are nuggets, nice’, use all of the space on the plate that they can to fill it with nuggets, eat all the nuggets first since they are on top, and then all of the rice is left and they waste the rice. When it’s a popular carb with a popular protein, then a lot of it ends up as food waste.” A, R3

> “Yes… What we can observe is that a lot of our staple food generates a lot of waste, and that’s because you for example take a lot of potatoes, you take a lot of rice and pasta. Because you might think that this is what I want, to feel full, or because it’s pretty cheap, but you add too much on the plate then.” B, R13

Five respondents said that the students' most common excuse for wasting food is that they are already full, which matches the quotes from the head chefs. In contrast, two of the respondents working in the kitchens believed that popular food cause less waste due to students finishing their plates. R5 thought that serving the students favourite dishes more often would decrease plate waste, and that it is unnecessary to be stubborn and serve food that you know the students do not like. R8 commented that they are reluctant to serve mostly prefabricated food, which they explained that a lot of the students favourite dishes are made of.

One other problem area which causes food waste, according to four respondents, are the start of new semesters and the arrival of new student cohorts. Both R1 and R5 mentioned that in lower school grades, there are limits on how much of certain food items that students' can take, whilst there are no such limits in upper secondary schools in the municipality. R1 explain that new students find out about this, are amazed by it, and then take more food than they can eat since it is new for them to not have a limitation. R5 explained a similar phenomenon, wondering if the first-year students take a lot of food since they are unsure if the food will run out, or because they do not realise that they can come back as many times as they want to get more food. R5 went on to explain that food waste varies, and that some years are better than others, but when a new semester starts it is usually a "catastrophe".

Another identified hot-spot for food waste was "high-wasting students", i.e. students that waste a lot of food from their plate often. It was not defined exactly how much the amount had to be to count as "a lot" by any respondent, but enough for the personnel to feel that it is an amount that is not okay to waste. R3 mentioned that there is no vision for zero plate waste, and that some waste must be allowed. R13 mentioned that even amongst adults there are always people that waste some food, and that this is difficult to avoid. However, high-wasting students are seen as a main cause of concern regarding plate waste according to the respondents that work in the school kitchens. R1 illustrated it by saying that it is enough if 30 students generate plate waste, out of 900, for them to fail the goal set by the municipality. R3 believed that students who generate a lot of plate waste are "repeat offenders", that it is the students which do not care, and that if you could reach this group the plate waste would probably lower by 25-30%. Four respondents thought that male students were more inclined to be high-wasting students than female students, though two respondents thought there was no difference or that it was hard to say. R2 thought that female students waste very little food in general, but noted that when many waste a little it still accumulates and becomes a lot of plate waste. R3 thought that high-wasting students were possible to profile, describing them as such:

> "I would say that men waste the most, but it's, like this, the general image of students that waste a lot, it's a guy, over 180 in height, probably wearing an outer coat. If a guy like that enters the dining hall you can guarantee that he will fill his plate to the brim,

and he, on the way out he will always drop something on the floor which we will have to clean up." C, R3

3.1.2.2 Challenges

Throughout the interviews, there was a recognizable pattern of different challenges that staff are faced with in their fight against food waste. One of the main causes for concern was that students do not listen to, or take in, the information they are presented with about food waste. R2 described telling students to take a little less food first and then come back if they want more, but that they do not listen. R8 mentioned similar discourses with students, but added that not only do they not listen, but they do not want to listen, and that they want to do what they want. R5 reasoned that it is probably due to their ages, that students at this point in life are unorganised and bad at keeping track of time, causing them to waste food when they realise that they have to leave the dining hall to get to their lessons on time. R4 also mentioned the difficulties of this age, and that especially new first years are more difficult to reach since everything is new for them and they can be a bit nervous at school.

There was also the challenge of how to perform interventions geared towards high-wasting students without singling out or offending any student. For example, R3 said that it is difficult to do targeted interventions without pointing out any demographics, hinting that this is not okay. The respondent also mentioned that nothing at schools are separated by gender, when discussing the possibility of male students being inclined to waste more, and that it would not only be difficult to target men when designing interventions but also that it has the possibility to backfire. R4 said that if we were not so afraid to offend people, we would be able to do targeted interventions. Social norms of fairness and inclusivity restrict the school and kitchen staff in this matter, affecting how they design interventions.

The most limited resource for the respondents when implementing actions to reduce food waste was said to be time. R5, R7 and R9 all expressed that it takes a lot of time to perform food waste reducing efforts. R13 relayed that it takes a lot of time but also energy to pursue campaigns and other efforts to reduce food waste, and that it requires motivation to do this work. R6, who does not work in the school kitchens themselves, also expressed concern that kitchen personnel probably have limited time that they can apply on reducing food waste. R11, a school headmaster, expressed that they personally do not have the time to initiate food waste interventions, but that they are inclined to support any initiative that the kitchen staff and meal services bring forth. R12, a teacher, said that they did not have the time to include information on food waste in their lessons this year. They went on to explain that there is too much in the central teaching plan that they have to include, and that if there existed prepared teaching material on food waste which clearly connected to the teaching plan then they would be more inclined to include

it. This indicated that proper teaching material, along with time, is a limited resource that teachers experience regarding the matter of food waste in schools. R4, R6, and R10 all noted that teaching efforts should be adapted to the programs that the students attend. R6 and R10 both mentioned that the students' basic knowledge differs between programs, which is why educational efforts have to be adapted in line with their knowledge and interests.

Another challenge mentioned was how to improve cooperation and communication between the kitchen personnel, the meal services, and the schools. R4 and R6 pointed out that it was easier to cooperate on food waste questions when the kitchen staff belonged to the school, as opposed to today when they are a part of the meal services. Some of the interviewed kitchen personnel felt that communication from the teachers to the kitchen is poor, with R13 saying that they have to attend teacher meetings regularly to give the teachers reminders. R8 also mentioned that the kitchens do not get information on how many students are absent, but thought it was due to caregivers not providing this information to the schools.

Throughout the interviews, respondents referred to students as either children or adults, and sometimes as both within the same interview. For example, R1 referred to the students as "our children", but also explained that they do not treat them as little kids, but as adults. The respondent later went on to, again, call the students children, and use it as an explanation as to why a reward such as ice cream is a good motivator for the students to waste less food. Then later calling them adults, stating that some are 18 and that it is difficult to communicate with them more than they already do, and that they can't "police" the students about their food waste. This confusion around the students' place in society, whether they are children or adults, seems to have caused a challenge of how to address the students in situations about food waste. R2 also expressed that it is more difficult to communicate with adolescent students than with smaller children. R3 claimed that the students are old enough to know how much food they are able to eat, expressing frustration and saying:

> "Like get to know yourselves, get to know your body, you are aware, you are at an age where you should know yourselves" D, R3

R4 mentioned several times throughout their interview that students in upper secondary schools are going through a difficult time in life, and that it is scary to become an adult. At school A, it was mentioned by three respondents that students sometimes provide reasons such as "I have a bad day today" for why they waste food, something they have only been met by when working at the upper secondary school. R8 explained it as such:

”Yeah, exactly. They won’t say ’Oh no I took too much’. They will never say ‘I took too much’. Yeah, they create something. ‘I’m in pain, I have a headache’, ‘I had a bad weekend’. I don’t know.” E, R8

The schools also face the challenge of students having to stand in long lines sometimes to get their food. Some respondents said that the waiting times are short and not a problem, while others emphasised how long they can become during rush hours. The problem that long waiting lines causes is that students take too much on their plates to avoid standing in line twice, according to respondents. This problem persists, even though the schools have implemented measures to reduce waiting times. It is worth mentioning that both schools were built for fewer students than attend them today. Waiting times are also caused by scheduling, according to R13, contributing to a concentrated rush hour:

“Because, for example, today we open at about ten to eleven, and from around half past eleven to a quarter to twelve, the usual days, so from 800 eating guests we have about 300, 350, maybe 400 coming in forty-five minutes.” F, R13

Another factor contributing to crowded dining halls is that the students often do not follow their schedules when they go and get lunch. At both schools, many students go to the dining halls and take either food, or just sandwiches, several times a day. This also causes unnecessary crowding, leading to students taking more food on their plates to avoid standing in line for a second portion. When kitchen staff have asked students why they waste food, not having enough time is one of two main reasons they provide. However, it is difficult to know if the limited time is caused by scheduling, a too small dining hall, or if the students themselves also contribute to this problem. Both R5 and R8 expressed examples of students sitting and looking at their phones, wasting away their lunchtime, before realising a lesson is starting and then wasting the food that’s left on their plates.

Finally, despite trying many kinds of interventions to reduce food waste, some with scientific evidence, the schools have a challenge of achieving long-term impact from their efforts. Both principals, R10 and R11, explicitly state that this is a large concern of theirs. R3 explained that they have never found a way to achieve long-term effect from any of the campaigns they have tried, and mentioned that their principal has been very engaged in these questions but that the disappointing results have led to less interest. This is also reflected in the interview with R10, the principal at the same school. When asked how to get more students involved in the food waste question, R10 responded:

”Well, this is an extremely important question and an extremely difficult one, because I believe that I have worked with this in different ways at different schools and that there’s so much you can do, but what gives an effect? That’s the 1000-crown question, what *de facto* makes food waste decrease? And I always believe that if there is student

> engagement where the students themselves get an awareness and reflect on where they see that they can make a difference, then it will lead to behavioural change. And I really believe we have worked hard to work this way, but still the food waste remains stable. And that has made me very surprised." G, R10

3.1.2.3 Opportunities

The interviews also highlighted possibilities towards reducing food waste. Two of the interviewed teachers highlighted that a better cooperation between teachers and the kitchen personnel could lead to reduced plate waste. There were also five respondents who mentioned that cooperating with the students, such as running campaigns with the student council, is a good way for reducing food waste. R4 who is a teacher at school B said:

> "And I believe that you have to get the student council involved, that that's what's most important, if they can reach out and do promotions, then it becomes something else as opposed to if us in the personnel do it." H, R4

Even though many challenges were identified with performing targeted interventions towards high-wasting students, there were also some possibilities. If you can identify a closed enough group, or an individual, then targeted interventions can be possible, according to interviews. R3 gave an example of when they had a conversation with a student who was often angry and complained a lot about the school lunches. The respondent said that you have to get the students "one-on-one" to have an impact on them, but also gave an example of when they talked with one class were a lot of plate waste had been identified. R12 also thought that targeted interventions should be possible if a clear group is identified. Both R3 and R13, head chefs at the schools, had examples of when they discussed plate waste with students who were identified to waste a lot. This had happened on several occasions and was seen as part of their jobs. There were other respondents who work in the school kitchens that mentioned that they can inform their head chef if they identify a student who generate a lot of plate waste, and that it's for the best that the head chefs are the ones to take that responsibility. For example, R1 said:

> "No, I remember, I've seen a guy, he threw away food every day, I kept an eye on him. Eventually, I went and told them [the head chef], I've had my eye on him for several days and he throws away the same [amounts]. Then I show [the head chef] and they go and talk to them [the students]. We're not allowed to talk and say whatever we want to them. We tell [head chef's name] and they go. You know, sometimes, it's better that they take that big role for us and talk to them [the students], it's better than having any conflict between us and them [the students]." I, R1

Another opportunity identified for decreasing food waste in the schools was that it is perceived to be easy to implement and test new interventions by respondents. The kitchen personnel was positive towards trying new ways of reducing food

waste, and both head chefs agreed that there is no hesitation from them if any one of their staff has an idea they would like to try. It was also identified that both school principals are engaged in the question of food waste and strive to be supportive whenever they have the possibility. Regarding resources, the head chefs, R3 and R13, both agree that interventions to reduce food waste are often free or very cheap, and that money is rarely a limiting factor in their work to reduce food waste.

3.1.2.4 Social influences

Another theme can be described as social influences, meaning instances when students waste food due to either pressure from their peers or due to current societal discourses affecting behaviour. Starting with peer pressure, respondents brought up that many students are likely to leave their tables before finishing their plates when their friends have finished eating and get up to leave. R11 expressed it like this:

> "It's about when you sit together and have lunch, so even in this constellation of students there are more or less informal of informal leaders, influential students, and when they are done and get up to leave, to leave their dishes, then the others at the table feels, to like not get excluded from the group, then they follow the rest even though they have food left on their plates and go and waste that food. They don't have this, what should I say, independence to stand up and say, 'Hey I'm still eating, I have food left'". J, R11

R13 and R4 mentioned this as well, that students waste food due to wanting to leave at the same time as their friends. R3 also mentioned students taking too much food on their plates in the first place since they know they will not have the time to take food twice, since their friends will finish and leave. R4 went on to say that a lot of plate waste could probably be explained due to social pressure of different kinds.

Other social pressures that were mentioned were not wanting to skip ahead in line, something that both R3 and R4 brought up. Even though students are allowed to skip ahead in line if it is their second portion, R4 mentioned that it is scary for them, especially for younger students to skip ahead of older ones. The behaviour of taking a lot of food on your plate to impress your friends was mentioned by R8, and R13 expressed that there are students who do not want to show that they like a certain food if their friends have shown disgust for it, causing them to waste.

Many respondents believed that food waste in schools has increased due to societal changes, with almost all respondents mentioning it at some point. For example, R4 and R13 said that they themselves were not allowed to waste food growing up. R6 mentioned experiencing very angry personnel in the school kitchen when they grew up, and that it is very different today. R9 was convinced that behaviour for reducing food waste has to come from home, and R7 mentioned that the municipality could increase their efforts to reduce food waste by focusing on

households as well as schools. R6 mentioned something similar, and expressed it by saying:

> "And they [the meal services] have tried competitions and several different challenges, so I, yeah I think it's related to upbringing really" K, R6.

R10 brought up the latest nationwide survey and report from *Ungdomsbarometern* (2025) as an example, pointing out that students today care less about the environment than they did a few years ago. R4 also mentioned that there used to be many vegetarians in their sustainability profiles at the school, and that today there is only one. R13 said that they had observed, as their own children grew up, that the discourse around food has changed and that students are very spoiled when it comes to food, and have a poor understanding of what food scarcity is like. They also said that parents today have focused more on their career and that fewer children today know how to shop or cook food from scratch. Finally, R6 and R3 mention that the environment has become a polarised subject, and that bringing it up may have the opposite effect of what you want. When asked if the students are interested or touched when they are taught about the food system and food waste, R6 responded:

> "Yes, but I always find it easier to get them on board if you explain the bigger picture, and not do it in a way that makes them feel like they're being pushed into a particular viewpoint. And I think that's something to be mindful of, even when it comes to the question about climate change, because it's better if it becomes a personal conviction for them rather than something they feel the school is trying to push them into, because then it can have the opposite effect. Then they become anti instead." L, R6

3.1.2.5 Emotional response

Many feelings related to food waste were identified from the interviews. Regarding respondents' perception of students emotions, two brought up a feeling of shame from the students when they waste food. R5 mentioned students looking uncomfortable if staff pointed out that they waste a lot of food, and R3 also mentioned that students find it uncomfortable to talk about their plate waste and explained students' awareness by saying:

> "And they know that they shouldn't waste, they are so aware of it, I don't think anyone is allowed to waste so much food at home." M, R3

R6 talked about students' reactions when the head chef comes to the classroom and talks about food waste, explaining how much effort has been put into the food and that it makes them sad to see it wasted. R6 explained that it has an effect on the students, and that they care more when they see a person behind the problem. There

was also a feeling of pride noticed from some students when they waste nothing, and R1 described students wanting to show off a clean plate to personnel.

Personnel described feelings of sadness or anger in relation to food waste. R8 mentioned feeling sad about the students wasting food, and talked about the resources that goes into the food. They also mentioned that there are countries where food is much scarcer, and that the school lunches are a valuable asset that students do not appreciate. R9 also expressed that it is a shame the amount of food that go to waste, and R4 said that no matter how much the students waste it is still too much, since they believe no food should be wasted. R3 also mentioned that it is frustrating to work with food waste reduction, that you care for periods but also lose your motivation when it increases again after an effort has been made. They expressed feeling more frustration than joy about it. This could reflect an emotional fatigue from repeated failures, something which was also reflected by R10 who relayed that many measures which they believed would work turned out to have a disappointing effect.

3.2 Survey

From the two participating classes, a total of 33 students responded to the survey. Of the respondents, 32 stated their gender, however all 33 respondents answered all remaining questions. The gender distribution of respondents was as follows: 56% men, 34% women, 6% non-binary, and 3% (one respondent) selected the option "*Do not wish to specify"*, see Appendix 2 for survey questions. A majority of the respondents answered that they waste food at least sometime each week, followed by "rarely" and "a few times per week", see Figure 2. There were 64% of respondents who answered that they waste little when they throw away food, while 6% responded that they waste half a portion or more, see Figure 3.

Figure 2. Share of answers to the question "How often do you throw away food at school?".

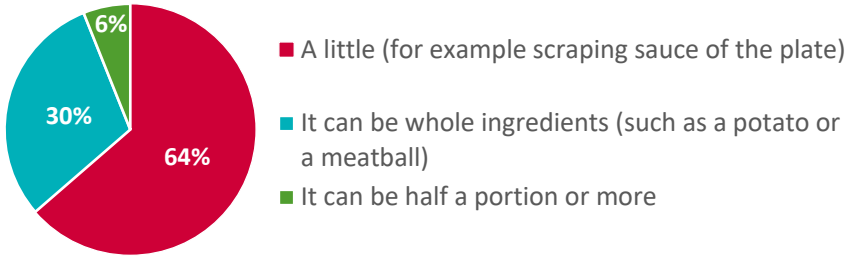

Figure 3. Share of answers to the question "How much do you usually throw away if you throw away food?".

The most common reason that students waste food at school, according to the survey responses, is that it does not suit their taste. The second most common reason is that they do not have enough time to finish eating, see Figure 4. The two respondents (6%) that answered *Other* to the question "*What is the most common reason for you to throw away food?*" both left a comment explaining why. One comment said that there was only fat or sauce left, while the other said that it was either due to a lesson starting or because the food was not very edible.

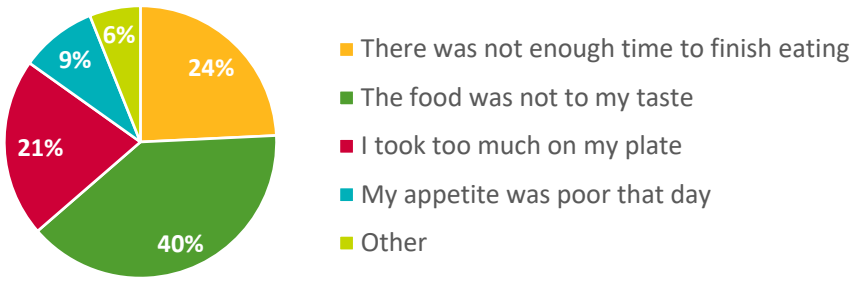

Figure 4. Share of answers to the question "What is the most common reason for you to throw away food?".

Of the 33 respondents, 30 responses were given to the question asking if the school could do anything differently that would lead to students wasting less food. One-third of the answers mentioned more delicious food as a suggestion to decrease food waste. Two respondents mentioned that they could take less food, and one suggested that the school could have a competition between classes to see which wasted less food. Two of the answers said to increase the break time and two suggested increasing the food options. Four comments mentioned specific food, where two said to serve more pancakes and two said to not serve oat rice at all. There were also six answers saying that they had no ideas for how the school could change in order for them to decrease food waste.

When asked whether given the opportunity, if they would make any changes to the school lunch, the majority answered yes (70%). The suggestions varied but

some patterns could be observed. Out of 19 suggestions for improvements to the school lunch, eight concerned the quality of the food, with comments such as *"More delicious food",* Swedish *"Godare mat",* and *"Ask what food we like and cook that food",* Swedish *"Fråga vad vi gillar för mat och laga den maten"*. Two comments mentioned increasing the alternatives, and two brought up that they wanted less vegetarian food or at least to have a meat option. Two respondents commented on decreasing or removing oat rice, and three suggestions concerned that the food should be less strange or complicated. For example, one comment said, *"To not make strange food",* Swedish *"Inte göra konstig mat"*, while another said, "*More basic food such as for example potatoes and meatballs instead of fish pudding with cornflakes and so on",* Swedish *"Mer basic mat tex potatis och köttbullar istället för fiskpudding med conflskes osv."*. There were also two responses that brought up yoghurt as suggestions.

For the last question, if there is anything that you (the students) could do to waste less, 14 of 27 responses (52%) said to take less food on the plate, i.e. smaller portions. Two responses said that they already wasted so little and therefore had no suggestions, while two stated that they should finish their plates.

3.3 Observations

During the lunchroom observations, school A generated on average 24 kg plate waste/day and school B generated 26 kg plate waste/day, see Table 2.

Table 2. Total plate waste in kilograms at School A and B from three observation days. The calculated average plate waste and standard deviations are presented in the table.

Total plate waste [kg]	
School A	School B
26	28
19	24
26	25
24 ± 3	26 ± 2

3.3.1 School A: Students per table and plate waste

Throughout the three observation days, 93 tables with 487 students were observed. See table 7 in Appendix 3 for information on how many tables were observed and number of students seated at those tables. From the observed tables, 40% were female students only and 38% were male students only, with the remaining tables having a mix of both genders. Of the total observed students, 48 (10%) were missed when returning their dishes, leaving 439 observations of plate waste, see Figure 5. The zero waste observations made up 46% of total observations.

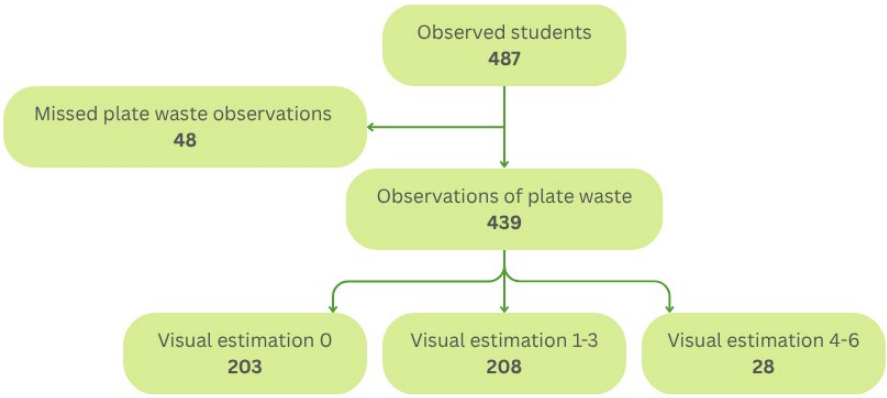

Figure 5. Flowchart with the amount of student observations at school A including missed observations and visual estimations of plate waste.

Figure 6 shows the proportion of students who generated plate waste in relation to students per table, or group size. The linear trendline shows a slight decrease, indicating that the share of students with plate waste decreases with larger student groups. This figure does not include estimations on amount of plate waste. The smaller tables in the figure, around 1 to 4 students, has a wide spread and do not follow the trendline.

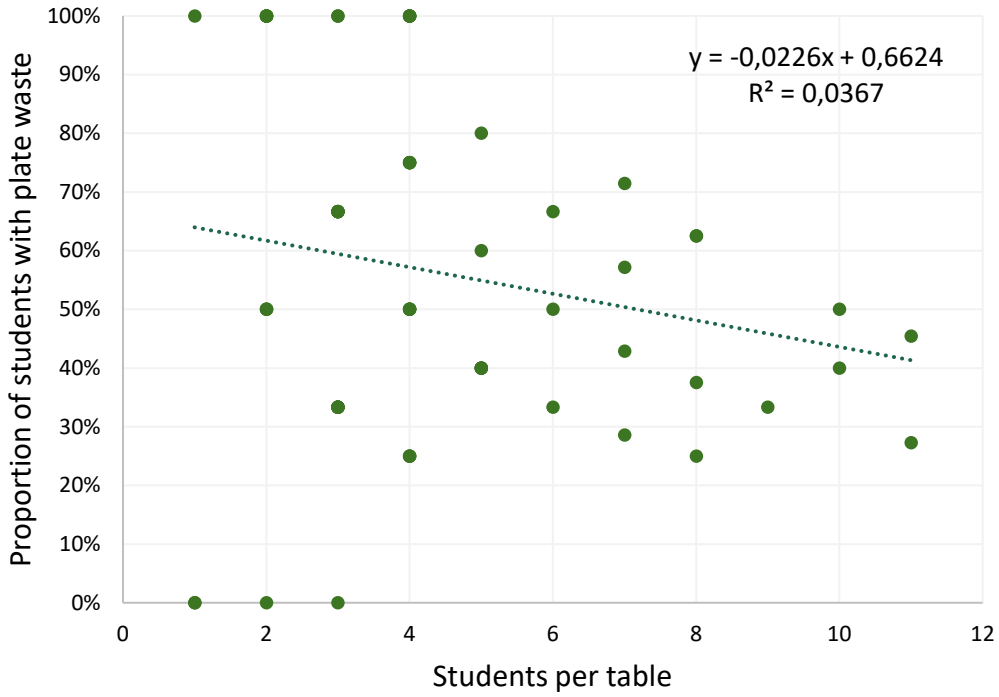

Figure 6. Proportion of students who generated plate waste per table, including a linear trendline with equation y and the R2-value.

From the 93 observed tables, 22 tables (24%) were observed to have at least one student producing plate waste between 4-6 on the visual scale, deemed a high-wasting student in this study. This does not include the missed observations and the number could be higher. Of the 22 tables, 10 were male students only, 10 seated a mix of male and female students, and 3 tables hosted female students exclusively. Most of the students that generated plate waste between 4-6 sat on tables of 8 (representing 46% of observations from tables of 8).

In Figure 7, the probability that a high-wasting student is present at a table is plotted against the number of students per table, or student group size. The green line shows the null-hypothesis, that the probability increases when the student group is larger, and the blue line shows the observational data. The lines intersect at some datapoints, but no clear pattern can be observed as roughly half of the datapoints do not line up. The hypothesis cannot be accepted based on the observational data. Calculated probabilities are used, rather than the number of high-wasting students, so that the increase of high-wasting students is not mistaken for an increase simply because the number of students increase.

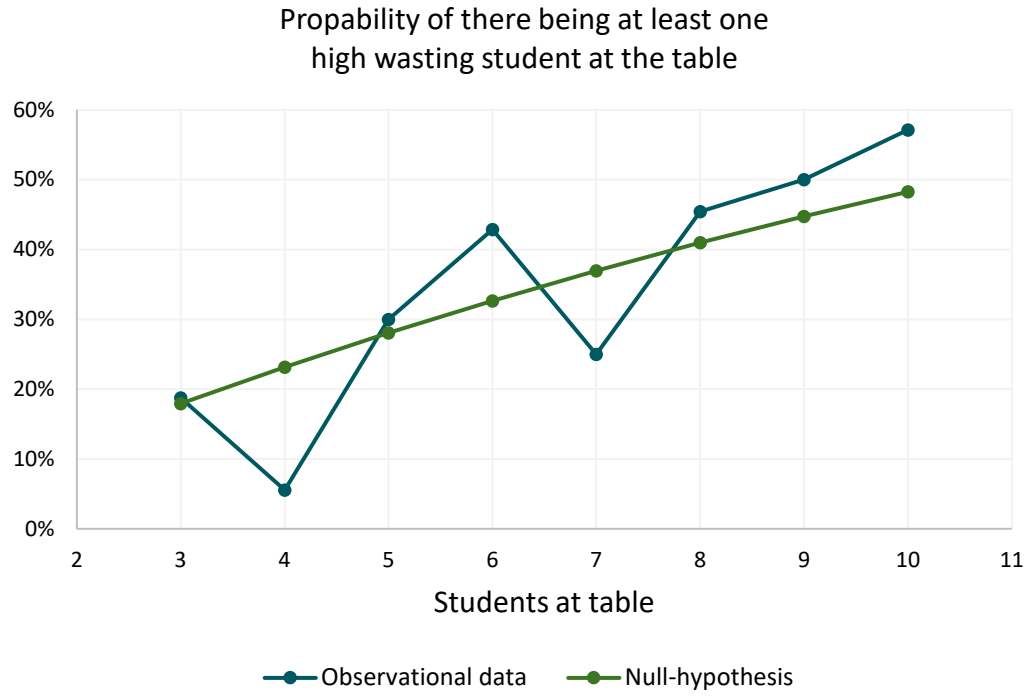

Figure 7. Scatter plot demonstrating the probability that there is a high-wasting student (plate waste between 4-6) at the table, and if the probability increases with the group size, or number of students, at the table.

Results from the logistic regression showed that time of day (divided into half hours when the lunch service was open), and which table (named after letters as explained previously) had no significant effect on the presence of high wasters.

Therefore, it was decided to perform a logistic regression using only gender and students per table as independent variables. These results showed that the increase of students per table has an impact on the presence of at least one high-wasting student, see Table 3. The odds ratio for students per table = 1.41, meaning that an increase with one extra person at a table increases the odds by 41% that at least one student is a high-wasting student. The results also show that tables with male students and tables with mixed genders have a higher probability of containing at least one high-wasting student than tables with only female students. Tables with only male students were 8.6 times more likely to have at least one high-wasting student compared to tables with only female students, while tables with mixed genders were 11.5 times more likely.

Table 3. Results from logistic regression

Variable	*Estimate*	*Odds ratio*
Intercept	-4.25	0.01
Gender male	2.15	8.59
Gender mixed	2.44	11.49
Students per table	0.34	1.41

3.3.1 School B: Gender-based differences in plate waste

In total, 1670 students were observed when leaving their dishes over the course of three days. Of these observations, 848 (51%) were of female students, see Table 4. Around 32% of observations were of zero waste occasions.

Table 4. The total amount of observations at school B divided into gender and visual estimation of plate waste.

Visual estimation of plate waste	*male*	*female*	*total*
0	275	255	530
1	209	257	466
2	133	167	300
3	90	95	185
4	73	53	126
5	38	19	57
6	4	2	6
	822	848	1670

As can be shown in Figure 8, the share of observations decreases as the visual estimation of plate waste increases. There were <0.5% of observations where a student's plate waste was categorised as a 6 on the scale of visual observations.

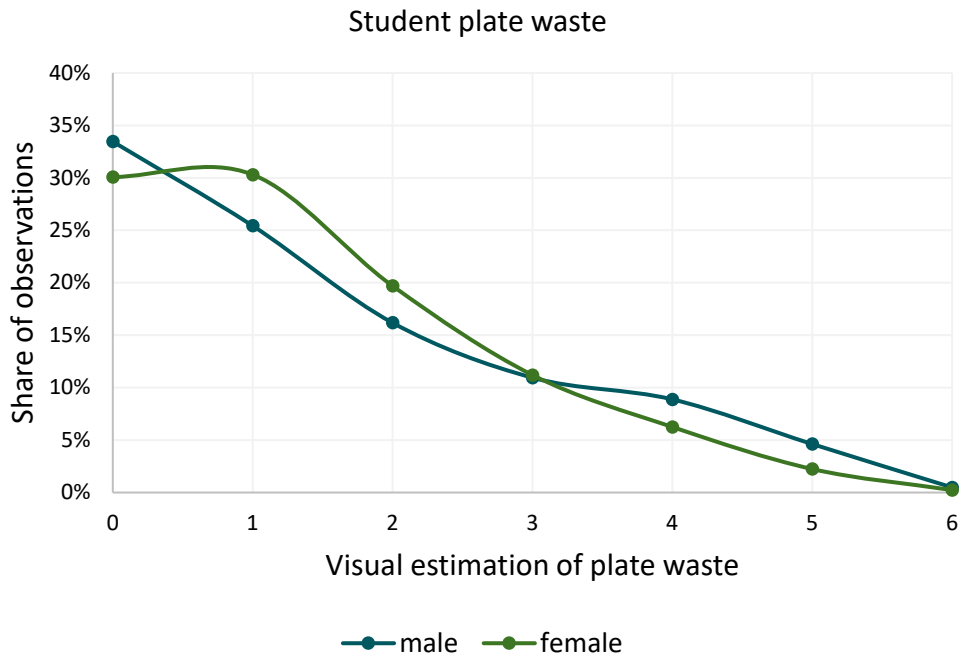

Figure 8. Share of student plate waste, divided by gender, showing % of observations which were categorised between 0-6 on an estimated visual scale of plate waste.

The Mann-Whitney U test showed that there was no statistically significant difference in the data between how much plate waste male and female students generate, see Table 5. Since the p-value > 0.05, the null hypothesis cannot be rejected and the median difference between pairs of observations is zero.

The two-sample Kolmogorov-Smirnov test also showed that there is no statistically significant difference between the groups, with p > 0.05, meaning that male and female students are a part of the same distribution.

Table 5. Results from the Mann-Whitney U test and the Two-sample Kolmogorov-Smirnov test on the observational data from school B. The abbreviation n/a (not applicable) is used when the value is irrelevant to the statistical test.

Statistical test	*p-value*	*W*	*D*
Mann-Whitney U	0.610	343644	n/a
Two-sample Kolmogorov-Smirnov	0.0514	n/a	0.0526

4. Discussion

This study investigated the plate waste fraction of food waste generated in upper secondary schools in Uppsala, Sweden, with the aim to explore what can be done to reduce it further. By examining two schools using interviews, a student survey, and lunchroom observations, it became clear that the schools have applied a variety of measures to reduce their plate waste. Stakeholders identified their perceived causes for plate waste generation, something which could be utilised when designing interventions in the future. Opportunities and challenges for food waste reduction were also investigated as they are key factors to consider when designing interventions. Special attention was paid to high-wasting students, as previous research has highlighted the potential for food waste reduction if these students are able to reduce their plate waste.

The discussion begins with considering different areas for future efforts and the possible implications, as well as when efforts could be concentrated to relieve some of the burden from kitchen personnel. This is followed by a discussion on study limitations, and ending with recommendations for future research.

4.1 Future efforts for plate waste reduction

The studied schools had already implemented several well-established interventions to reduce food waste, including daily weighing and follow-up of waste and reminders to students not to take more than they can eat. These align with the Swedish Food Agency's current recommendations for reducing food waste in public catering (2020), and are widely described in literature (Eriksson et al., 2025). Findings by Reynolds et al. (2019) indicate that changing plate shape or size might be most effective in reducing consumer food waste, while Liechti et al. (2024) suggest that multi-component interventions with nudges have the potential to decrease consumer food waste greatly, providing examples of nudges such as food waste reduction tools, plate size, and feedback. These are all interventions which the schools have applied either currently or in the past, supporting their current efforts where they are applying multiple interventions at once. At school B, it was specifically mentioned by the head chef that they had decreased plate size when starting their position. Even though portion size has been observed to affect plate waste, with smaller portions resulting in reduced plate waste, consumption is affected by portion size as well (Berkowitz et al. 2016; McCrickerd et al. 2017; Werkman et al. 2022). As the most important aim of the school lunches are to provide students with meals covering 30% of their daily recommended nutrient and energy intake, reducing portions further is not a viable option to reduce plate waste going forwards.

Comparisons with previous studies show that the schools' plate waste is close to the national median (Fritz & Jonsson 2025), and lower than other reports on upper secondary schools in Uppsala (Gerstbrein 2024) and schools in general in Sweden (Malefors et al. 2022a). Even though the schools wish to achieve the municipality goal of 20 g plate waste/portion (Uppsala municipality 2025a), they are already at the forefront and their current efforts could inspire other schools to follow suit in decreasing their plate waste. Therefore, it is worth discussing if they should focus on maintaining current levels rather than increase their efforts for further food waste reduction. It would also be interesting in future studies to try and identify which measures are applicable to other schools, and whether they would have the same effect. As a suggestion, schools which generate food waste above the national average could draw inspiration from the two schools in this study. Reducing the waste from schools with higher waste levels would make a more substantial contribution to Sweden's effort towards SDG 12.3.

As identified by interviews, feelings of frustration and fatigue may occur when results are underwhelming in relation to efforts. Respondents mentioned that there is no vision for zero plate waste, indicating that a low and stabilized level of plate waste has to be reached eventually. With the schools' current efforts, it is possible that this level is already reached, and that fluctuations will always exist since students' are constantly interchanging. However, many savings in terms of costs, environment, and nutrition can be made if food waste is reduced further, and the personnel were positive that it is possible. If schools continue in the same way, however, the lack of further reduction may instead lead to frustration and declining motivation. Therefore, key problem-areas are hereby discussed as potential focuses going forward. Concentrating efforts on problem areas and at certain times of the year could potentially decrease the burden on kitchen staff while resulting in food waste reduction.

4.1.1 High-wasting students

High-wasting students were identified as one of the hot-spots for causing plate waste. In the present study, around 10% of observed students fell into the high-waste category (visual scores of 4–6), while most students had little or no waste. This aligns with Malefors et al. (2024), who found that 20% of students generate about 60% of plate waste, indicating that few students generate a majority of plate waste. Responses from the student survey showed a similar pattern, where a minority of students (6%) admitted to wasting quantities such as half a portion or more (Figure 3).

Interviews showed possibilities and challenges with targeting high-wasting students. Routines at school A and B show that head chefs shoulder a lot of the responsibility for trying to correct the behaviour of these students. There are currently no quantifiable effects of these actions, however the head chefs describe

them as positive experiences. There are several ethical implications with targeting high-wasting students, as there are possibilities of causing offence when singling out individuals or groups of students. It is difficult to recommend measures which targets high-wasting students without first understanding the impact they have and considering trade-offs. With the current rate of these occurrences, where head chefs converse with high-waste students on-one-one, the head chefs view them as a part of their job. It could be recommended to other schools to implement similar routines if the impact these conversations have are proven to be effective. If head chefs would have to individually target 20% of students, if comparing results with Malefors et al. (2024), it could become too labour intensive and distracting from their other tasks. This illustrates a conflict and challenge in food waste reduction. On one hand, research shows that a minority of students generate a lot of food waste, and targeting them could significantly impact food waste reduction. On the other hand, singling out and targeting students has ethical concerns and is labour intensive compared to interventions applied to all students. Therefore, further investigations are necessary to uncover the feasibility and effectiveness of interventions targeting high-wasting students.

Logistic regression results from school A indicated that group size and gender composition influence the presence of high-wasting students. Important to keep in mind is that gender was not observed on an individual level at school A, which limits the strength of any gender-related conclusions made in the study. Tables with a mix of genders had a higher odds ratio of a high-wasting student being present than male only tables had in relation to female only tables. Since there is no data on gender composition from the mixed tables, it was not possible to identify which students generated high plate waste, and only speculations can be made. There are previous studies which have found that male students generate more plate waste than female, such as Gerstbrein (2024) who also made observations at schools in Uppsala, and this is something which stakeholders and researchers should keep in mind when designing interventions. Despite results, it is not appropriate or realistic to suggest separating tables by gender in Swedish schools. Given the mixed-tables had higher odds of having high-wasting students, it could be worth doing further observations to see whether group dynamics affect students to waste more. While interviewing Chinese college students, Jia (2025) found that it varied whether peer pressure affected the respondents food waste behaviour or not. During interviews, one respondent mentioned the attitude of their peers when eating, expressing that they might correct their behaviour if they are eating in a group where students are frugal. Another respondent expressed more of a sense of individuality, indicating that it was unlikely they would stop eating because their peers already finished their meals. Other factors explored by Jia (2025) include attitudes towards food waste, with results indicating a sense of guilt from students, similar to the results in this thesis, and normalization which lessened the feelings of guilt. Results from Jia

(2025) also indicated that female students were more likely to not finish their meals and waste food, due to societal pressures on body image. Contradicting results showing either male or female students as potential high-wasting students could be due to cultural factors and environmental contexts.

The logistic regression results also indicated that the presence of high-wasting students increased with the number of students per table. To test this hypothesis, the schools could separate the long tables into smaller tables and see if the plate waste levels are affected. However, important to keep in mind is that the schools already struggle with crowding during certain times of day, and separating tables would decrease the open spaces in the dining halls. This could result in other problems, such as more crowding and movement during rush hours, which could also affect plate waste. Since separating tables is a low effort and a cost-effective intervention, it could still be worth testing to see if the effect observed from the logistic regression is really due to table size and not some other unknown factor. Though looking at Figure 6, observations indicate that the share of students with plate waste decrease with larger student groups, contradicting staff belief that more students waste their leftovers due to friends leaving the table. A possibility is that there could be peer pressure to finish ones plate, as Jia (2025) observed in some students. The share of students who generate waste does not tell us anything about the amount of plate waste, however, and a small share of students could still affect waste levels greatly.

Although many staff perceived that male students wasted more food, this was not statistically confirmed at School B. Observing the data in Table 4, however, there were more male than female students that generated plate waste at higher volumes. Therefore, the perception from staff that male students waste more food could be due to more male students wasting fuller plates of food than female students. Interestingly, male students were also more frequently observed as zero-wasters, while female students were more common in the low-waste categories (scores 1–2). These mixed patterns highlight that while extreme waste was more common among male students, female students were more consistently low-level wasters. These results could have implications for future interventions. If high-wasting students are predominantly male, then social patterns and behavioural research might be helpful when designing interventions going forwards. Even though the schools want to avoid targeting groups of students out of ethical concerns, interventions which are applied to all students today, such as information or education, could try to cater to interests observed among Swedish male youth. There were small differences in the number of observations per gender, though this was reasonable according to kitchen staff as the school has more female students.

Targeting low-waste students could also have an impact on total plate waste, however the schools do not have a zero-waste policy and advocate that some waste must be allowed. Reaching a few high-wasting students could most likely have the

same impact on plate waste as targeting a large amount of low-waste students, and one could argue that it would be considered unfair to put more responsibility on students that already waste low amounts rather than confronting why some students generate high waste. Interventions focusing on this subgroup, while preserving anonymity and avoiding stigma, may offer a more efficient use of resources than broad campaigns.

4.1.2 Carbohydrate sources

Respondents were in agreement that food staples such as potatoes, rice, and pasta make up the majority of plate waste. This is in line with results from Sundin et al. (2024), who found that carbohydrate sources represented 59% of plate waste from two schools in Uppsala. An earlier study by Engström & Carlsson-Kanyama (2004) also found that pasta, potatoes and rice made up the majority of plate waste while examining two schools. Therefore, designing interventions to target carbohydrate sources specifically could have the potential to further decrease plate waste. However, it would be important to consider possible rebound effects if decreased carbohydrate waste would lead to other food groups increasing in their waste fractions.

Two measures that the schools' have done to reduce plate waste from carbohydrate sources is to only serve one option when a popular carbohydrate source is served, and to reduce plate waste from potatoes by halving them when they receive bigger potatoes. Something the schools could implement going forward is to reduce the size of serving utensils, as smaller serving utensils may decrease plate waste (Ahmed et al. 2018). Research also suggests that serving order affect consumption and waste. Adams et al. (2016) found that placing vegetables before staple foods increased consumption and lowered waste, suggesting that placing staple foods later in the serving line might help reduce their over-selection and waste. School A and B already have their salad bar positioned before the warm food, and this measure might be more relevant for other schools to consider. However, even though they are placed closest to the entrance of all the food, the salad bars at the studied schools are detached in separate installations from the serving line containing warm food. It could be worth investigating if the separation of the salad bar makes students more inclined to skip it than if vegetables were placed even closer to the warm food.

A final suggestion could be to utilize material from the meal services where the schools can write serving suggestions for students. While there is no limitation on food, the schools are allowed to make recommendations per portion. These are mostly utilized by schools to offer recommendations on protein sources, such as how many meatballs to take per portion, but a new way to use them could be to recommend portion sizes for carbohydrate sources as well as protein sources, perhaps including recommendations for vegetable intake as well. At the studied

schools, these signs are rarely used, and have mostly been applied when food has been limited for reasons such as late or wrongful deliveries, to ensure all students get a certain foodstuff. Informational interventions are not always proved to be effective (Stöckli et al. 2018b), and it is unclear what effect these signs currently have. Since it is a time and cost-effective suggestion, however, it might be worth for the schools to explore.

4.1.3 Popular meals

Other than food staples, kitchen personnel perceive popular food as a main cause for plate waste. This is a myth that has been previously identified in school kitchens in Uppsala municipality by Sundin et al. (2023). The authors identified popular meals and analysed food waste quantification data to find that popular meals did not cause more food waste compared to unpopular dishes.

In the student survey, a majority of students (40%) chose disliking the food as their most common reason for generating waste (Figure 4). Students also responded that they wanted more delicious food when asked what the schools could do differently in order for them to waste less. However, during interviews, the kitchen staff relayed that the two most common reasons students provide for wasting food are that they are full or that they do not have time to finish eating. This could indicate that students are unwilling to tell kitchen personnel when they dislike the food, making it difficult for staff to identify which meals the students do not prefer, while also maintaining the myth that popular food leads to more waste.

Since many of the respondents working in the kitchens believe that popular meals cause more plate waste, it could be worth investigating if this is true for upper secondary schools, given that Sundin et al. (2023) looked at primary and secondary schools. Though, given student responses and the previous research, it could also be that popular meals are not the plate waste hot-spot that respondents perceive them to be. One possibility could be that days with popular menus result in higher total plate waste compared to days with unpopular dishes because more students attend lunch when they expect to enjoy the food.

Going forward, the schools could compare attending students with the amount of plate waste between days when popular and un-popular meals are served. Either confirming or refuting this theory, in an upper secondary school setting, could provide useful to the schools and the meal services when designing menu rotations and for food waste reduction.

4.1.4 Informing students

Many of the challenges for reducing plate waste ties into questions surrounding how to influence student behaviour. Interviewed respondents expressed short-term effects of campaigns, little to no attention given to signage in the dining halls, and societal changes pointing to declining awareness surrounding food waste. One way

to improve chances of getting students attention might be to adapt communication according to their ages and interests. Respondents seem confused on how to address students in upper secondary school, viewing them as both children and adults. This dual framing could affect how interventions are designed, seeing as children are often guided while adults are expected to take responsibility. For example, this study uncovered interventions such as rewarding students with sweet treats if they reduce food waste, but also information campaigns with information on the economic costs of food waste. Signage also differed from signs with the climate impact of meals to illustrations of a child with an explanation of which components belong on a plate to create a full meal. These inconsistent communication strategies could affect the outcome of food waste interventions. Moshman (2011) argues that teenagers cannot be empirically distinguished from adults, using the term young adults instead, and goes on to say that development beyond the age of 12 is individually driven and not age-related. The schools could try to focus their informative measures on age-appropriate messaging, as many respondents believe that they as young adults, should take responsibility for their food waste. Respondents also mentioned that student cooperation often leads to more successful campaigns, and future campaigns should strive to include student influence when possible.

A concern brought up during interviews is that students are too busy with other tasks during school lunches, such as engaging in conversation with friends and choosing their lunch, to pay attention to any signage in the dining hall. Shahrzadi et al. (2024) reviewed literature concerning the causes and consequences of information overload, as well as strategies to reduce these consequences. They found five causes which contribute to information overload, including personal factors and characteristics of the information. The review found several consequences of informational overload, such as impacts on individuals decision making processes and feelings of anxiety and confusion. With this in mind, seeing as schools' main focus is to educate, students are already met with a lot of information before they reach lunch time. It could be that students are saturated with information and find it difficult to digest more educational material outside of lessons. Stöckli et al. (2018b) found that informational interventions are the most commonly applied intervention when promoting sustainable behaviour, such as food waste reduction, and highlights that there is lacking evidence on the effectiveness of informational interventions, suggesting that combining informational prompts with other intervention types is often more effective. Eriksson et al. (2025) also found informational interventions to be the most common type, and presents a large variety on the reported effects of such interventions. To increase the impact of signage at the schools, for one they could be renewed often, as respondents describe them as having very short effect on the students. The content of the signage could also be reviewed to see if it is eye-

catching enough amongst other decoration and information in the dining halls, and easy to digest. There are many studies where messages including social norms have resulted in food waste reduction, see for example Whitehair et al. (2013) and Stöckli et al. (2018a). The schools have utilized informational messages in the dining hall related to environmental impact and costs, rather than social norms. If students are effected by peer pressure, including social norms in food waste messaging might be an effective method of reaching more students than current messaging does. Since informational prompts might not be effective on their own, they could also be combined with other efforts that the schools have applied.

Education on food waste seem to have untapped potential in upper secondary schools, and is a tool which could be used more to raise awareness. Many studies have assessed the effect of education on plate waste (Chen & Serrano 2018; Antón-Peset et al. 2021; Catalina & Yazmin 2024), and it could be worth for the schools to include education in classes where it is not present today. The main challenge is the limited time the teachers have to develop appropriate material, which should fit within the curriculum for different programmes in upper secondary schools. At school A, it was only possible to meet with one teacher, who expressed that there was not enough time in their schedule to include food waste, and that they preferred to focus on issues that interest students. At school B, it became clear that food waste is integrated into some classes, but not all, and the effect that education may have has not been evaluated. One opportunity could be if principals encourage teachers to assign a week in the semester where food waste is woven into the educational material, something which was mentioned by the principal at school A (R11).

As mentioned by several respondents, the students' behaviour could also be influenced by societal changes. For example, *Ungdomsbarometern* (2025) state that students care less today about the environment today than they did five years ago. Many respondents also mentioned that efforts to reduce food waste and inform students must come from home, and that food waste behaviour is affected by how a student has been raised. This is a challenge that is difficult for the schools to affect, and it is possible that their efforts have limited impact on their own if influence must come from households. A multi-stakeholder partnership could be the way forward, combining sectors and ideas to collaborate on food waste solutions. A study by de Visser-Amundson (2022) illustrates how food waste reduction was possible in the Dutch hospitality industry via a partnership between multiple stakeholders, including a bank, a food waste foundation, a technology start-up, one university, and one government department. In Uppsala, other municipal organisations might have better resources to reach out to households with food waste information than the schools or the meal services have. Also, ideas from the civil society could contribute if given the opportunity, and collaboration between the meal services and universities might increase the schools access to the latest research concerning food waste reduction. Results from the interviews have already

stated that improved collaboration between the schools and the meal services are seen as an opportunity for decreasing food waste further, and it is worth exploring how their partnership could be improved without straining the already tight schedule of teachers and kitchen personnel alike.

4.1.5 Could efforts be concentrated to improve efficiency?

Given student cohorts are annually renewed, efforts have to be continuous. Research on recycling has shown that reminders are successful for establishing sustainable behaviour (Essl et al. 2021; Putnam-Farr et al. 2023; Fuhrmann-Riebel et al. 2024), indicating that food waste reducing behaviour could be induced with reminders as well. However, to reduce fatigue and increase motivation it would be beneficial to investigate when efforts have the greatest potential.

The start of semesters, along with new student cohorts, were pointed out during interviews to increase plate waste. At school B, efforts are made to lessen this effect, with the head chef visiting all year-one classes when the autumn term begins to tell them about the school lunch and how it works, including information on food waste. Concentrating efforts at the start of a new semester may be a way to influence new student cohorts to adopt a positive behaviour, leading to decreased plate waste long-term, and decreased burden on personnel. This could improve the working environment for kitchen staff and possibly provide more time for focusing on other tasks, which could potentially affect plate waste as well e.g. if the saved time could be spent on improving recipes or other routines.

Examining when food waste is highest throughout the year, aside from the start of the semester, and applying measures at that point in time is another possibility for increasing impact of measures. Does rain vs sunshine impact plate waste for example? Or is there more plate waste in autumn than in spring? Does waste increase before or after holidays? Answering these questions could provide guidance for when it is most effective to perform measures. Seeing as the schools have access to year-long food waste data it should be possible to analyse fluctuations and peaks in food waste levels, though this could be outside of the kitchen staffs scope or competence and a statistician might be needed for such an analysis. Once again, this highlights the possibilities with cooperation and the involvement of multiple stakeholders for food waste reduction.

4.2 Study limitations

Convenience sampling limits the generalizability of the results from this study. It was used due to the advantages that it presents and because of the temporal limitations of this study. While probability sampling, such as simple random sampling, gives more generalisable results, convenience sampling, which is a non-probability sampling, is cheaper, simpler to implement, and more efficient in

research (Jager et al. 2017). Since this study investigates two of the municipal upper secondary schools in Uppsala thoroughly, it could be described as a case study (Robson & McCartan 2016), and results reflect the studied schools rather than all upper secondary schools in Uppsala or Sweden. However, results might be transferable to schools with similar characteristics to those included here. To improve the generalizability of study findings, more schools should be further investigated.

The choices made during the thematic analysis greatly affected the interview results (Braun & Clarke 2006). The researchers previous knowledge on food waste reduction in schools, and recent developments in the research area, influenced the decisions made when conducting the analysis. Since a theoretical approach was used, a more in-depth analysis on certain aspects was made leading to a less rich description of the data set as a whole (Braun & Clarke 2006). The adopted approach for the thematic analysis was discussed between researcher and supervisor and different approaches were considered before settling on a theoretical, semantic, and realist perspective. This means that the approach was not decided on before data collection began, or when analysis first started, as recommended by Braun & Clarke (2006). Sample size of the interviews have not been tried for saturation and it is possible that the sample size was too small to be representative of the stakeholders opinions. However, all head chefs and principals were interviewed at school A and B, meaning these representations should be accurate.

It was decided to investigate student opinions with a survey rather than interviews since it is less resource intensive, given the time restrictions of the study. However, student interviews could have provided valuable insight to the study results had they been conducted. Another weakness of the study is the small survey sample. The 33 respondents represent <2% of the population at the two schools. Therefore, survey results can only be used as an insight and is not representative for student opinions at the schools. The results are also skewed as 20 of the 33 respondents attended one school, with an unequal distribution. School staff stated that the students receive a lot of surveys during the spring semester, and they were reluctant to distribute more during this period of time, citing that the students would not give it their full attention. A recommendation from school staff was to distribute surveys in autumn instead. However, even with a representative survey sample, students could be reluctant to admit to wasting food, and survey results should be interpreted cautiously. In the study by Malefors et al. (2024) where authors analysed plate waste quantifications, the automated tool also allowed students to choose options for why they generated plate waste that day. From the 20% of students that generated the top fraction of plate waste in the study (66-500 g), 25% responded that the food was not to their taste, 19% responded that they took too much, and 13% responded that they did not have enough time to eat. These results are similar

to the survey responses, however, about 43% of students chose the option “I ate up my food” (Malefors et al. 2024:6) despite wasting amounts between 66-500 g.

There are uncertainties in the observational data which could have an impact on the results. There is no seasonal variation in the data as all observational days were completed within a span of two weeks. Statistical testing showed that there was no statically significant difference between men and women’s plate waste during the observation days, though it is difficult to claim that results are true for all other days in the semester as well. Another limitation with the observations are the visual estimations of plate waste. Many studies have evaluated different methods for quantifying plate waste and consumption (Dubois 1990; Liz Martins et al. 2014), showing that weighing food waste is the most accurate method. The use of visual estimations means there are no quantified amounts of how much food is wasted by any student or the high-wasting students. There could also be some uncertainties from the observations due to the missing data. At school A, it was documented how many observations were missed, however, it was not at school B, and the possible effect of missing data has not been looked into. Observational data only looked at number of students, and gender, not including any other possible identifiers which might have an impact on plate waste. This decision limits the analysis and was made consciously as the researcher has limited knowledge on behavioural patterns.

4.3 Future research

Based on the results of this study and previous studies (Gerstbrein 2024; Malefors et al. 2024) research should continue to study high waste behaviours and contexts which may lead to increased plate waste. Understanding contexts for high waste behaviours may lead to more informed interventions, though it is important to consider ethical implications if interventions are designed based on a minority of students. Since the results suggested that large groups affected high-wasting students, further studies could look into groups dynamics to deepen the analysis on possible effects from social groups and implications of peer pressure.

Something that could potentially impact food waste levels at the schools is if research focus on developing educational material for students of ages 16-20, so that teachers at upper secondary schools have more accessible teaching material for this area of study. The material could be developed in cooperation with teachers and students, and should not only be age appropriate but also be developed to suit different programmes in upper secondary schools, focusing on student knowledge levels and interests.

Future efforts could also focus on identifying schools with high amounts of plate waste, and evaluate if the measures such as those made by school A and B in this study can be applied to others with similar results. Despite the insights of the current study into two upper secondary schools, more research is necessary to test the

replicability and scalability of measures. In this study, it is suggested that one-on-one conversations are possible interventions for targeting high-wasting students, however further research should be made to evaluate whether these efforts achieve the desired effect and if they are scalable.

Since the schools have worked extensively with strategies aimed at reducing food waste, one way forward could also be to investigate interventions aimed at increasing consumption instead, while examining possible spillover effects on food waste levels. This could be a sustainable way to include nutritional aspects when working with food waste reduction.

5. Conclusions

This thesis has investigated plate waste in two of Uppsala municipality's' upper secondary schools, and tried to ascertain where efforts can be made in the future to reduce it further. The schools have tried and tested many measures throughout the years, with one of the most recent being a board displaying the previous day's food waste in comparison to the municipal goal. Many of the measures the school has done are supported by research, such as decreasing plate size or conducting information campaigns. Due to lower than national average waste levels, using the experience from the schools and applying it to upper secondary schools with higher plate waste could be a better way to decrease food waste than increasing efforts at the studied schools.

Plate waste is generally believed to be caused by high-wasting students, certain foods such as popular meals or carbohydrate sources, and the arrival of new student cohorts at the start of new semesters. Focusing efforts on these areas might lead to decreased food waste in the future, while decreasing workload for staff overall. Student perceptions indicated that good food is the best way to avoid plate waste, however staff perceived the opposite, making it ambiguous whether serving popular meals could lead to decreased plate waste or not.

Targeting high-wasting students' could be a more efficient way of spending resources than focusing on all students equally, however further research is needed in this area, and ethical implications are important to consider going forward. The schools' already have routines for approaching high-waste students, although whether this results in food waste reduction or not is unknown. In this study, results suggested that male students represented more of the high-wasting students than female students do, and that larger student groups increased the probability of high-waste students. These insights could affect how interventions are designed going forward.

For more reliable results, lunchroom observations could be made for longer periods of time to capture seasonal variation, and at additional upper secondary schools to be more generalizable. Future research should also collect student opinion from a representative sample to confidently find out what students would like to see improved from school lunches.

Further studies are needed to continue exploring the effects of peer pressure and social influences on plate waste, as results indicate their impact in educational settings. Lastly, future research should also focus on evaluating long-term effects of interventions to assess their effectiveness, making it easier for stakeholders and policy-makers to choose between the vast amount of interventions. This could lead to increased efficiency and less workload for the schools that are looking to reduce their plate waste and food waste overall.

References

Adams, M., Bruening, M., Ohri-Vachaspati, P. & Hurley, J. (2016). Location of School Lunch Salad Bars and Fruit and Vegetable Consumption in Middle Schools: A Cross-Sectional Plate Waste Study. *JOURNAL OF THE ACADEMY OF NUTRITION AND DIETETICS*, 116 (3), 407–416. https://doi.org/10.1016/j.jand.2015.10.011

Ahmed, S., Shanks, C., Lewis, M., Leitch, A., Spencer, C., Smith, E. & Hess, D. (2018). Meeting the food waste challenge in higher education. *INTERNATIONAL JOURNAL OF SUSTAINABILITY IN HIGHER EDUCATION*, 19 (6), 1075–1094. https://doi.org/10.1108/IJSHE-08-2017-0127

Antón-Peset, A., Fernandez-Zamudio, M. & Pina, T. (2021). Promoting Food Waste Reduction at Primary Schools. A Case Study. *SUSTAINABILITY*, 13 (2). https://doi.org/10.3390/su13020600

Benton, Tim.G., Bieg, C., Harwatt, H., Pudasaini, R. & Wellesley, L. (2021). Food system impacts on biodiversity loss: Three levers for food system transformation in support of nature. https://www.unep.org/resources/publication/food-system-impacts-biodiversity-loss [2025-05-17]

Berkowitz, S., Marquart, L., Mykerezi, E., Degeneffe, D. & Reicks, M. (2016). Reduced-portion entrees in a worksite and restaurant setting: impact on food consumption and waste. *PUBLIC HEALTH NUTRITION*, 19 (16), 3048–3054. https://doi.org/10.1017/S1368980016001348

Boakes, E.H., Dalin, C., Etard, A. & Newbold, T. (2024). Impacts of the global food system on terrestrial biodiversity from land use and climate change. *Nature Communications*, 15 (1), 5750. https://doi.org/10.1038/s41467-024-49999-z

Braun, V. & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, 3 (2), 77–101. https://doi.org/10.1191/1478088706qp063oa

Brinkmann, S. & Kvale, S. (2018). *Doing Interviews*. SAGE Publications Ltd. https://doi.org/10.4135/9781529716665

Burg, X., Metcalfe, J., Ellison, B. & Prescott, M. (2021). Effects of Longer Seated Lunch Time on Food Consumption and Waste in Elementary and Middle School-age Children A Randomized Clinical Trial. *JAMA NETWORK OPEN*, 4 (6). https://doi.org/10.1001/jamanetworkopen.2021.14148

Bustamente, M., Afonso, A. & De los Ríos, I. (2018). Exploratory analysis of food waste at plate in school canteens in Spain. *LA GRANJA. Revista de Ciencias de la Vida*, 28 (2), 20–42

Catalina, P. & Yazmin, F. (2024). Importance of school gardens. As a strategy for the consumption of healthy food in an early childhood home in Bogota-Colombia. *JOURNAL OF THE SELVA ANDINA RESEARCH SOCIETY*, 15 (1), 29–45

Chen, S. & Serrano, E. (2018). Exploring food waste at a residential youth summer camp. *Journal of Nutrition Education and Behavior*, 50 (7, Suppl. 1), S6–S7. https://doi.org/10.1016/j.jneb.2018.04.027

Connors, P.L. & Rozell, S.B. (2004). Using a visual plate waste study to monitor menu performance. *Journal of the American Dietetic Association*, 104 (1), 94–96. https://doi.org/10.1016/j.jada.2003.10.012

Directorate-General for Environment (2023). *Proposal for a targeted revision of the Waste Framework Directive*.

https://environment.ec.europa.eu/publications/proposal-targeted-revision-waste-framework-directive_en
Dubois, S. (1990). Accuracy of visual estimates of plate waste in the determination of food consumption. *Journal of the American Dietetic Association*, 90 (3), 382–387
Engström, R. & Carlsson-Kanyama, A. (2004). Food losses in food service institutions Examples from Sweden. *Food Policy*, 29 (3), 203–213. https://doi.org/10.1016/j.foodpol.2004.03.004
Eriksson, M., Halvarsson, R., Ran, Y., Sundin, N., Malefors, C. & Kastner, L. (2025). Mindre matsvinn, större nytta – en litteraturöversikt om åtgärder för offentliga måltider
Eriksson, M., Persson Osowski, C., Malefors, C., Björkman, J. & Eriksson, E. (2017). Quantification of food waste in public catering services - A case study from a Swedish municipality. *Waste Management (New York, N.Y.)*, 61, 415–422. https://doi.org/10.1016/j.wasman.2017.01.035
Essl, A., Steffen, A. & Staehle, M. (2021). Choose to reuse! The effect of action-close reminders on pro-environmental behavior. *Journal of Environmental Economics and Management*, 110, 102539. https://doi.org/10.1016/j.jeem.2021.102539
Eurostat (2024). *Food waste and food waste prevention - estimates*. https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Food_waste_and_food_waste_prevention_-_estimates [2025-05-18]
Fritz, K. & Jonsson, P. (2025). *L 2025 nr 07: Matsvinn i kommunala förskolor och skolor*. (L 2025 nr 07). The Swedish Food Agency. https://www.livsmedelsverket.se/om-oss/publikationer/artiklar/2025/l-2025-nr-07-matsvinn-i-kommunala-forskolor-och-skolor [2025-06-10]
Fuhrmann-Riebel, H., D'Exelle, B., López Vargas, K., Tonke, S. & Verschoor, A. (2024). *Can Reminders Promote Regular Pro-Environmental Behavior? Experimental Evidence from Peru*. (IZA DP No. 17013). https://www.iza.org/publications/dp/17013/can-reminders-promote-regular-pro-environmental-behavior-experimental-evidence-from-peru [2025-07-15]
Gerstbrein, T. (2024). *Investigating students' characteristics and behavioural factors driving plate waste in school canteens*. (Master thesis). Uppsala university. https://urn.kb.se/resolve?urn=urn:nbn:se:uu:diva-531566 [2025-02-03]
Hultén, J., Eriksson & Villner, M. (2024). *Livsmedelsavfall i Sverige 2022*. (INFO-serien 8908). Svenska MiljöEmissionsData (SMED). https://www.naturvardsverket.se/publikationer/8900/978-91-620-8908-5/ [2025-02-07]
IPCC (2019). *Climate Change and Land: an IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems.* Cambridge University Press. https://doi.org/ 10.1017/9781009157988 [2025-05-30]
Jager, J., Putnick, D.L. & Bornstein, M.H. (2017). More than Just Convenient: The Scientific Merits of Homogeneous Convenience Samples. *Monographs of the Society for Research in Child Development*, 82 (2), 13–30. https://doi.org/10.1111/mono.12296
Jia, L. (2025). *Under the Plate : Exploring Factors Influencing Food Waste Behavior from the Perspective of Chinese College Students*. https://urn.kb.se/resolve?urn=urn:nbn:se:uu:diva-562477 [2025-07-10]
Junkkari, T., Kantola, M., Arjanne, L., Luomala, H. & Hopia, A. (2024). The effect of nutrition labels on lunch buffet consumption: a real-life

experiment. *BRITISH FOOD JOURNAL*, 126 (13), 18–39. https://doi.org/10.1108/BFJ-06-2023-0532
KnowFife (2018). Semi-Structured Interviews
Kvale, S. & Brinkmann, S. (2014). *Den kvalitativa forskningsintervjun*. 3. ed. Studentlitteratur AB.
Liechti, C., Mack, G. & Ammann, J. (2024). A systematic literature review of impactful food waste interventions at the consumer level. *Sustainable Production and Consumption*, 52, 552–565. https://doi.org/10.1016/j.spc.2024.11.023
Lipinski, B. (2024). *SDG Target 12.3 on Food Loss and Waste: 2024 Progress Report*. Champions 12.3.
Liz Martins, M., Cunha, L.M., Rodrigues, S.S.P. & Rocha, A. (2014). Determination of plate waste in primary school lunches by weighing and visual estimation methods: A validation study. *Waste Management*, 34 (8), 1362–1368. https://doi.org/10.1016/j.wasman.2014.03.020
Malefors, C., Callewaert, P., Hansson, P.-A., Hartikainen, H., Pietiläinen, O., Strid, I., Strotmann, C. & Eriksson, M. (2019). Towards a Baseline for Food-Waste Quantification in the Hospitality Sector—Quantities and Data Processing Criteria. *Sustainability*, 11 (13), 3541. https://doi.org/10.3390/su11133541
Malefors, C., Strid, I. & Eriksson, M. (2022a). Food waste changes in the Swedish public catering sector in relation to global reduction targets. *Resources, Conservation and Recycling*, 185, 106463. https://doi.org/10.1016/j.resconrec.2022.106463
Malefors, C., Sundin, N., Tromp, M. & Eriksson, M. (2022b). Testing interventions to reduce food waste in school catering. *RESOURCES CONSERVATION AND RECYCLING*, 177. https://doi.org/10.1016/j.resconrec.2021.105997
Malefors, C., Svensson, E. & Eriksson, M. (2024). Automated quantification tool to monitor plate waste in school canteens. *RESOURCES CONSERVATION AND RECYCLING*, 200. https://doi.org/10.1016/j.resconrec.2023.107288
Måltidsservice (n.d.). *Om oss*. https://maltidsservice.uppsala.se/om-oss/ [2025-05-17]
Martins, M., Rodrigues, S., Cunha, L. & Rocha, A. (2020). Factors influencing food waste during lunch of fourth-grade school children. *WASTE MANAGEMENT*, 113, 439–446. https://doi.org/10.1016/j.wasman.2020.06.023
McCrickerd, K., Leong, C. & Forde, C. (2017). Preschool children's sensitivity to teacher-served portion size is linked to age related differences in leftovers. *APPETITE*, 114, 320–328. https://doi.org/10.1016/j.appet.2017.04.003
Moshman, D. (2011). Adolescents Are Young Adults, Not Immature Brains. *Applied Developmental Science*, 15 (4), 171–174. https://doi.org/10.1080/10888691.2011.618098
Persson Osowski, C., Osowski, D., Johansson, K., Sundin, N., Malefors, C. & Eriksson, M. (2022). From Old Habits to New Routines—A Case Study of Food Waste Generation and Reduction in Four Swedish Schools. *Resources*, 11 (1), 5. https://doi.org/10.3390/resources11010005
Putnam-Farr, E., Dhar, R., Gorlin, M., Upritchard, J., Hatzis, M. & Bakker, M. (2023). Forgot Your Bottle or Bag Again? How Well-Placed Reminder Cues Can Help Consumers Build Sustainable Habits. *Journal of the Association for Consumer Research*, 8 (3), 264–275. https://doi.org/10.1086/725110
Reynolds, C., Goucher, L., Quested, T., Bromley, S., Gillick, S., Wells, V.K., Evans, D., Koh, L., Carlsson Kanyama, A., Katzeff, C., Svenfelt, Å. &

Jackson, P. (2019). Review: Consumption-stage food waste reduction interventions – What works and how to design better interventions. *Food Policy*, 83, 7–27. https://doi.org/10.1016/j.foodpol.2019.01.009
Riksdagsförvaltningen (2010). *Skollag (2010:800) Svensk författningssamling 2010:2010:800 t.o.m. SFS 2022:1319*. https://www.riksdagen.se/sv/dokument-lagar/dokument/svensk-forfattningssamling/skollag-2010800_sfs-2010-800 [2023-05-16]
Robson, C. & McCartan, K. (2016). *Real World Research*. 4. ed Wiley. https://www.wiley.com/en-gb/Real+World+Research%2C+4th+Edition-p-9781119144854 [2025-06-05]
SCB (2022). *Statistisk lägesbild 2022 Genomförandet av Agenda 2030 i Sverige*
SCB (2025). *Folkmängd och befolkningsförändringar - Kvartal 1, 2025*. *Statistikmyndigheten SCB*. https://www.scb.se/hitta-statistik/statistik-efter-amne/befolkning-och-levnadsforhallanden/befolkningens-sammansattning-och-utveckling/befolkningsstatistik/pong/tabell-och-diagram/folkmangd-och-befolkningsforandringar---manad-kvartal-och-halvar/folkmangd-och-befolkningsforandringar---kvartal-1-2025/ [2025-06-12]
Scherhaufer, S., Moates, G., Hartikainen, H., Waldron, K. & Obersteiner, G. (2018). Environmental impacts of food waste in Europe. *Waste Management*, 77, 98–113. https://doi.org/10.1016/j.wasman.2018.04.038
SDG 12 Hub (2024). *12.3 Food Loss & Waste | SDG 12 Hub*. https://sdg12hub.org/sdg-12-hub/see-progress-on-sdg-12-by-target/123-food-loss-waste [2024-01-25]
Shahrzadi, L., Mansouri, A., Alavi, M. & Shabani, A. (2024). Causes, consequences, and strategies to deal with information overload: A scoping review. *International Journal of Information Management Data Insights*, 4 (2), 100261. https://doi.org/10.1016/j.jjimei.2024.100261
Silvennoinen, K., Heikkilä, L., Katajajuuri, J.-M. & Reinikainen, A. (2015). Food waste volume and origin: Case studies in the Finnish food service sector. *Waste Management*, 46, 140–145. https://doi.org/10.1016/j.wasman.2015.09.010
Steen, H., Malefors, C., Röös, E. & Eriksson, M. (2018). Identification and modelling of risk factors for food waste generation in school and pre-school catering units. *Waste Management*, 77, 172–184. https://doi.org/10.1016/j.wasman.2018.05.024
Stöckli, S., Dorn, M. & Liechti, S. (2018a). Normative prompts reduce consumer food waste in restaurants. *WASTE MANAGEMENT*, 77, 532–536. https://doi.org/10.1016/j.wasman.2018.04.047
Stöckli, S., Niklaus, E. & Dorn, M. (2018b). Call for testing interventions to prevent consumer food waste. *RESOURCES CONSERVATION AND RECYCLING*, 136, 445–462. https://doi.org/10.1016/j.resconrec.2018.03.029
Strohbehn, C.H., Strohbehn, G.W., Lanningham-Foster, L., Litchfield, R.A., Scheidel, C. & Delger, P. (2016). *Impacts of Scheduling Recess Before Lunch in Elementary Schools: A Case Study Approach of Plate Waste and Perceived Behaviors – School Nutrition Association*. *https://schoolnutrition.org/*. https://schoolnutrition.org/journal/spring-2016-impacts-of-scheduling-recess-before-lunch-in-elementary-schools-a-case-study-approach-of-plate-waste-and-perceived-behaviors/ [2025-01-31]
Sundin, N., Halvarsson, R., Scherhaufer, S., Schneider, F. & Eriksson, M. (2024). From plate to waste: Composition of school meal waste and associated carbon footprint and nutrient loss. *Resources, Conservation and Recycling*, 206, 107656. https://doi.org/10.1016/j.resconrec.2024.107656

Sundin, N., Malefors, C., Danielsson, M., Hardiyanti, M., Osowski, C.P. & Eriksson, M. (2023). Investigating goal conflicts in menu planning in Swedish school catering on the pathway to sustainable development. *Resources, Conservation and Recycling*, 190, 106822
Swedish environmental objectives (2025). *Matsvinnet ska minska mätt i mängd livsmedelsavfall - Sveriges miljömål*. https://www.sverigesmiljomal.se/etappmalen/minskat-matsvinn/ [2025-05-17]
Swedish Food Agency (2010). Portionsguide. https://www.livsmedelsverket.se/matvanor-halsa--miljo/matvanor---undersokningar/portionsguiden [2025-05-19]
Swedish Food Agency (2019). *Nationella riktlinjer för måltider i skolan*
The Global Goals (2015). *Goal 12: Responsible consumption and production*. *The Global Goals*. https://globalgoals.org/goals/12-responsible-consumption-and-production/ [2024-02-21]
UNEP (2024). *Food Waste Index Report 2024*. https://www.unep.org/resources/publication/food-waste-index-report-2024 [2025-05-18]
Ungdomsbarometern (2025). *Generationsrapporten 2025*. https://info.ungdomsbarometern.se/publika-rapporter/generationsrapporten-2025 [2025-05-17]
United Nations General Assembly (2015). *Transforming our world: the 2030 Agenda for Sustainable Development*. (A/RES/70/1). United Nations. https://undocs.org/en/A/RES/70/1 [2025-05-30]
Uppsala municipality (2023). *Hållbara måltider*. https://maltidsservice.uppsala.se/klimatsmarta-maltider/ [2025-05-26]
Uppsala municipality (2025a). Mål och arbetssätt för att minska matsvinnet
Uppsala municipality (2025b). Miljö- och klimatprogram. Dokumentansvarig: Kommunstyrelsen (KS). [2025-01-30]
Utbildningsguiden (n.d.a). *Det här är den svenska skolan*. [text]. https://utbildningsguiden.skolverket.se/languages/svenska/det-har-ar-den-svenska-skolan [2025-05-29]
Utbildningsguiden (n.d.b). *Gymnasieskolan*. [text]. https://utbildningsguiden.skolverket.se/languages/svenska/gymnasieskolan [2025-05-29]
de Visser-Amundson, A. (2022). A multi-stakeholder partnership to fight food waste in the hospitality industry: a contribution to the United Nations Sustainable Development Goals 12 and 17. *JOURNAL OF SUSTAINABLE TOURISM*, 30 (10), 2448–2475. https://doi.org/10.1080/09669582.2020.1849232
Werkman, A., van Doorn, J. & van Ittersum, K. (2022). Are you being served? Managing waist and waste via serving size, unit size, and self-serving. *FOOD QUALITY AND PREFERENCE*, 99. https://doi.org/10.1016/j.foodqual.2022.104568
Whitehair, K.J., Shanklin, C.W. & Brannon, L.A. (2013). Written messages improve edible food waste behaviors in a university dining facility. *Journal of the Academy of Nutrition and Dietetics*, 113 (1), 63–69. https://doi.org/10.1016/j.jand.2012.09.015
WWF-UK (2021). *Driven to Waste Global Food Loss on Farms*. https://wwf.panda.org/discover/our_focus/food_practice/food_loss_and_waste/driven_to_waste_global_food_loss_on_farms [2023-09-22]

Popular science summary

Food waste causes harm to people and the environment. Production of food is one of the leading causes of biodiversity loss, and food waste alone generates almost 10% of global greenhouse gases, contributing to climate change. In Sweden, all schools offer tax-funded free lunches for students, which are supposed to cover 30% of children's daily energy intake. In schools, food left on plates, called plate waste, therefore has an impact on nutrition as well as the environment. Because of this, decreasing production of food in schools is not the way forward to reducing plate waste.

Previous research shows that a small group of students is responsible for a large share of plate waste, and that waste tends to increase with age in schools. Based on this, the present study investigated plate waste in two upper secondary schools in Uppsala, Sweden. The goal was to understand the current situation, why plate waste happens, how it might be reduced, and whether students who waste a lot of food can be identified. Uppsala municipality was chosen because of its ongoing work to promote sustainability in public catering, including efforts to reduce food waste.

Two upper secondary schools participated in the study which used three different methods. First, interviews were conducted with personnel working in the schools kitchens, with teachers, and with principals. Results found the schools have worked hard to reduce food waste, running several information campaigns throughout the years and always maintaining a discussion with the students. Several challenges and opportunities the schools face for reducing plate waste were identified, such as students not caring but also routines for targeting high-wasting students, and so were hot spots which lead to food waste. Emotions related to food waste such as frustration or shame could be seen in the interviews, and so could social influences on food waste levels such as peer pressure. A survey was conducted to gather student opinions and indicated that their reason for wasting food is most often due to disliking the menu. Observations of school lunches then showed that there are no differences between the amount of plate waste that male and female students generate, which was previously thought. However, observations also showed that more male students waste a high amount of plate waste compared to female students, and that bigger group sizes at dining hall tables lead to more students wasting large amounts.

One of the main challenges the schools face is that their efforts often have a short-term effect on food waste. Therefore, this study recommends that future research focus more on investigating long-term effects. Another recommendation is that students who waste high amounts of food should be studied further, since targeting them could lead to meaningful reductions in plate waste.

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Appendix 1 – Sample of interview questions

Interview questions have been translated from Swedish to English for this report.

- Which position do you hold in the kitchen / at the school? How long have you worked at this school?
- Could you tell me about your work towards reducing food waste?
- Have you seen any development in the work towards food waste since you started working here? How?
- Do you have any example of when you have seen a decrease in food waste, where you have reflected over why? Could you tell me about it?
- Are there any measures that are unique to your kitchen? If yes, which?
- What do you believe causes the most plate waste?
- What would you say that the plate waste consists of?
- Do you believe that all students waste an equal amount of food? If no, could you say which students waste the most?
- What do you believe could reduce the food waste further?
- In your opinion, is it possible to implement more measures to decrease food waste than what is done today?
- Would it, in your opinion, be possible to perform targeted interventions (interventions that are designed to target students that waste high amounts)? How would that work?
- Do you have anything else to ad or would you like to elaborate on something we have discussed?

Appendix 2 – Survey questions

Survey questions have been translated from Swedish to English for this report.

Gender

- ☐ Woman
- ☐ Man
- ☐ Non-binary
- ☐ Other
- ☐ Do not wish to specify

How often do you throw away food at school?

- ☐ Rarely
- ☐ Someday every week
- ☐ A few times per week
- ☐ Every day

How much do you usually throw away if you throw away food?

- ☐ A little (for example scraping sauce of the plate)
- ☐ It can be whole ingredients (such a potato or a meatball)
- ☐ It can be half a portion or more

What is the most common reason for you to throw away food?

- ☐ There was not enough time to finish eating
- ☐ The food was not to my taste
- ☐ I took too much on my plate
- ☐ My appetite was poor that day
- ☐ Other (please leave an example) _____

What do you think the school could do differently for you to waste less food?

_____
_____
_____
_____
_____

If you had the chance, would you make any changes to the school lunch?

- ☐ No
- ☐ Yes (please leave an example) _____

Is there anything that you could do differently to waste less food?

_____
_____
_____
_____
_____

Appendix 3 – Menus & tables from lunchroom observations

Table 6. Dates and the menus served during lunchroom observations at school A and B. Both schools also has a salad bar which varies from day to day with a wide assortment of vegetables. The schools usually serve at least two dishes.

School A	
2025-04-10	Several types of pasta gratin: one with chicken, one with turkey, one with minced beef, one with Quorn, and one with pea-mince. There were also some fish sticks with boiled potatoes at the start of the lunch service (leftovers from the day before)
2025-04-11	Chicken meatballs with boiled potatoes, gravy, and lingonberry jam
2025-04-22	Cauliflower soup with curry, and potato pancakes with lingonberry jam
School B	
2025-04-23	Chicken stew with rice
2025-04-24	Cauliflower soup with curry, and potato pancakes with lingonberry jam
2025-05-07	Fish gratin with boiled potatoes

Table 7. Observational data from School A, showing the number of students per table and how many tables with that number of students that was observed.

Number of students per table	Number of observed tables
1	3
2	9
3	16
4	18
5	10
6	7
7	8
8	11
9	2
10	7
11	2
Total	93

Appendix 4 – Excerpts from the portion guide by the Swedish Food Agency

Visual estimations of plate waste were based on a portion guide by the Swedish Food Agency (2010). Below are two examples from the guide which were used when estimating plate waste during the lunchroom observations in this study:

Figure 9. Screenshot showing portion sizes of salad with a Swedish description of when the guide should be used (Swedish Food Agency 2010:12).

Figure 10. Screenshot showing portion sizes of stew/casserole with a Swedish description of when the guide should be used (Swedish Food Agency 2010:19).

Appendix 5 – Original Swedish quotes from the interview transcripts

”Men, dem [eleverna] har ju sina skygglappar på, så dem går och tar ris, dem älskar ris, fyller tallriken med ris, och sen ser dem ’åh det är nuggets, najs’, använder all yta dem kan för att bygga upp det på tallriken med nuggets, äter ju nuggets först som ligger där överst, sen är allt ris kvar så ska dem kasta riset. När det är populär kolhydrat med ett populärt tillbehör då går det mycket matsvinn, eller då hamnar mycket i matsvinnet.” A, R3

”Ja... Det vi kan se är ju att en hel del av våran basmat genererar väldigt mycket svinn, och det är ju att man till exempel tar väldigt mycket potatis, man tar väldigt mycket ris och pasta. För då tänker man kanske också att det är det jag vill ha, för att bli mätt, eller för att det är ganska billigt, men man lägger på väldigt mycket på tallriken då.” B, R13

”Jag skulle väl säga att män slänger mest, men det är, asså såhär, generella bilden av dem som slänger mycket, det är en kille, över 180, att han gärna kommer med ytterjackan på sig. Kommer en kille med ytterjacka på sig in i matsalen kan du garantera att han fyller tallriken så bra han kan, och han, på vägen ut trillar det alltid ned något på golvet som vi får gå och plocka upp.” C, R3

”Alltså lär er känna er själva, lär er känna er kropp, ni är medvetna, ni är i en ålder där ni borde känna er själva.” D, R3

”Ja, exakt. De kommer inte att säga ’A nej jag har tagit för mycket’. De kommer aldrig att säga så här ’Jag har tagit för mycket’. Ja, de skapar någonting. ’Jag har ont’, ’Jag har huvudvärk’, ’Jag har inte haft en bra helg’. Jag vet inte.” E, R8

”Därför att, idag har vi till exempel så här att vi öppnar ungefär, 10 i 11 öppnar vi, och kanske från halv tolv till kvart i tolv, de vanliga dagarna, så utav de här 800 ätande som vi har i snitt så kommer det kanske 300, 350, kanske 400 på trekvart.” F, R13

”Ja, men det här är en jätteviktig fråga och jättesvår fråga, för jag tycker att jag har jobbat med det på olika sätt på olika skolor och det finns mycket man kan göra, men vad är det som ger effekt? Det är det som är den här 1000-kronors frågan, vad gör att matsvinnet de facto minskar? Och jag tror ju alltid att om det blir elevengagemang och där eleverna själva får en medvetenhet och reflektion och ser att de kan göra skillnad, då kommer det leda till beteendeförändring. Och jag tycker verkligen vi har jobbat att försöka jobba på det sättet, men ändå har inte matsvinnet gått ner. Och det har ändå gjort mig mycket förvånad.” G, R10

”Och jag tror man ska få med elevkåren, att det är typ det viktigaste, om de kan gå ut och promota saker, då blir det något annat än att det är vi som är personal som gör det.” H, R4

”Nej, jag kommer ihåg, jag har sett en kille, då kastade han mat varje dag [utdraget varje för att betona], då hade jag koll på honom. Tillslut jag gick och sa till dem, jag har koll på honom i flera dagar och han kastar samma. Då visar jag det till [kökschefens namn] och han går och pratar med dem. Vi får inte prata och säga vad vi vill med dem. Vi säger till [kökschefens namn] och han går. Du vet ibland, det är bättre att han tar den där stor rollen för oss och pratar med dem, det är bättre än att det blir konflikter mellan oss och dem [eleverna].” I, R1

”Det handlar ju om när man sitter tillsammans och äter lunch, så även i den här församlingen av elever så finns det mer och mer informella såhär informella ledare, inflytelserika elever, och när de är klara och reser sig och går, för att lämna sin mat, då känner sig de andra, för att liksom inte känna sig utanför i gruppen, då följer de med fast de har mat kvar på tallriken och går och kastar maten. Alltså de har inte det här, vad ska jag säga då? Självständigheten att stå upp och säga ’Hörni jag sitter och äter, jag har mat kvar’.” J, R11

”Och de har provat med tävlingar och massa olika utmaningar, så jag, jamen jag tror det är en fostransgrej egentligen.” K, R6

”Ja, men jag tycker alltid att det är lätt att få dem med på tåget om man förklarar de stora sammanhangen och inte gör det på ett sätt så att de känner att de måste in i ett visst åsiktshörn. Och det kan, det får man vara lite försiktig med även när det gäller klimatfrågan tycker jag, för att det är bättre att det landar hos dem som en övertygelse som är förankrad, än att det blir något de känner att skolan vill ha in dem i, för då slår det helt tvärtom. Då kan de bli lite anti istället.” L, R6

”Och dem vet att dem inte ska kasta, dem är så medvetna om det, jag tror ingen får kasta så mycket mat där hemma.” M, R3

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