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Original article

Evaluation of food intake through residual analysis in 90 Basque school canteens

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ABSTRACT

Objective: To measure the consumption of 25 food items (Comstock scale), to test whether school management type (public schools vs. private with subsidy schools) and food origin (on-site preparation vs. catering) affected food consumption and to quantify variability associated with territory, school and individual.
Method: This cross-sectional study involved 14,717 schoolchildren of ages 2-16, recruited in 90 schools of the Basque Autonomous Community (Spain). Waste (non-consumed food) of 25 analysed food items was visually estimated by trained school monitors, via the Comstock categorical scale thus adapted: 1 = 0%; 2 = 25%; 3 = 50%, 4 = 75% and 5 = 100%. To analyse the data, mixed modelling was applied.
Results: Vegetables, fish and fruits were the less-accepted food types. While school management did not affect food intake, on-site food preparation had better acceptance for legumes with vegetables, oily and lean fish, meat and pre-cooked meals. The largest source of variability in food intake not accounted for by school management and food preparation was the individual subject, while school and territory had moderate and almost no effects, respectively.
Conclusions: Acceptance of the 25 evaluated foods is adequate, albeit can be improved. We believe that promoting on-site food preparation should improve the acceptance of legumes with vegetables, oily/lean fish, meat and pre-cooked meals. We recommend that future interventions oriented to improve intake should focus on individual subjects.
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Evaluación de la ingesta de alimentos a través del análisis residual en 90 comedores escolares vascos

Palabras clave:
Preferencias alimentarias
Ciencias de la nutrición infantil
Escuelas
Comidas
Abastecimiento de alimentos
Registros de alimentos
Salud pública

RESUMEN

Objetivo: Medir el consumo de 25 alimentos (escala Comstock), comprobar si el tipo de gestión escolar (pública o concertada) y el origen de los alimentos (*in situ* o transportados) afecta al consumo, y cuantificar la variabilidad asociada con el territorio, la escuela y los individuos.
Método: Estudio transversal con 14.717 escolares de 2-16 años reclutados en 90 escuelas del País Vasco. La estimación de residuos (alimento no consumido) de 25 grupos de alimentos la realizó visualmente personal escolar entrenado, mediante la escala categórica de Comstock así adaptada: 1 = 0%, 2 = 25%, 3 = 50%, 4 = 75% y 5 = 100%. Para analizar los datos se aplicó un modelo estadístico de efectos mixtos.
Resultados: Verduras, pescado y frutas fueron los alimentos menos consumidos. Aunque el tipo de gestión escolar no afectó a la ingesta alimentaria, se determinó que la cocina *in situ* logró una mejor aceptación de legumbres con verduras, pescado azul y blanco, carne y precocinados. La mayor fuente adicional de variabilidad en la ingesta alimentaria fue el sujeto individual, mientras que la escuela y el territorio tuvieron efectos moderados y casi nulos, respectivamente.
Conclusiones: La aceptación de los 25 alimentos evaluados es adecuada, aunque mejorable. Creemos que la promoción de cocinas *in situ* mejoraría la aceptación de legumbres con verduras, pescado azul y blanco, carne y platos precocinados. Recomendamos que las futuras intervenciones para mejorar la ingesta se dirijan al sujeto individual.
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Introduction

Childhood obesity is one of the biggest health challenges of the 21st century. The problem is global and is progressively affecting many countries, where the prevalence of overweight and obesity among children has increased significantly in recent years. This is a concern shared by governments and institutions at international level, which has materialized in various prevention plans and strategies aimed at encouraging children and young people to adopt healthy lifestyles, mainly through healthy eating and regular physical activity.

In Spain, according to the 2019 ALADINO study, childhood obesity and overweight have reached figures of 17.3% and 23.3% respectively, i.e. 4 out of 10 (40.6%) of schoolchildren aged between 6 and 9 years are overweight.[1] The 2015 ALADINO-Euskadi report also showed a prevalence of childhood obesity and overweight of 34.2%.[2]

The pattern of food consumption in children is characterized by the following aspects: 4% of children and adolescents in the Basque Autonomous Community (BAC) do not eat breakfast; the consumption of dairy products and cereals consist of about 50% of estimated daily consumption; girls consume more fruit than boys, while boys have higher intakes of cereals, meat and juices. In general, daily food intake increases with age; however, the consumption of milk and its derivatives is higher among younger people and a higher consumption of milk, fish and fruit is observed in the high-socioeconomic status, while meat and dairy products are more consumed by socioeconomically disadvantaged people.[3]

In addition to the fact that the Basque Government's Directorate of Public Health and Addictions in 2019 presented "SANO", the Comprehensive Strategy for the Prevention of Childhood Obesity in the BAC,[2] which aims to reduce the prevalence of childhood obesity and overweight in the BAC, the Basque Health Plan 2013-2020 also includes among its provisions measures to curb this situation. In its objective 4.1.5. (Child Health Area) establishes as a priority to monitor the risks of child malnutrition and develop prevention and approach mechanisms in coordination with social and educational services. To this end, the Basque Government Departments of Health, Education and Agriculture have promoted the "Initiatives for Healthy Eating in the Basque Country" Plan with the aim of promoting healthy eating and thus limiting the increase in chronic diseases such as cardiovascular diseases, diabetes and some types of cancer.[4] This Plan contemplates 18 initiatives (included in 5 actions lines) to be developed until 2020, ranging from the reduction of salt and sugar consumption to the promotion of seasonal fruits and vegetables, or the promotion of healthy eating in school canteens, among many others. The present study corresponds to the last-mentioned initiative which requires the coordinated intervention of different actors (central kitchens, schools, food industry, distribution and authorities) working synergistically to achieve the improvement of healthy eating. These agents take care of the appearance of the dishes, improve their format and make them more attractive and appetising in order to facilitate healthier choices. One of the first result of this collaborative work was a Guide of recommendations for healthy eating at school age published in 2018, which have been adopted in BAC school canteens.[5]

Strategies to address the problem of obesity from an early age must be considered with a multidimensional approach, in which unhealthy eating habits together with sedentary lifestyles are the main aspects to reduce. In this comprehensive approach, school canteens are a key tool for proper child and youth nutrition. Schools, overall, provide a key platform for multiple community health benefits for children and young people.[6] Recent research in countries such as Sweden or Brazil,[7,8] shows that school lunches are contributing positively to school children's dietary intake and are determinants of their long-term health, as they positively affect the consumption of healthy foods. In the case of Spain, there is not enough bibliography to support it.

Considering the different educational centres models currently existing in Spain and in the BAC more than two thirds of schools belong to the public network. Regarding the management of school canteens, in the same area, the model of catering (food prepared in a central kitchen and transported to the school for direct consumption), is predominant compared to the model that consist of food prepared on-site (school canteens that include a kitchen).[9,10]

More than 300,000 schoolchildren eat daily in 905 school canteens in the BAC, so that school meals represent a significant proportion of children's food in the BAC. School menus must comply with the technical specifications established by the Department of Education,[11] which include the proposals within the framework of the Plan of Initiatives for Healthy Eating in the BAC,[4] so they are carefully designed, but their usefulness depends on their actual consumption.

Thus, the aim of this study is to measure and determine whether the effort to improve the quality of the menus made by public institutions, central kitchens and education centres, have been effective, in terms of tolerance, among school population because if the acceptance to the modified menus is void, all the effort made will have proved fruitless.

To this end, this study wants to evaluate and measure the consumption of 25 types of food present in the school menu by analysing the fraction not consumed. In addition, the study tries to determine whether the type of school management (public vs. private with subsidy) and the food origin (processed on site vs. catering) influences consumption.

Method

Design and study population

This is a cross-sectional study carried out in 90 school canteens in the BAC with 14,717 participants for 3 months (January-March) in 2021. The inclusion criteria correspond to students attending school canteens in randomly selected schools aged 2-16 years. Students with any type of food allergy or intolerance were excluded from this evaluation (only students with basal menus were considered).

This is a stratified sample (Table 1) where the sample units are the centres with a school canteen in the BAC and the allocation or distribution of the sample in the strata is carried out according to the number of students in each one. By means of simple random sampling, the number of centres set within each stratum is extracted. The Cube Method has been used to balance the proportions of the original population in the sample.[12] This method maintains the proportions of the original population in the sample at equilibrium variables, taking into account the inclusion probabilities of the design. The sample of schools has been balanced on the following variables: the total number of pupils by historical territory, the total number of pupils according to public/private with subsidy network and the total number of pupils according to whether meals are prepared at the school.

The optimal sample size for a complete cluster sample is calculated from the following formula:

$$n_{schools} = n_a \frac{\left[(1 + \delta(\bar{M} - 1))\right]}{\bar{M}}$$

where n_a is the sample size in student body, for simple random sampling and the remainder is the so-called design effect in cluster

Table 1
Stratified sample of schools.

Centres with school canteen	Historical territory of BAC	School management	Food origin	Total of centres	Total of students	Analysed centres	Analysed students
Stratum 1	Araba	Public	*In situ*	19	3561	1	85
Stratum 2	Araba	Public	Catering	56	10833	11	984
Stratum 3	Araba	Private with subsidy	*In situ*	13	4108	3	270
Stratum 4	Araba	Private with subsidy	Catering	15	2968	3	321
Stratum 5	Bizkaia	Public	*In situ*	70	19938	7	1239
Stratum 6	Bizkaia	Public	Catering	142	27135	13	1414
Stratum 7	Bizkaia	Private with subsidy	*In situ*	58	41089	21	7120
Stratum 8	Bizkaia	Private with subsidy	Catering	41	13584	5	674
Stratum 9	Gipuzkoa	Public	*In situ*	37	10539	6	646
Stratum 10	Gipuzkoa	Public	Catering	74	12936	10	1215
Stratum 11	Gipuzkoa	Private with subsidy	*In situ*	36	10389	6	487
Stratum 12	Gipuzkoa	Private with subsidy	Catering	31	7775	4	262

sampling, $\bar{M}$ is an average number of pupils per school and δ is intra-school correlation:

$$n_a = \frac{Nz^2_{a/2}S^2}{Ne^2 + z^2_{a/2}S^2} = \frac{N}{\left[1 + (N-1)\frac{e^2}{z^2_{a/2}pq}\right]}$$

The equation above indicates that N is the total number of pupils, e is the maximum permissible error, $z^2_{\alpha/2}$ is the critical value for the significance level, p is the expected probability of occurrence of the event to be estimated and q is 1-p.

The final error considers the sub-sampling of size m in each sample cluster and is given by the next equation where m is the sample size per school centre. The sample size has been set at 110 centres, estimated under the following parameters: an intra-cluster correlation coefficient of 0.10, a confidence level of 95%, an estimation error of 3% and a p of 0.5:

$$e = 1,96\sqrt{\frac{PQ}{n_{schools}}\frac{(1+(\bar{m}-1)\delta)}{\bar{m}}}$$

Collection of variables

To measure the rejected fraction of each of the 25 selected items, the Comstock scale was used, which consists of the indirect measurement of the percentage of wastage through visual estimation.[13] The estimation of residues (food not consumed) was carried out visually by trained school staff, using the categorical Comstock scale thus adapted: 1 = 0%, 2 = 25%, 3 = 50%, 4 = 75%, and 5 = 100%. It should be noted that a full plate (100%) meant that the participant did not ingest any of what was offered, and thus an empty plate meant that all of what was offered was consumed.

The school staff had records prepared exclusively for this study and for the training they received a bilingual (Basque and Spanish) video for 8 minutes, which showed, among other things, the objectives of the study, the measurement scale, the duration of the study, the procedures to be carried out and recommendations.[14]

Observations of school staff were carried out in each school for 10 consecutive days. The researchers previously selected the days with the most suitable menus for the analysis. The selection criteria was based on the minimum existence of the following three foods: oily fish, lean fish and precooked food, since according to the technical specifications that Basque school menus must comply with,[11] there are only 2 days with pre-cooked food and 6 days with fish per month. We also consider that it would be important to observe differences in the intake of lean and oily fish.

The 25 food items studied (Table 2) are grouped into A (pasta, rice and other cereals and derivatives), B (cooked vegetables), C (cooked potatoes), D (legumes), E (soups), F (lean and oily fish), G (meats), H (meat products such as sausage, “chorizo”, black pudding, hamburger, etc.), I (pre-cooked products such as pasties, croquettes, “san jacobo”, etc.), J (eggs), K (dairy desserts), L (other desserts such as flan, custard, sponge cake, milk with sweetened cocoa powder), M (fruit), N (canned fruit) and make up the basic, most nutritious foods, representative of the Mediterranean diet and they cover all foods on offer on the menus.

Ethical considerations

The study was approved by the scientific research ethics committee of the Basque Government Department of Health.

Statistical analysis

In order to measure the food consumption, for each sampled food, the mean, standard deviation (SD) and response of the fraction not consumed were estimated. For other two objectives, the consumption of each food was analysed using a Gaussian-type or normal mixed-effects model (that is, a statistical model with both fixed-effects and random-effects factors).[15,16] The adjustment of the models for each food, and the corresponding estimation of the parameters of each adjusted model, was carried out by means of the maximum likelihood method using the R package “nlme”.[17]

In this mixed effects statistical model, the type of management (with two levels: public and private with subsidy) and the food origin (with two levels: *in situ* and catering) represented the two fixed effects factors analysed in this study. By contrast, the territory (with three levels: Araba, Bizkaia, and Gipuzkoa) and the school (with as many levels as schools, that is, 90) were analysed as random effects factors. Due to the very nature and structure of the data, individual, school and territory are hierarchically structured. Thus, the school random factor is nested in, or belongs to, the territory random factor, and the commensal random factor (that is, the individuals, at the lower level of said hierarchical structure) is nested in the school random factor.

In addition, as a measure of the goodness of fit of each of the fitted models, we calculated both the conditional coefficient of determination ($R^2{}_c$) and the marginal coefficient of determination ($R^2{}_m$), which correspond to the total variability explained by all the factors and variability retained by only the fixed factors, respectively.

In a simplified way, the adjusted statistical model for each food can be represented as:

$$y_{ijklm} = \mu + \alpha_i + \beta_j + (\alpha\beta)_{ij} + \gamma_{k(i,j)} + \delta_{l(k(i,j))} + \varepsilon_{ijklm}$$

In the equation above, and considering first the fixed part of the model, μ is the reference level (here a public school with an on-site kitchen has been chosen), α corresponds to the (fixed) effect of the type of management (with two levels: i = public school, private school), β represents the (fixed) effect of food origin (with two

Table 2
Waste (percentage of not consumed food) for 25 food items. Estimates were made using the adapted Comstock scale (%). In addition to the mean and standard deviation, the frequency of response is reported for each cut-off point of the Comstock scale (0%, 25%, 50%, 75%, 100%). The data are based on a sample in which 14,717 schoolchildren from 90 schools in all the territories of the BAC participated, but *n* varies in each case because not all the dishes are served in the canteens with the same frequency.

Food code	*n*	Mean	SD	Freq. 0%	Freq. 25%	Freq. 50%	Freq. 75%	Freq. 100%
PAST-V1	16642	12.96	26.18	74.6	10.6	7.4	3.1	4.3
PAST-C1	627	6.62	15.35	80.9	13.4	4.3	1.3	0.2
A-V1	10146	13.92	24.37	68.4	16.1	9.4	3.6	2.5
A-C1	2835	20.87	29.90	57.8	18.1	12.6	5.5	5.9
VCOC1	33437	21.12	33.23	63.6	12.3	9.5	5	9.6
VCOC.PAT1	9834	40.35	37.43	35.1	15.1	21.8	9.5	18.6
PAT-PC1	5742	14.14	25.61	70.3	13	9.8	3.7	3.2
PAT-P.Az1	958	25.97	32.30	51.6	16.3	15.6	9.9	6.7
PAT-V1	1226	20.68	34.13	66.2	11.3	7.2	4.6	10.8
LEG-V1	38879	20.04	30.57	61.4	15.5	11	5.4	6.6
LEG-Arr1	4529	16.39	28.51	68.6	11.7	10.2	4.5	5
LEG-PC1	3290	14.76	26.15	67.2	18.4	6.7	3.3	4.3
SOP-V1	1193	10.92	23.66	77.8	9.1	7.3	3.2	2.6
SOP-P1	10065	12.61	27.54	77.8	8.1	5.9	2.4	5.9
SOP-PESC1	2502	20.81	33.08	63.8	13.1	8.8	4.7	9.6
PESC.BL	34032	21.29	31.90	60.6	14.7	11.8	4.6	8.2
PESC.AZ	11301	24.33	32.83	55.8	14.4	14.8	6.6	8.4
CARNE	45149	14.60	26.19	69.8	12.8	10.1	3.5	3.7
PROD.CARN	17793	9.49	23.04	81.3	7.6	6	1.9	3.2
PRECOC	13483	6.62	19.10	85.9	7	3.8	1.4	1.9
HUEVOS	22544	15.64	28.46	70.6	10.8	9.6	3.6	5.5
YOGQUECUA	33042	5.45	20.86	92.3	2	1.3	0.6	3.9
OTROSPOST	6259	7.07	23.00	89.2	3.4	1.9	0.9	4.6
FRUTA	107005	20.01	33.61	68.3	7	11.2	3.1	10.3
FRUTACON	1284	26.38	38.34	62.3	6.3	11.1	4.2	16.1

A-C1: rice with meat; A-V1: rice wth vegetables; CARNE: meat; FRUTA: fruit; FRUTACON: canned or preserved fruit; HUEVOS: eggs; LEG-Arr1: legume with rice; LEG-PC1: legume with meat product; LEG-V1: legume with vegetables; OTROPOST: other desserts; PAST-C1: pasta with meat; PAST-V1: pasta with vegetables; PAT-P.Az1: potato with oily fish; PAT-PC1: potato with meat products; PAT-V1: potato with vegetables; PESC.AZ: oily fish; PESC.BL: lean fish; PRECOC: precooked food; PROD.CARN: meat product; SD: standard deviation; SOP-P1: soup with pasta; SOP-PESC1: soup with fish; SOP-V1: soup with vegetables; VCOC.PAT1: boiled vegetables with potato; VCOC1: boiled vegetables; YOGQUECUA: dairy products.

levels: j = *in situ*, transported), and $\alpha\beta$ represents the interaction (also a < fixed > effect) between both factors.

In the random part of this mixed model, γ represents the effect of the territory (with three levels: k = Araba, Bizkaia, Gipuzkoa), δ corresponds to the effect of the school (with 90 levels, since 90 schools have been sampled: l = school 1, school 2, . . ., school 90), which is nested in the random factor territory, and ε is the residual component, which represents m individuals and is nested in the random factor school. These random factors are of the form: $\gamma \sim N(0, \sigma^2\gamma)$, $\delta \sim N(0, \sigma^2\delta)$, and $\varepsilon \sim N(0, \sigma^2\varepsilon)$. Therefore, the focus of statistical inference is the contrast and estimation of the parameters corresponding to the fixed effects specified above, as well as the estimation of the three present variances, $\sigma^2\gamma$, $\sigma^2\delta$, and $\sigma^2\varepsilon$, corresponding to the three nested random effects.

Results

Food consumption

A total of 25 foods items were analysed, the results of which are reported in Table 2. If we consider the mean of the Comstock scale to identify the amount of waste by food type, boiled vegetables with potatoes was the food that, in general, the schoolchildren gave up the most, with 40.35% of waste (SD: 37.43), followed by canned fruit with 26.38% (SD: 38.34) and potato with oily fish with 25.97% (SD: 32.30). On the contrary, the foods with the lowest score on the Comstock scale, i.e. with the best acceptance by the students, were dairy products with a mean of 5.45% (SD: 20.86), pasta with meat with 6.62% (SD: 15.35), pre-cooked food with 6.62% (SD: 19.10) and other desserts with 7.07% (SD: 23.00).

The influence of the type of management and food origin

We only found statistically significant differences ($p < 0.05$) associated with the type of management or food origin (catering vs. *in situ*) for five of the food items: legumes with vegetables, oily fish, lean fish, meat and precooked foods. However, for these five foods, the influence of these fixed factors is always very small (explained variance: $R^2{}_m$ = 0.86-2.34%). For the other 20 food items, neither the type of management (public vs. private with subsidy school), nor the origin (catering vs. *in situ*) seems to significantly influence their acceptability. Only for oily fish (Fig. 1), the effect of the origin of food depends on the type of management. In the case of legumes with vegetables, lean fish, meat and precooked foods, the only significant effect is associated with the food origin.

Variability explained by territory, school and individual

The random factors territory and school, together with the residual variability due to the individuals (or diners) themselves, quantify in the form of explained variance the effect associated with them (Fig. 2). In the case of territory, the estimated variances of the corresponding normal distributions (which are always indexed by zero mean), lie between 0-10. In the case of schools, between 5-15. And in the case of individuals, between 15-35. Except in one case (canned fruit), therefore, the greatest variability is always due to the individuals; the second most influential factor is the school itself, and the last (in quantitative terms) is the historical territory. In other words, the territory where meals are served is hardly associated with food wastage, while the school has a moderate influence and the individual himself has a strong influence.

Discussion

Foods offered in school canteens from the BAC are generally well accepted. However, certain foods which are an essential part of healthy diets, such as cooked vegetables dishes, legumes, dishes with oily or lean fish, and fruit, have average residues of around 20% or more. A study in Bizkaia published in 2015 that evaluated the offer of school menus according to NAOS indicators pointed out

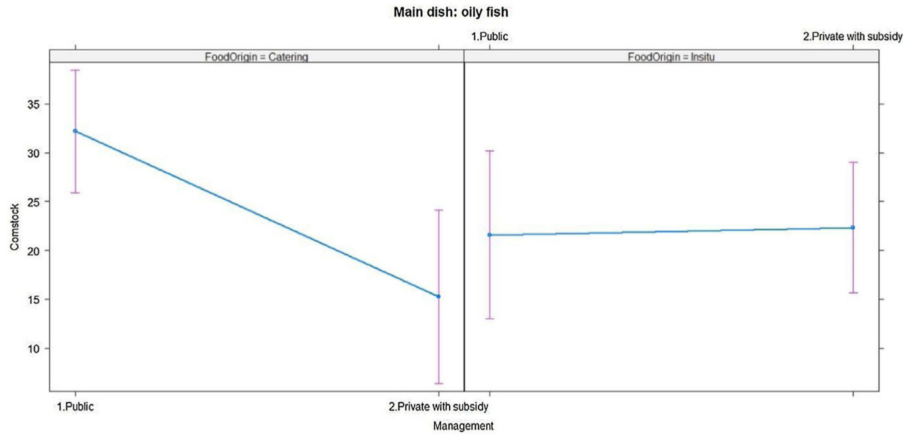

Figure 1. Effect of food origin and management type significantly associated with the consumption of oily fish.

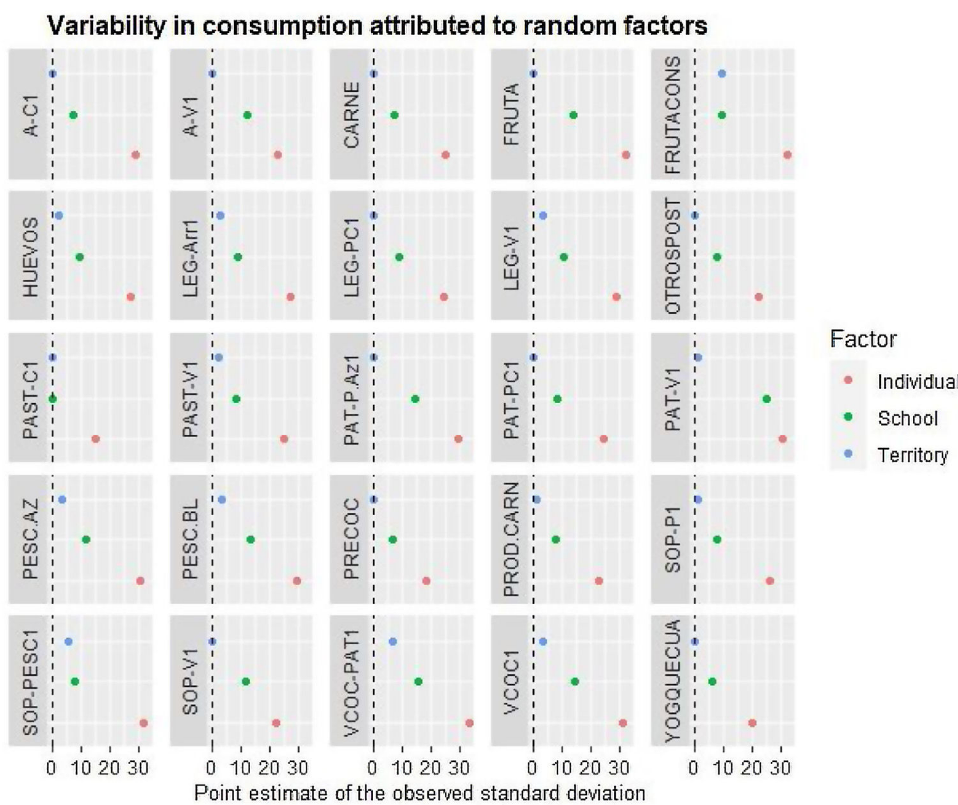

Figure 2. Variability (estimated variance) in food wastage attributed to nested random factors territory, school and individuals. The largest source of variability is the individual, followed by the school and, finally, the territory.

that one of the stumbling blocks reported by central kitchens was the significantly poorer acceptance of vegetables, fish and fruit.[18] Another study from Bizkaia also observed a lower success rate in vegetable intake compared to other foods as a whole.[6] The lower overall acceptance of fruit and vegetables by the school population has also been demonstrated in other studies in Spain and the United States.[19,20] Furthermore, the lower acceptance of fish dishes, which is related to family habits, is also known in other countries, such as Italy, which has led to the search for recipes and presentations that improve their acceptance.[21] Nevertheless, legumes, fish and fruit have obtained better acceptance in our environment than that observed in previous national studies.[19,22] Legumes are also better accepted in our area (BAC) than the two options of rice dishes, a food considered (together with meat and pasta) to be preferred by the Spanish child population.[19]

Management model and food origin do not seem to affect the acceptance of 80% of the food items (20 of 25 food items). However, the acceptance of five food items does seem to be influenced, although only very moderately (between 0.86% and 2.34% of the acceptance), by the type of management, the origin, or both.

The management model does not seem to affect, in general, the acceptance of food in schools. Only in the case of oily fish, however, was its acceptance positively affected (lower average wastage) in private schools when it came from central kitchens, although this does not seem to be the case in public schools, where the origin of the fish is irrelevant to its level of consumption. After inspecting the data underlying these results, we found that in the private schools that bring their food from central kitchens, during the study period only tuna/bonito in tomato sauce was served, while at all other levels, trout, salmon, cobbler and mackerel were also served, and prepared in a variety of ways (baked or battered). Thus, we believe that it is this particular preparation (bonito/tuna with tomato) that explains the optimal consumption of oily fish observed in the private school, as the tomato sauce softens the taste of the fish and makes it juicier.

It is considered that the fact that there are no differences in food consumption between Basque private and public schools can be at least partially explained by the fact that is the same central kitchens that supply both public and private schools. Among the studies reviewed that provide data on food acceptance in schools,[23–25] none of them compare differences in consumption between private and public schools. Even so, discrepancies have been found between public and private school students in terms of knowledge about healthy eating and a healthy lifestyle.[26,27]

The food origin (*in situ* vs. catering) negatively affected, although also very moderately, the consumption of legumes with vegetables, oily fish, lean fish, meat and pre-cooked foods. For all these foods, intakes were lower (i.e. wastage was higher) when the food came from central kitchens than when it was prepared in on-site kitchens. This may be explained by the fact that processing food products in advance can generate organoleptic alterations and loss of quality due to excessive regeneration or simply because there is a long time between processing and consumption.[28] Long periods between processing and consumption can lead to hardening and browning unsalted meats,[29] wilting or oxidation of vegetables or fruits,[30] surface drying of products such as fish, pasta and eggs, overcooked products in legumes and loss of crispiness in frying,[31,32] especially in precooked foods. In contrast, on-site cooking facilitates healthier cooking techniques such as grilling or steaming and reduces the need for breading or sauces,[33] which serve to help maintain temperatures, while adding fat content to foods.[5] The on-site origin also helps to increase the supply of salads or to keep leftover fruit for a few days until it is at optimum ripeness, for example.[24]

The greatest source of variability in food consumption has been the individual, followed by the school (the magnitude of whose associated influence is quantified as approximately half of that associated with the individual) and, lastly, in an almost negligible way for most of the food, the territory. For this reason, we believe that further educational campaigns should be directed, in the first instance, to intervention at the individual (or family) level and, in the second instance, to schools. We have not found any findings to compare these results with similar studies in this field.

This study has three limitations. One of them is that we had to modify the initial sample size, due to difficulties in collaborating with school canteen monitors because of the pandemic period. Furthermore, it should be noted that although there is a technical specification that indicates the grammage that should be offered for each food in each age group,[11] it is difficult to control the amount offered to students and therefore there may have been small variations in the result of Comstock wastage. Finally, although the school canteen monitors responsible for visual assessment have been trained with audio-visual training,[14] it has not been possible to examine the degree of accuracy of each monitor on the Comstock scale.

Conclusions

The overall acceptance of the 25 foods evaluated is acceptable, with consumption between 90% and 60%, although there is room for improvement in the case of vegetables, fish and fruit. We believe that the promotion of on-site kitchens would improve the acceptability of legumes with vegetables, fish, meat and pre-cooked foods. We recommend that future interventions to improve intake be designed to be more personalised.

Availability of databases and material for replication

Authors are not owners of the data. In order to request the database used in this study, contact the Department of Health of the Basque Government: salimentaria-bizkaia@euskadi.eus

What is known about the topic?

Despite the fact that menus offered at Basque school centres are nutritionally assessed according to NAOS indicators, the importance of this work lies in the monitoring of food consumption, since it is necessary to know the actual intake to formulate future public health interventions.

What does this study add to the literature?

Some foods are less accepted when they are transported than other which are prepared in on-site kitchens. No differences were found in food consumption between public schools and private schools.

What are the implications of the results?

Healthy foods should continue to be promoted with policies aimed at the individual and families.

Editor in charge

Carlos Álvarez-Dardet.

Transparency declaration

The corresponding author on behalf of the other authors guarantee the accuracy, transparency and honesty of the data and information contained in the study, that no relevant information has been omitted and that all discrepancies between authors have been adequately resolved and described.

Authorship contributions

Study design: S. Valcárcel, I. Egaña, N. Macazaga. Methodology: S. Valcárcel, G. García-Baquero, I. Egaña. Literature review: I. Egaña. Data collection and clean-up: I. Egaña, N. Macazaga, C. Oria, S. Valcárcel. Data analysis and interpretation: I. Egaña, G. García-Baquero. Writing the manuscrite: I. Egaña, G. García-Baquero. Critical review: I. Egaña, G. García-Baquero, S. Valcárcel, N. Macazaga, C. Oria. Final version approval: I. Egaña, G. García-Baquero, S. Valcárcel, N. Macazaga, C. Oria.

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Conflicts of interests

None.

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