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COVID-19 Driven Adaptations in the Provision of School Meals in the Baltic Sea Region

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The instability, rapid changes, and restrictions generated by the COVID-19 pandemic tested the provision of school meals in the Baltic Sea Region (BSR). School meal services were affected by factors such as full or partial lockdowns, strict hygiene regimes, lay-offs or staff shortages, stressful working environments, supply shortages, and changes to storing, cooking, and serving models. However, the responses to the COVID-19 crisis were highlighted by innovation, new opportunities, and cooperation. This paper reviews several examples of COVID-19 crisis management at school canteens in five BSR countries [Estonia, Finland, Poland, Russia (Saint Petersburg), and Sweden] between March 2020 and March 2021. The paper reveals the significant operational, logistical, and systemic problems that appeared because of the pandemic; the solutions and adaptations that were developed are also identified. The preparatory processes, logistics, and services that were adapted during the COVID-19 pandemic resulted in a new school meal provision model—a takeaway model; that includes similar features and unique characteristics across the different countries. Overall, the provision of school meals was carried out successfully in the BSR during the pandemic. Responsible, competent, and innovative professionals used their organizational skills, flexibility, and responsiveness to feed school pupils in a highly restricted and rapidly changing environment. It is expected that several of the COVID-19-driven innovations will remain in use following the pandemic.

Keywords: school meal, COVID-19 pandemic, Baltic Sea Region, takeaway meal, social innovation, crisis management, school closure, distance learning

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INTRODUCTION

School meals play an essential role in society by providing food and shaping healthy lifestyles and eating habits. The content and design of school meals have an impact on children's health and well-being, and they can support better learning (Anderson et al., 2017; Schwartz and Rothbart, 2019). For children from deprived families, a school lunch may be their only proper meal during the day; thus, school meals can contribute to achieving food security in society (Van Lancker and Parolin, 2020).

The provision of school meals requires numerous preparatory as well as logistical processes. In selected Baltic Sea Region (BSR) countries, namely Estonia, Finland, Sweden, Poland, and Russia

(Saint-Petersburg) (**Figure 1**), an ordinary school lunch is a hot meal with regulated nutritional values. School meal frameworks depend on national and local government regulations that control factors such as full or partial meal subsidies, in-house food preparation vs. procurement from external catering companies, and on-site kitchens vs. centralized facilities with delivery services.

The recent Coronavirus (COVID-19) pandemic has put school food provision under severe pressure worldwide. While there have been fewer cases of COVID-19 among children, national responses to the pandemic have had significant effects on child nutrition and educational outcomes (WFP et al., 2020). A US study covering all US jurisdictions analyzed the child nutrition administrative agencies' responses to meal service provision during COVID-19–related school closures; the study concluded that understanding the initial approaches of the jurisdictions are critical to emergency planning in order to better address food insecurity (McLoughlin et al., 2020a). Research by Parnham et al. (2020) revealed that up to half of the children entitled to free school meals in the UK did not have access to the scheme during the COVID-19 lockdown, and this has increased the discussion of food insecurity. Kinsey et al. (2020) reached similar conclusions in a study of free-of-charge or subsidized meals that were disrupted because of long-term COVID-19-related school closures in the US: both the nutrient intake of students and household food security were potentially decreased during the pandemic period. However, the majority of scholars have taken a different approach to researching food provision and well-being during the pandemic; instead, they have addressed the impact of COVID-19 on general eating behavior (Janssen et al., 2021; Jia et al., 2021; Philippe et al., 2021) or stress-related, emotional eating (Cecchetto et al., 2021; Jansen et al., 2021; McAtamney et al., 2021). Therefore, the exact adaptations of school meals during the crisis, particularly in transnational studies, are yet to be analyzed.

School closures and the introduction of distance learning were widely implemented as pandemic-related restrictions between spring 2020 and spring 2021. The aim of this article is to discuss how schools adapted their school meal provision during the changing phases of the COVID-19 pandemic and address how this has affected the primary stakeholders. This article reviews regional approaches to providing school meals during the COVID-19 pandemic in selected BSR countries. This paper focused primarily on the service providers' point of view, as this presented a unique opportunity to evaluate the front-line of school meal provision during the crisis. How did the COVID-19 pandemic influence the provision of school meals in practice? What were the most significant challenges, and what solutions were implemented while providing school meals during the COVID-19 pandemic? In line with the results reported by Kinsey et al. (2020), this study identified a set of COVID-19-related innovations in school catering services and public authorities.

The paper first provides the theoretical background regarding the regulatory frameworks and organizational models of school meal provision in the studied countries. This is followed by a description of how the COVID-19 pandemic affected schools between spring 2020 and spring 2021. Finally, the paper analyzes how the provision of school meals was adapted and the responses to the rapidly changing situations are identified. This research has established how the theoretical operational models were altered during the pandemic, resulting in the emergence of a new take-away school meal model that was adapted to the specific conditions of the pandemic in each country.

Regulatory and Organizational Models of School Meal Provision

The overview of the regulatory frameworks and theoretical models of school meal provision are based on the analysis of public meals in the Baltic Sea Region completed in the StratKIT project (StratKIT, 2019). School meals are served under several different cost-sharing, organizational, and manufacturing models (**Table 1**). Some of the models are strictly regulated by national or local laws; other models involve freedom of choice, including at an individual school level.

Cost-Sharing Models of Catering Services

From the perspective of the consumer, there are different cost-sharing models of school meals (StratKIT, 2019). School meals can be (1) fully subsidized by public institutions, (2) partially subsidized (a share of the cost is covered by the consumer), or (3) not subsidized (the consumer must pay the total cost of the meal). There is also the option of a (4) mixed model that applies all of the previous models. All of the studied countries offer partially subsidized school meals, at least to selected groups. For example, all school levels in Finland and Sweden provide a fully subsidized (free-of-charge) daily meal. In Estonia, the state provides a subsidy of 1 euro per meal. The remaining cost is covered by the municipality (fully subsidizing the meal) or the child's guardians, or both. Similarly in Poland, primary schools are partially subsidized—parents pay for the food and, in most cases, the local governments cover all other costs (e.g., labor and facilities). In Saint-Petersburg, Russia, school meals are either fully subsidized (for children from specific social categories that are determined by the Social Code of Saint-Petersburg) or partly subsidized; however, the free-choice menu that is regulated by Rospotrebnadzor and the Department of Social Nutrition (DSN) is not subsidized.

Organizational Models of Catering Services

The preparation of school meals can be divided into two main organizational categories: (1) in-house—meals are prepared and catered by the schools themselves, and (2) contract catering—meals are procured from private companies that organize the catering. The school (or municipality) is responsible for procuring the food in the in-house operational model and the service is also provided by the schools. In contract catering, the service is tendered by public procurement and provided by a selected commercial enterprise according to the procurement criteria.

The studied countries tend to use a contract catering model that generally employs a private catering company to provide the catering services. In Estonia, this service covers the supply of goods and food products, cooking, recruitment, and quality control. In Saint-Petersburg, Russia, the catering model is the

FIGURE 1 | Map of the study area.

TABLE 1 | The school meal framework in selected BSR countries.

Framework model	Estonia	Finland	Poland	Russia, Saint-Petersburg	Sweden
Cost-sharing models of catering services	Subsidized by the state up to 1 euro per meal, the rest fully or partially subsidized	Fully subsidized	Partially subsidized	Mixed model (from full to no subsidies)	Fully subsidized until 9th grade.
Main organizational models of catering services	Mainly contract catering	In-house by schools Contract catering	In-house by schools	Contract catering	In-house by schools Contract catering
Main manufacturing and delivery models	On-site kitchen, *Cook and serve*	Central kitchen, *Cook and serve, Cook and chill, Cook cold*	On-site kitchen, *Cook and serve*	On-site kitchen, *Cook and serve, Cook and chill*	On-site kitchen, *Cook and serve*

Source: StratKIT (2019) and own research.

only organizational model that is available for educational institutions. In Finland, catering services can either be managed by the education provider, such as the municipality or the school, or procured from a company that is owned by the municipality or a private business. Primary schools in Poland traditionally use the in-house model for providing meals—schools are equipped with kitchens and employ cooking staff (usually municipal workers) to procure and process food at an individual unit level; this system is most popular in the bigger cities. In Sweden, most primary schools operate their own food service; in-house catering by public bodies accounts for 87% of public catering and contract catering accounts for 13%. Almost three-quarters of the Swedish municipalities have a single organization that manages all public meal activities (school, pre-school, elderly care, etc.). In contrast, 20% of the meal provision is divided over several administrative bodies.

Manufacturing Models for Preparing and Distributing Public Meals

Traditionally, educational institutions have had kitchens on their premises. Therefore, food is prepared *in situ* ["On-site" model (1)] and provided as ready-to-eat, hot meals (*cook and serve*). This model is common in Estonia, Poland, and Russia. In Sweden, almost 60% of public primary schools have an on-site kitchen that is connected to their school restaurant. The central kitchen model (2) is an emerging trend, particularly in Finland; central kitchens follow sanitary rules and prepare meals, either partially or entirely, that are then transported to schools. In Finland, there has been a continuous increase in the number of modernized central manufacturing kitchens. On-site kitchens that were previously used for food manufacturing now often operate as satellite or service kitchens that have food delivered to them from a central kitchen. The decision for a central manufacturing kitchen is often made when old premises require refurbishment; Finnish municipalities make significant long-term investments to establish new premises, equipment, and even cooking methods. Central kitchens in Finland operate mainly by cook and serve and cook and chill manufacturing methods. The less frequent method of cooking cold is also being used more often. In Poland, Estonia, and Russia, the meals are rarely cooked in central kitchens.

The COVID-19 Pandemic in BSR Countries

The outbreak of COVID-19 was caused by the spread of the SARS-COV-2 virus, and was first discovered on December 31, 2019 in Wuhan, China. COVID-19 was detected in Europe on January 24, 2020 in France[1], and a global pandemic was declared on March 11, 2020. In all the studied BSR countries, the first COVID-19 cases were confirmed within a five-week period, starting in Finland on January 30, 2020 and ending on March 4 in Poland[2]. A state of emergency was declared in Estonia, Poland, and Finland. The BSR countries often followed a similar pattern during the period under review (March 2020 to March 2021), with a first wave of COVID-19 during spring 2020, a rapid increase in the number of cases through March and April, and then a second wave in autumn 2021 or March 2021 (see **Figure 2**). The lengths and severity of these waves and the measures undertaken to control the spread of the virus varied in each country. Full or partial national lockdowns were imposed during the first months of the pandemic in Estonia, Finland, Poland, and Russia; schools and school canteens were closed as part of the restrictions. Sweden was a worldwide exception in terms of its response to the COVID-19 pandemic, as schools were kept operating, with several modifications, throughout the whole period.

Figure 2 shows the monthly averages of the reported COVID-19 cases per 100,000 population for a 14-day period between March 2020 and March 2021 in five BSR countries: Estonia, Finland, Poland, Russia, and Sweden. **Figure 2** clearly shows the timeline of the two or, in some cases, three surges in COVID-19 cases, often referred to as COVID-19 waves; the first waves started in March 2020 in all of the studied countries. The second waves began in autumn and winter 2020; cases increased sharply in October and November in Poland and in November and December in Sweden. Estonia had the longest and strongest increase in COVID-19 cases and had the maximum average of new reported cases in March 2021—over 1,400 cases per

[1]https://www.who.int/director-general/speeches/detail/who-director-general-s-opening-remarks-at-the-media-briefing-on-covid-19---11-march-2020 (accessed June 15, 2021).

[2]https://www.ecdc.europa.eu/en/publications-data/download-todays-data-geographic-distribution-covid-19-cases-worldwide (accessed July 26, 2021).

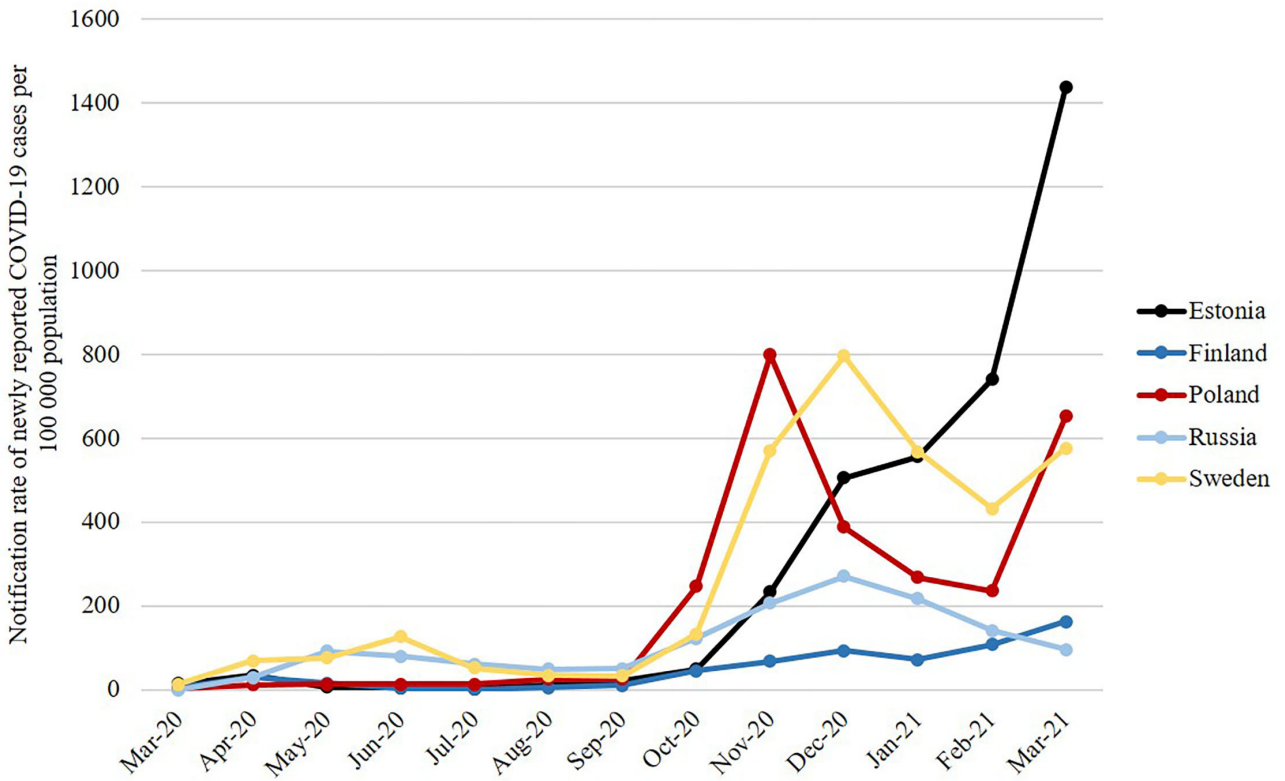

FIGURE 2 | Monthly averages of the 14-day notification rate of newly reported COVID-19 cases per 100 000 population between March 2020 and March 2021. Source: own calculation based on ECDC.

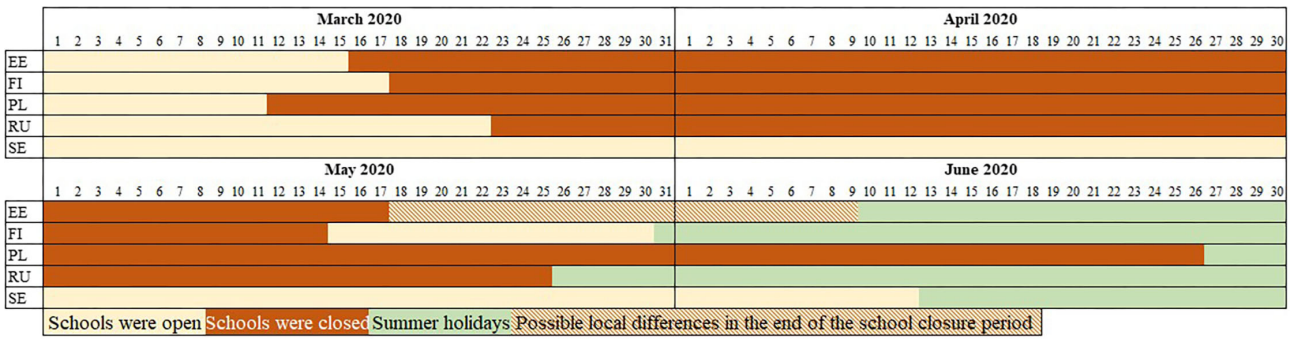

FIGURE 3 | School lockdowns in studied BSR countries in spring 2020. Source: based on ECDC data.

100,000 population in a 14-day notification rate. Russia was the only country among the five to show a decrease in rates after December 2020. In comparison to the other BSR countries, Finland had a very mild second wave that started in 2021.

In response to the first wave of the pandemic in March 2020, the studied BSR countries either closed schools or kept schools open (shown in **Figure 3**). Furthermore, the gap between the first confirmed COVID-19 case per country (data published by the European Center for Disease Prevention and Control) and the closure of schools and the introduction of distance learning can be counted in days: the number varied from 9 days in Poland to 52 days in Russia. Sweden was an exception, as schools were not closed at any point following their first COVID-19 case on February 5, 2020. In contrast, Poland maintained the longest lockdown for schools, which ceased at the end of the school semester after 106 days. Schools in Saint-Petersburg, Russia, also ended a 63-day lockdown at the start of the summer holidays. In spring 2020, Finland kept its school closed for 58 days and Estonia for 62 days; both countries then resumed contact learning for at least 2 weeks before the summer break.

TABLE 2 | Data collection method summary.

Country	Study case(s)	Selected methods and additional information
Estonia	City of Tallinn, City of Tartu, Baltic Restaurants Estonia	Telephone interviews with stakeholders followed a general list of nine questions (**Annex 1**) and included an open discussion.
Finland	Municipality of Seinäjoki, Municipality of Tuusula, Saimaa Support Services	Online interviews with stakeholders following a **Annex 1** questions as well as an open discussion. The conclusions drawn from the discussions were sent to the stakeholders for verification.
Poland	Municipality of Rybnik, Municipality of Izabelin	A questionnaire consisting of eight questions (**Annex 2**) was sent *via* email to the headmasters of all the primary schools in Rybnik and several schools in Izabelin. Twenty-four responses came from Rybnik and four from Rybnik. Additional telephone interviews were conducted with six schools and covered information on opportunities and positive developments.
Russia (Saint-Petersburg)	School No. 126, School No. 249, Private school "Shamir"	Three stakeholder interviews were conducted: one on-site and two telephone interviews. The on-site visit allowed a participatory and observatory research experience. All three interviewees were initially asked the same questions: 1) How was the school meal provision organized in each school, and how did it change in response to COVID-19-related restrictions and new regulations? 2) Were there any additional challenges? If yes, how were they solved? 3) Will any positive developments be retained in the future?
Sweden	City of Gothenburg	In order to gain an overall picture of the national situation, the Swedish input was primarily based on the National Food Agency's country-wide report (Livsmedelsverket, 2021). The city of Gothenburg was used as a case study, and an interview with Gothenburg's municipal food services was conducted. The interview lasted 45 min and addressed the questions in **Annex 1**. In addition, e-mail correspondence with five food service managers was used to gain a more detailed picture. The interviews and e-mail responses were compiled, and categories were created based on the relevant data. The report from the National Food Agency was used as a supplement.

Source: own research.

However, some municipalities in Estonia, including Tallinn, kept schools closed until the end of the school year in 2020. The regional examples described in section Results also show that in autumn 2021 additional preventive measures were introduced, as a second wave was expected (e.g., obligatory face masks, restocking of cleaning equipment, changes to dining order, and physical distancing).

The school year of 2020/2021 started with contact learning in all of the studied countries. The school lockdowns that followed differed nationally and regionally because of the regional COVID-19 case ratios and the speed of local transmission.

MATERIALS AND METHODS

The paper is based on a mixed-method approach, combining a literature review and case studies to review the unfolding COVID-19 situation and examine how the five selected countries adapted to the crisis; a total of 12 regional examples are provided.

Representatives from each country selected a suitable method for their regional data collection; however, baseline questions were constructed for comparative purposes (see **Annex 1**). Each country contributed between one and three different cases. The selection was based on availability and convenience, as well as national organizational schemes when the data concerned a municipality as a whole or a particular school. The study identified other national variations in the management of school meals during the pandemic; therefore, the collected data does not provide a complete representation of the studied BSR countries. In order to provide a full description of the different cases, the data were collected in three different ways: (i) stakeholder interviews, (ii) stakeholder questionnaires, and (iii) a literature review and web-based searches to identify the national and local emergency regulations that were implemented during the COVID-19-related school closures between March 2020 and March 202. **Table 2** summarizes the data collection and selected methodology per country.

Based on the results, a comparative textual analysis summarized the joint findings. Additionally, a word cloud algorithm was generated to identify the challenges and opportunities that were reported most frequently.

RESULTS

School Meal Provision During the COVID-19 Pandemic in Reported Case Studies

Estonia

Schools in Estonia were affected by two official COVID-19 waves, the first in spring 2020 and the second in spring 2021. Schools were fully closed throughout Estonia from mid-March until mid-May 2020 and from early March until May 2021. Most of the municipalities, including Tallinn, kept schools closed until the end of the 2020 school year. From autumn 2020 until March 2021, schools tried to minimize the contact between pupils. Thus, many schools combined contact learning with distance learning. For example, classes could attend school on different weekdays or on alternate weeks. These timetable shifts were not usually applied to the younger pupils in grades 1–4. Between March 2020

and June 2021, whole classes were frequently instructed to stay in quarantine because of a close contact with a classmate or teacher who had tested positive for COVID-19. Distance learning was practiced during the quarantine period. If a pupil had individual contact with a COVID-19 infected person, the pupil remained in mandatory individual quarantine for 10–14 days.

During the COVID-19 pandemic, hot school meals were provided throughout the periods of in-school teaching. Measures were taken to minimize the contact between children in the canteens. For example, pupils could eat in their classrooms or meal breaks were extended (while shortening the lessons) to allow only one class at a time in the canteen. Extra attention was also given to hygiene and sanitary requirements (e.g., cleaning tables and common surfaces thoroughly and more often, frequent handwashing).

Hot school meals were not provided during the periods of distance learning. Instead, children were generally supplied with food packages. The contents of the food packages adhered to the requirements of the sub-regulation of the Public Health Act: Health protection requirements applicable to catering in pre-school childcare institutions and schools. The food package usually included ingredients for making meals at home, such as pasta, rice, or buckwheat, a can of soup, cereals, fresh fruit and vegetables, milk, yogurt or other dairy products, bread, and meat products (e.g., sausages and meatballs). The kitchens distributed the packages once a week, and the contents of the package varied from week to week.

In spring 2020, some municipalities only provided the food packages to pupils from deprived families (e.g., Tartu); other municipalities supplied food to any pupil who signed up to the meal program. However, in spring 2020, the number of pupils receiving the food packages was relatively small. From autumn 2020 onwards, all distance learning pupils who signed up for the food packages could pick them up once a week; the packages could also be collected by the parents. Children in individual quarantine could only receive food packages following a special request.

The municipalities managed the contents of the food packages differently. The system was similar in spring 2020 and spring 2021, although the details and organization were refined in spring 2021. Initially, there was significant confusion; therefore, the city of Tartu developed a guide for caterers that outlined the type and quantity of food each package should contain. The guide followed the Ministry of Education and Science regulation that sets the requirements for school catering.

The food package content in Tallinn differed during the full and partial distance learning. When individual classes were distance learning, the school caterer assembled the food package in cooperation with the school. During the nation-wide period of distance learning, the content of food packages was managed centrally by the Tallinn Education Department. The aim was to include a wide variety of products (cereals, fruit and vegetables, milk and dairy products, meat or eggs, etc.) while also considering the limiting factors of shelf-life, storage conditions, and price. The Education Department provided school caterers with a list of product groups; however, they did not specifically define the products, as it was thought that this could create problems with supply. To maintain a diverse selection, the content of the food packages varied from week to week. During the complete lockdown, the budget for a food package was increased to allow for more fruit and vegetables. Allergies and special diet requirements were considered at the school level.

A significant number of takeaway packages were not picked up, and this put pressure on the management of food waste. Therefore, caterers tried to find solutions to avoid food waste. For example, the perishable food products were distributed among kitchen staff and teachers, and products with a longer shelf-life were reused in packages in the following weeks. **Table 3** lists the key COVID-19 related problems in Estonia and the reported solutions.

TABLE 3 | Challenges and positive developments during COVID-19 in Estonia.

COVID-19 driven reported main challenges and problems
Communication between schools and parents or schools and caterers was not well-organized even though it depended greatly on school.
The generation of food waste increased due to takeaway packages not being picked up.
Organizing social distancing when eating at school (separating classes, eating in classes, etc.)
Communication between municipalities and parents increased tremendously and consumed a lot of time for municipality officers.
Parents' views of the food package content varied considerably. Therefore, getting consent on the issue among the parents, municipalities and/or caterers was difficult.
It was challenging to manage kitchen/canteen staff, who did not have full-time work anymore but at the same time might unexpectedly stay in quarantine due to COVID-19 close contacts, and the replacement was needed.
Agreeing on the cost of food packages between municipalities and caterers was problematic at times or in some municipalities.
Introduced solutions and other positive developments
The food ordering system became particularly useful in pandemic times (Tartu).
Parents donated the unneeded food from the package to the Foodbank on their initiation or the school (or municipality) organized it.
Hygiene standards and behavior improved considerably.

Source: conducted interviews.

Finland

In Finland, schools continued to operate, at least at a minimal level, throughout the COVID-19 pandemic. From late March 2020 to mid-May 2020, most pupils in Finland were moved to distance learning. Children requiring special assistance continued to attend classes with contact learning. At the beginning of the pandemic outbreak, the obligation to provide school meals did not extend to pupils involved in distance learning. As a result, municipalities could decide whether, when, and how they offered school meals to children studying at home. The various initial approaches included not supplying a meal, distributing food vouchers, or providing industrial food packages; however, the most common option was the supply of prepared takeaway meals. In summer 2020, the Ministry

of Education made school meals for distance learning pupils obligatory and unified the rules for the main dish, stating that the school meal must include good quality ingredients and have a high nutrition value. In addition, special diets had to be considered when distributing meals. During autumn 2020, Finland removed the requirement for distance learning (except when pupils were in quarantine). For 3 weeks in March 2021, schools were asked to organize distance learning; however, the need to implement distance learning was based on the infection rate in each region. The Municipality of Seinäjoki in South Ostrobothnia is an example of a region that was not required to lockdown in March 2021.

When the first COVID-19 restrictions, including school lockdown, were implemented in March 2020, Seinäjoki municipality only provided meals for children in contact learning. A month later in mid-April and prior to the national regulations, the school meal provision was extended to include a hot takeaway meal for pupils in distance learning. During March 2020, ready-made industrial meals were not used. However, an updated crisis management plan accepted the introduction of industrial foods if future lockdowns were required. The cost of a school meal during the lockdown, despite its bigger size, was estimated to be the same as a standard in-school meal. Several reasons for this consistency were that side products, such as salads and milk, were not included, and staff costs did not change.

During the first COVID-19 wave, schools in Tuusula (a Helsinki sub-region) were operating with only ∼20 pupils per school requiring special assistance. Following the introduction of distance learning, within 1 week the municipality had introduced a drive-through that provided a once-a-week pick-up point for meals for the whole week. The cooked cold meals were usually prepared in the central kitchen, where they were cooked, chilled, and then distributed frozen. Acquiring adequate space for the chilling phase was a technical issue; however, no infrastructure investments had to be made. At the pick-up point (first from the central kitchen and then also from schools), pupils were served without the need to sign up or apply in advance. Approximately 60% of meals were picked up, and the remaining frozen meals were distributed during the next round. The menu list was modified to support the changes to the preparation processes. During the COVID-19 pandemic, the cost of the school meals in Tuusula doubled because of higher staff costs, packaging, and the large, unified portion sizes. In spring 2020, the municipality of Tuusula introduced an additional set of modified practices. To avoid lay-offs, municipal workers were reallocated to different units and tasks, such as cleaning. Unpaid holiday leave was also granted at the employee's request. A new practice, which is likely to remain permanent, was the introduction of an extra summer meal served to pupils at a park. The outdoor dining in 2020 was very popular and greatly appreciated. Each working day in summer, pupils with their own food containers and cutlery were given a hot meal (soup and pasta from the school menu list).

At the Eastern borders in Lappeenranta and Imatra (operated by Saimaa's Support Services), a takeaway school meal was introduced in late April 2020. The takeaway system was first based on an application list; however, pupils were removed from the list if they failed to pick up the food twice in a row. This requirement was no longer in practice in spring 2021. The takeaway food was delivered to schools twice a week, although pupils with a right to communication support (e.g., living in remote areas) had the food delivered to their homes. This hybrid arrangement (in-school meals for pupils requiring special assistance, takeaway meals, home delivery) in spring 2020 and spring 2021 required significant changes to the food manufacturing processes. Initially, when the meals were only required for about 10% of pupils, 350 employees were temporarily laid off. On the other hand, the preparation and delivery of meals for pupils in distance learning required an extra labor force because of weekend and evening shifts. Another major change was the significant need for packaging materials and equipment. As a result, the cost of these modified school meals was calculated as 1.5 times the original price.

Throughout the COVID-19 pandemic, pupils in contact learning were served food under very strict hygiene rules. For example, schools in Lappeenranta, Imatra (Lpr), and Seinäjoki (Sjk) extended the duration of the lunch period (from 10 a.m. to 1 p.m.). Pupils were instructed to dine in class groups and eating in classrooms was also recommended. In addition, the serving cutlery was replaced, and the tables were wiped clean after each group. From autumn 2020, visitors to the canteens were asked to wear face masks. The Tuusula (Tuu) municipality held a series of planning meetings with school principals to organize school dining once the schools reopened. The general rule was to not allow the classes to mix. However, each school could decide if pupils ate in their classrooms or at different times in the school canteen.

Table 4 lists the main reported challenges in the Finnish municipalities from March 2020 to March 2021; the positive developments are also listed.

Poland

In Poland, the implementation of the required tasks for each school was determined by the degree of risk related to the COVID-19 pandemic. Therefore, schools followed the recommendations of the Ministry of Education and the Ministry of Health and only conducted distance or hybrid learning in the more severe periods of the pandemic. All schools were closed from mid-March 2020 to the end of the school year (end of June 2020), and pupils were taught by distance learning. The following school year began with contact learning, but most schools reintroduced distance learning from November 2020 to the end of the first semester (January 31, 2021). In the second semester (February 1, 2021–June 25, 2021), lessons were again being carried out in schools; however, between March and April 2021, schools were required to teach remotely or use hybrid methods. Contact learning resumed at the beginning of May.

During the pandemic, school canteens usually only served meals while schools were operating normally. However, some schools continued to serve meals to pupils who remained at school because they did not have the required conditions for distance learning at home. Some schools provided takeaway meals when they were closed. A number of canteens also prepared meals for specific groups, such as children requiring

TABLE 4 | Challenges and positive developments during COVID-19 in Finnish municipalities.

COVID-19 driven reported main challenges and problems
The amount of communication between parents and the kitchen increased tremendously during the takeaway period (Sjk).
Receiving up-to-date and accurate information on pupils in distance learning and their special food requirements (Lpr).
Adjusting to modified cooking methods supporting takeaway meals (Lpr, Tuu).
Stressful and heavy time for the staff in general (Tuu).
Usually, the food that was to be wasted was collected by the local church food bank. However, during the COVID-19 lockdown period, their activities were also quite limited, and they could not successfully further use the meals. The unpicked meals were therefore regarded as biowaste (Sjk).
Higher packaging waste (Lpr, Tuu, Sjk).
Introduced solutions and other positive developments
Both the importance and the appreciation of school meals have increased during the COVID-19 pandemic (Sjk).
The staff has been healthier than normal because people have taken good care of distances, protection and hand hygiene (Sjk, Lpr).
The cooperation between the central kitchen and the schools has been strengthened (Sjk).
The staff has been very committed to their work, and there has been little reluctance to work (Lpr). The circulation of the staff raised up team spirits (Tuu).
In general, the amount of food waste generated in schools has decreased, strengthening collaboration with a third sector organization that would further distribute the un-picked takeaway meals for those in need. (Lpr), (Tuu).
Developed a new summer outdoor meal service for children (Tuu).

Source: conducted interviews.

TABLE 5 | Challenges and positive developments during COVID-19 in two Polish municipalities.

COVID-19 driven reported main challenges and problems
The problem with scheduling work for the canteen staff, limited by sickness and quarantines (Izabelin).
Uncertainty of the school opening times and work hours followed by an unpredictable number of pupils and lunches (Izabelin, Rybnik).
Strong fear of contamination and worries about keeping a hygienic regime in kitchens and work areas, additional stress for the staff (Izabelin, Rybnik).
Uncertainty of the number of pupils and lunches that have to be served led to organizational issues. It often was indicated as a reason for the higher food waste rate than usual (Rybnik).
The often changing numbers of pupils and times of lunch, as well as new regulations including special dining groups (children supported by social services, children of medical personnel), created logistic and operational complications (Rybnik).
Introduced solutions and other positive developments
Based on the high demand for a school meal that started to include adults, an online application for ordering takeaway lunches and serving food for the whole community—pupils and adults (in different price ranges) was created (Izabelin).
Strengthen communication between pupils' parents and the municipal staff (Izabelin).
Stronger sense of solidarity—during the lockdown the personnel started to make masks and aprons for the local community (Izabelin).
Serving food for smaller groups and diversifying the lunch breaks' hours led to a better atmosphere in the canteen, especially between the youngest pupils, as they more tranquility with less of the waste (Rybnik).
Higher hygienic education within all stakeholder groups, personnel, teachers, and pupils helped prevent disease spreading among many canteen staff members (Rybnik).

Source: conducted interviews.

special education, children and families of medical and social service employees, and law enforcement employees engaged in duties relating to the pandemic to ease the childcare burden on them. During the periods of school closures, the school canteens did not prepare meals. However, the school canteens that prepared meals also for kindergartens were constantly operating, as the daycare was operating normally.

School canteens applied different solutions to the numerous problems that arose during the pandemic (see **Table 5**). The serving times of meals were often changed, and pupils were frequently served in smaller groups to comply with the new sanitary regime and physical distancing requirements. In addition, pre-registration for meals was required to avoid waste. Additional lunch breaks were also organized, meals were served to the tables, and pupils were encouraged to always sit in the same place in the canteen.

Russia (Saint-Petersburg)

In Saint-Petersburg, Russia, schools were closed from mid-March 2020 until the end of the school year (end of May 2020). The spring holiday was then extended from 1 to 3 weeks (from the end of March until mid-April). This was followed by distance learning, which lasted until the end of the school year. Therefore, from March to May, school canteens were closed; however, food packages were supplied to all elementary school pupils (aged 7–10 years) and children from certain social categories (children from low-income families, families with three or more children, orphans, children with disabilities) who were entitled to fully subsidized school meals during the regular school year.

These packages were put together by catering companies and included foodstuffs such as oatmeal, buckwheat, rice, canned meat, chocolates, tea, and jam. School administrators and staff (School No. 126, School No. 249) worked with catering companies to hand out the packages twice a week to parents, who could collect them according to a schedule developed by school staff. If parents were unable to come to the school, the administrators delivered the packages to the pupils' homes (School No. 126). According to the schools' representatives, they received mostly positive feedback from parents; the packages were a significant help for parents who had lost jobs or were struggling financially during the 1st months of the pandemic.

Schools fully reopened in September 2020 and followed the very strict hygiene guidelines and regulations developed by the Federal Service for Surveillance on Consumer Rights Protection and Human Well-being (Rospotrebnadzor). The new regulations required a strict shift schedule, and pupils from each class had

TABLE 6 | Challenges and positive developments during COVID-19 in Saint-Petersburg schools.

COVID-19 driven reported main challenges and problems
Once reopened, schools had to add separate entrances and exits into the canteen, so more classes could get to the canteen during the breaks and not cross each other's paths (all schools).
Sometimes the food got cold while staff had to set a lot of tables during the break.
Menus of the free choice were canceled for the 2020/2021 school year. All elementary school students got the same meals according to 12-days menus developed by the Department of Social Nutrition. It was done in order to prevent long lines and mix-ups in the canteen during the breaks (No. 126).
Canteen staff was exhausted and had to overwork—earlier start, additional shifts, stricter rules, less time for breaks (No. 249, No. 126).
Introduced solutions and other positive developments
Increased hygiene. Pupils became more organized and responsible and washed their hands more carefully (all schools).
More automated process: teacher noted in computer system how many pupils were in class, and canteen staff set the tables based on this information. A No-cash system was further developed to pay for the meals.
The snack buffet was closed during the day and children got only hot and cooked meals, thus a healthier option. Before the COVID-19 times, the school also sold pastry and baked goods (prepared on-site) that children really liked, during the pandemic, the pastry was served only twice a week (No. 249).
Decreased food waste, resulting from fewer meal potions.

Source: conducted interviews.

to have meals at the same time and sit separately in the canteen. This led to extended lunch periods and strict monitoring of the new safety measures, such as sanitizers in the canteens, physical distancing, and a 30-min disinfecting process between the dining shifts. During the 2020/2021 school year, distance learning was only implemented when a whole class went into quarantine. Private schools also had to comply with the general Rospotrebnadzor rules and follow the same safety guidelines.

Canteen staff in elementary schools set the tables for pupils before the pandemic, and this process continued in the 2020/2021 school year. When pupils followed the school schedule and arrived in the canteens, the food was already on the tables, and they were not required to line up to get food or pay for meals. In School No. 126, only non-cash payments were allowed. Students used a special "student card" to enter the school at set times, and parents could load money onto these cards (or the government transferred the money if a student was provided with fully or partly subsidized meals). Teachers recorded how many students were in class and their lunch options; this information was then sent to the canteen staff so that they could accurately set the tables in advance.

Table 6 lists the main reported challenges in the Saint-Petersburg schools from March 2020 to March 2021; the positive developments are also listed.

Sweden

In Sweden, most primary schools were open throughout the pandemic. Some schools occasionally organized distant learning using several different systems: some pupils had 2–3 days of homeschooling per week (and the rest on campus), while others had homeschooling every other week. These measures were taken to reduce the number of pupils on school premises and minimize the risk of spreading COVID-19. By law, pupils have the right to school meals even when their learning is based at home (but not if the school is closed). However, regular homeschooling was primarily only used for pupils in upper secondary school (grades 10–12), although some lower secondary schools (grades 0–9) also implemented homeschooling during winter/spring 2021.

In spring 2020, the Swedish authorities announced that the measures developed to limit the spread of COVID-19 were affecting public meal services. This was primarily due to an increase in staff absenteeism and the rise in questions concerning the requirements for reduced congestion and infection control in public domains. The National Food Administration then mapped the pandemic's influence on the activities of meal services (Livsmedelsverket, 2021). Large scale organizations often need long lead times for meal preparation, and their processes were significantly affected by the expedited decisions from the authorities and management; for example, organizations had to adapt to the rapid changes in the number of people allowed in indoor spaces. Overall, catering services struggled to reorganize their systems at the management levels, and this contributed to a variety of problems, such as increased food waste.

In some Swedish schools, salad buffets were downsized, completely removed, or exchanged for ready-made salad plates; these changes reduced queuing, released time for kitchen staff, and limited the number of occasions when pupils shared serving utensils. To reduce workloads and manage staff absenteeism, menus were often modified to include fewer dishes or simplified recipes. In some schools, menus were made more flexible so that ingredients could be utilized in dishes that were not part of standard meal plans (Livsmedelsverket, 2021).

School canteens strengthened hygiene protocols to address infection control; the additional measures included increased use of disinfectants, control of handwashing, additional cleaning of surfaces, and frequent changes of the serving utensils. Textile cleaning cloths were replaced with spray bottles and paper towels. Schools also began to use additional spaces, such as classrooms, for dining. Moreover, the furniture in dining halls was reduced and markings on the floor were used to remind people to maintain physical distancing. The lunch periods were extended to ensure fewer pupils were in the canteen at the same time.

Food waste increased, especially at the beginning of the pandemic. The number of diners varied daily; therefore, it was difficult to predict the volume of food required. Several school canteens also noted that a large amount of food waste was connected to the introduction of lunch boxes for distance learning pupils, as many boxes were not picked up. During autumn 2020, pupils could collect a takeaway lunch box every day from the school canteen. The pick-up frequency was low; therefore, during spring 2021, kitchen staff reduced food waste by changing the meal program: once a week, pupils could collect a week's worth of chilled meals.

The pandemic response focused on issues related to crisis preparedness and provided an opportunity to review and test contingency plans in a real life situation (**Table 7**). Topics that

TABLE 7 | Challenges and positive developments during COVID-19 in Sweden.

COVID-19 driven reported main challenges and problems
Uncertainty about staffing and the number of meals.
Communication and decision-making were challenging in rapidly changing conditions.
At the beginning of the pandemic, there was a shortage of disinfectants, gloves, and disposable products.
Making pupils keep their distance from each other in food queues and at tables (and in the school as a whole) was an additional burden and challenge to the staff.
It was difficult to interpret the directives from the Swedish Public Health Agency guidelines for school canteens compared to regular restaurants.
Introduced solutions and other positive developments
If the shortage of staff occurred, either re-allocation of own staff or hiring professionals from the private restaurant industry, that suffered extensive lay-offs, took place.
Both sense of community in the kitchen (team-building), and cross-administrational cooperation increased.
Contingency plans were developed or improved if already existing.
Digital competence among the staff increased.
Increased hygiene and hygiene education.

Source: conducted interviews.

have been discussed include food storage, staffing during a crisis, non-delivery of supplies, and prioritization of tasks in the event of a staffing shortage.

The BSR Response to the Crisis

As presented in section School Meal Provision During the COVID-19 Pandemic in Reported Case Studies, all the studied countries, except Sweden, responded to two observable waves with complete or partial (hybrid systems) school closures. Regardless of their vastly different populations or COVID-19 occurrence rates, the studied BSR countries all faced a challenging period. The studied regions adopted similar methods when providing meals for contact learning pupils; the new systems were based around improved hygiene regimes and extended lunch periods. The primary differences were related to meal provisions during school closures, including when and how often a takeaway meal or its equivalent was offered. The studied BSR regions operate under a variety of regulatory and organizational models for food provision, and there were clear structural differences between the adaptations of their school meal programs in response to the COVID-19 crisis. However, this study recorded similar challenges and COVID-19 driven developments.

The key issues reported above were extracted using the word cloud algorithm that analyzes the frequency of words and word phrases. **Figures 4**, **5** visually present the joint findings from the BSR, the regional COVID-19 related problems and challenges, and the positive developments in the provision of school meals in the regions. The problems that were listed most often by the countries included unpredictable staff changes, uncertainty about potential school closures, and constant variation in the number of meals required. The working hours and stress levels of canteen staff were strongly interconnected and often increased. The communication between all of the actors involved in the school meal system—including canteen and kitchen staff and their managers, school officials, municipal authorities, food suppliers, parents, and pupils—were either problematic or caused distractions because challenging issues were amplified. Food waste, especially at the beginning of the lockdown, and packaging waste were common problems in the BSR countries. Furthermore, national regulations changed frequently, and the immediate actions that followed required extraordinary flexibility in terms of structures and processes. Physical distancing was also identified as difficult to organize and monitor.

The adaptations to the COVID-19 pandemic produced novel solutions to significant problems. The responses to the crisis led to a range of innovations and developments concerning people (canteen/kitchen staff, pupils, and community), places (canteens, schools, and kitchens), and products and processes (hygiene, meals, food waste, and food education). An important development was the increased awareness of hygiene, including pupils' hygiene education and behavior. Another key finding was the increased importance of the school meal during the crisis period. The health of canteen staff has generally improved because of the widespread use of hand sanitizers and the high standard of the new hygiene measures. Overall, the spread of many seasonal diseases has been minimized. Schools have reported that the highly organized lunch breaks have led to more pupils finishing their meals, especially younger children. The effort to reduce food waste during the COVID-19 pandemic also required significant attention. Steps were taken to minimize food waste following the unforeseen school closures in March 2020; these measures included redistributing unused meals/food products, collecting attendance data for accurate meal preparation, and establishing cooperative partnerships with third sector organizations. Following the COVID-19 pandemic, a number of innovations and developments are likely to become standard procedures: non-cash payments in canteens (RU), attendance records related to the canteen by class teachers (RU), outdoor meals during the summer (FI), commercialization of the school meal *via* a phone application (PL), digital training and meetings for canteen staff (multiple countries), frequent use of hand sanitizers and adherence to strict hygiene standards (all countries).

Public Procurement and Catering Services Response to the COVID-19 Pandemic

Public procurement and catering services in the BSR have a history of being well-organized and regulated. However, the COVID-19 pandemic presented a range of new challenges; for example, school meal services had to adapt to states of emergency, rapidly changing national regulations and ministerial decisions, and changing requirements of parents and pupils. Section Regulatory and Organizational Models of School Meal Provision presented the regulatory and organizational models of school meal provision while section Results outlined the different effects of the COVID-19 pandemic in the studied BSR countries;

FIGURE 4 | A word cloud for the reported BSR challenges and problems. Source: own analysis based on interviews.

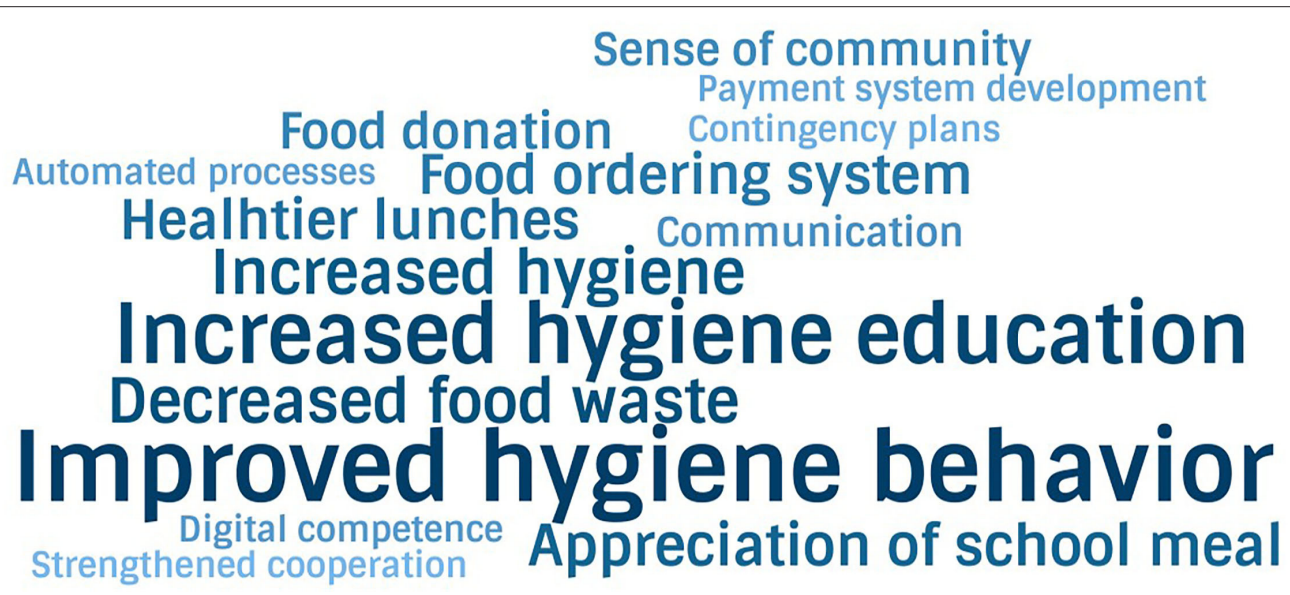

FIGURE 5 | A word cloud for the reported BSR solutions and developments. Source: own analysis based on interviews.

this study also observed that the countries developed similar adaptations (see **Table 8**). Corresponding with the results of the reviewed literature (Kinsey et al., 2020; Parnham et al., 2020), this study observed that the provision of subsidized school meals and access to school meals in general were considered a matter of food security in the BSR region. The cost of a school meal during the COVID-19 pandemic varied; some regions were able to maintain their existing budgets, while for others the cost doubled. The factors that contributed to the rise in costs included packaging materials, additional work shifts that included weekends and evenings, and problems with food suppliers. A new role assigned to both on-site and centralized kitchens during the pandemic

TABLE 8 | COVID-19 pandemic effects on regulatory and organizational models of school meal provision.

Models of school meal provision	Generalized COVID-19 pandemic effect
Cost-sharing: fully subsidized	No changes in the full meal subsidies of school meals were observed. If operating under a fully subsidized model, the obligation to provide meals also for pupils in distance learning occurred (either immediately or after some time). The price of meals for the state or local authority in most cases increased. At the same time, variety of served meals decreased.
Cost-sharing: partially subsidized	From the parents' perspective, partial subsidies were also mainly unaffected, while the cost covered by the state/municipal authority could increase. Partial subsidies, in the case of distance learning, in practice might have resulted in no school meal. In contrast, the variety of served meals decreased.
Cost-sharing: not subsidized	No subsidies, in the case of distance learning, in practice might have resulted in no school meal. The variety of served meals decreased.
Cost-sharing: mixed model	Mixed models, in the certain cases, resulted in specific groups of pupils receiving takeaway meals during the school closure. Provision of meals for pupils in contact learning continued, often with less served options.
Organizational: in-house	In the in-house organizational model, staff circulation was observed in order to avoid lay-offs. Such practice affected better internal communication and understanding of others responsibilities. Increased communication with local authorities and parents.
Organizational: contract catering	Contact catering model was in higher risk of personnel lay-offs, especially at the beginning of the pandemic. Communication with local authorities and parents increased.
Manufacturing and delivery: On-site kitchen	During the school closure, on-site kitchens were either closed or operating in a strongly modified environment to prepare takeaway meals and packages. On-site kitchens were a popular pick-up point for the takeaway meals.
Manufacturing and delivery: Central kitchen	Central kitchens were mainly open through the pandemic. The meals were prepared (often in modified conditions and methods) and then distributed to the schools or picked by parents directly.
Methods: Cook and serve	In open schools, the cook and serve cooking method was used with small modifications such as limited choice, longer lunchtime or meal served on the plate and table instead of a buffet. Cook and serve method was not adequate for takeaway meals.
Methods: Cook and chill	Cook and chill model was used both to prepare meals for contact and distance learning.
Methods: Cook cold	In order to prepare takeaway meals, additional phases had to be added: cooking, chilling and freezing. This extension required a set of modifications in the kitchen, e.g., additional ovens and space for chilling.

Source: own analysis.

was to serve as a pick-up point for takeaway meals. At the same time, staffing issues were also reported, such as temporary lay-offs, redeployment to other municipal services, and additional shifts and cleaning requirements.

The results revealed a strong sense of duty to provide a nutritious meal to children, especially during the COVID-19 pandemic. This finding advocates for the role of public procurement and catering services in addressing food insecurity (McLoughlin et al., 2020b; Borkowski et al., 2021).

The Rise of a Takeaway School Meal Model

In response to the COVID-19 pandemic and the ensuing school lockdowns, school nutrition programs in the BSR countries developed innovative ways to secure safe access to nutritious meals. Based on different national and regional examples, this paper outlines the takeaway model for school meals that evolved under COVID-19 pandemic conditions. Before COVID-19, a takeaway school meal was regarded as an unhealthy fast-food style meal that children obtained independently (Patterson et al., 2012). This paper offers a new definition of a takeaway school meal as an innovative and nutritious meal that supports a community. The takeaway school meal model, presented in **Figure 6**, is described using four main features: meal provision, accessibility, distribution, and the generation of food waste.

The first distinguishing feature of the takeaway school meal concerns the meal itself, whether pupils were offered a ready-made meal (to be re-heated or cooked) or a package of food products to prepare at home. In the latter case, the meal's nutritional value was supported by a greater variety of foodstuffs, which represented all the basic nutritional categories: cereal and bread, dairy, vegetables, fruit, and meat. The package size was adjusted to the times of the weekly pick-ups. When served as a pre-prepared nutritious meal, whether frozen, chilled, or hot, the portion size was also unified, and thus, in general, increased to meet everyone's needs. However, these meals often did not include sides, such as bread or salads. Additionally, the freshness of the food products in the lunch packages was also questioned when the ingredients were used to prepare meals later in the week. During the studied period from March 2020 to March 2021, pupils could not select the types of takeaway meals they received. However, several municipalities are planning to include vegetarian options in the future. Overall, schools were able to account for known and documented special diets in the meal planning (e.g., food allergies).

The second fundamental characteristic of the takeaway school meals was the variable conditions of availability; for example, the provision of meals could be based on socio-economic statuses, a prior application, or a universal distribution without pre-conditions. In the early stages, pupils could be dropped from the application list if, for example, meals were not collected on a number of occasions. In one particular region, the school meal became a commercial meal, offered with a range of prices, that pupils and adults could order *via* a mobile application.

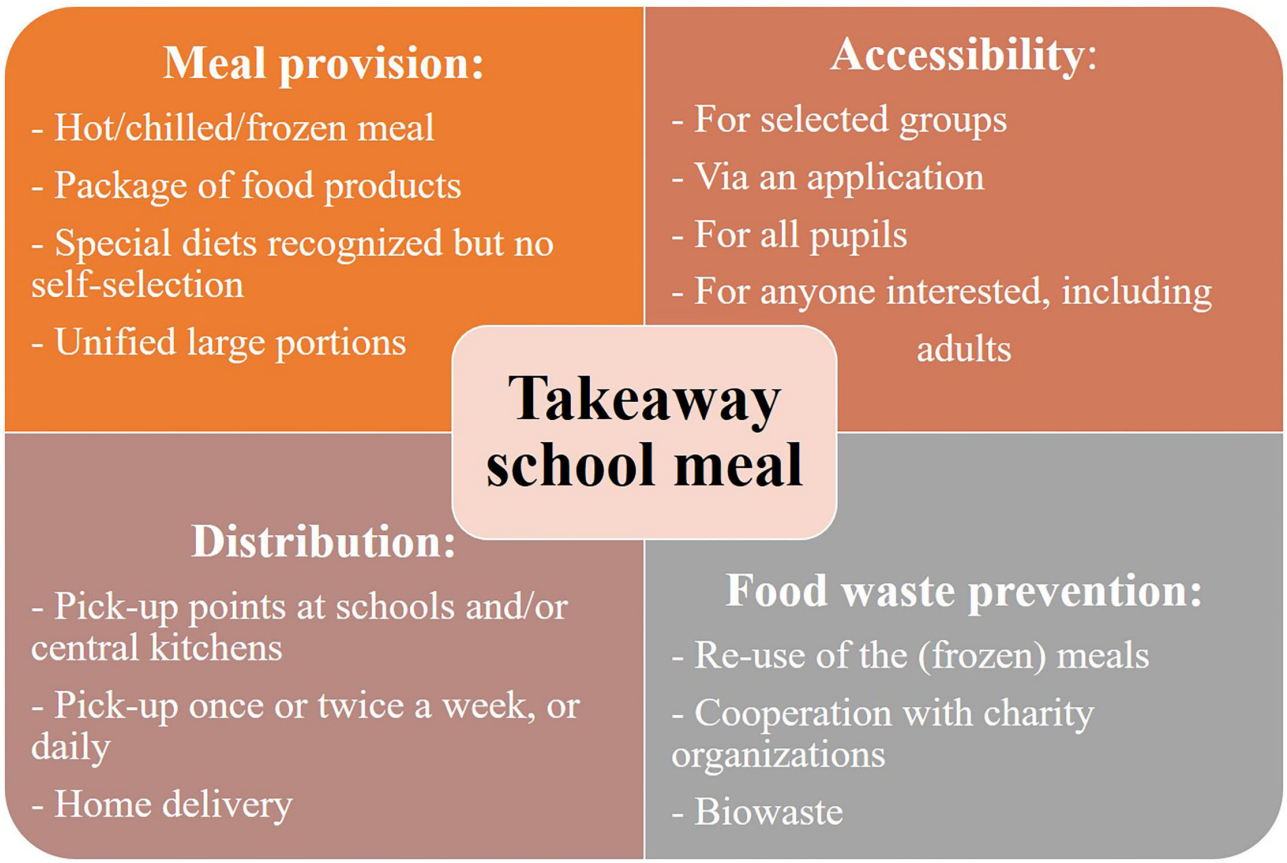

FIGURE 6 | The characteristics of the takeaway school meal model evolved during the COVID-19 pandemic in the BSR countries. Source: own analysis based on interviews and collected data.

The meal distribution was generally organized as a pick-up from school premises, and/or, if available, from a central kitchen. The pick-up frequency varied from daily to weekly. Takeaway school meals were sometimes delivered to pupils' homes; however, this option was only applied under certain conditions and was rarely used.

Finally, food waste generated by the takeaway meals was avoided or decreased *via* two methods. First, unclaimed meals were often donated to charity or, if possible, offered again at the next available pick-up. Meals that were not consumed were then collected separately as biowaste. Second, it was assumed that the large meal portions would be shared with other family members, and at least one region noted that parents had openly complimented the food. However, organizations should record more accurately the volume of food waste that is produced when using the takeaway meal model.

FURTHER DISCUSSION AND CONCLUSIONS

The provision of school meals has a definite impact on the nutritional status of children and adolescents; therefore, there is a requirement to provide healthy and well-balanced meal options. In addition to nutritional value, the provision of school meals can extend pupils' nutritional knowledge and skills (Frobisher et al., 2005). Scholars have analyzed the school meal from the paradigm of multi-level social interaction and social learning, where the satisfaction derived from a meal is a complex process that includes taste, nutritional values, atmosphere, and canteen organization (Lülfs-Baden and Spiller, 2009; Berggren et al., 2020). Further research is required to define how the COVID-19 pandemic has influenced the provision of school meals from the perspective of pupils' satisfaction. During the study period, the provision of school meals, as described in this paper, differed both nationally and regionally and often evolved over time in response to changing conditions and regulations.

This paper has focused on the organizational aspects of school meal provision during the COVID-19 pandemic. More specifically, *why* and *how* pupils received their meals during both the school lockdowns and the periods of contact teaching was analyzed. The national differences originated from high-level ministerial decisions, yet there was also a unified need to apply the restrictions and recommendations in a short time frame. The sustainability adaptations of catering services were supported by the reported actions to prevent food waste

and the sense of social responsibility to provide a nutritious meal (Mikkola and Post, 2012; Post and Mikkola, 2012), and this study found that these factors retained their importance during the COVID-19 crisis. The COVID-19 pandemic required numerous rapid adjustments and extensive changes to well-established food services in schools and other educational institutions worldwide. All of the actors within the sector (schools, caterers, and suppliers) had to acquire new skills to manage the rapidly changing conditions and emerging challenges. In several BSR countries, schools provided meals even when it was not legally required (e.g., early in the pandemic in Finland and Poland); this voluntary provision of meals acknowledged the social importance of the public procurement and catering services and their positive impact on well-being. This paper also, indirectly, presents public procurement and catering services (especially those operating in small and centralized units) as dynamic, flexible, and reliable organizations that value pupils' welfare. Finally, the COVID-19 pandemic provided a significant opportunity to acquire new knowledge and skills for the actors involved in the provision of school meals. The experiences gained during this period of rapid change could also lead to future developments that are more flexible, mobile, and innovative. In addition, the open appreciation of school meals has been a positive social impact of the COVID-19 pandemic, and it has directed attention toward the importance of the preparatory processes and primary stakeholders.

DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/**Supplementary Material**, further inquiries can be directed to the corresponding author/s.

AUTHOR CONTRIBUTIONS

The work was led and directed by UA-K, its foundation was developed during meetings with RG-W, RK, EP, EF, AP, and MM. All authors contributed to the analysis and writing and the data collection in their own country (i.e., *EE*—EP, *FIN*—UA-K and MM, *PL*—RG-W and RK, *RU*—EF and VM, *SE*—AP), contributed to the manuscript editing, and have approved its final form.

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SUPPLEMENTARY MATERIAL

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