

# Plate Waste as an Indicator of Portions Inadequacy at School Lunch

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**Abstract**—Quality of school meals is one of the major concerns of governments and international organizations worldwide. This study aims to evaluate nutritional compliance of meals served at a Portuguese primary school considering the portions stated by Portuguese Education Ministry. To evaluate adequacy of portions served, weighing of all meal components offered to students and leftovers was performed during ten consecutive days at two different moments. Plate waste (%) was calculated by the ratio of food discarded and food served to the children. Nutritional evaluation of menus was made using the Portuguese Food Composition Table. Meals evaluated showed a percent contribution to energetic daily intake higher than recommendations. Meals served to children were considered high energy and protein dense. No significant waste of soup was accounted and the main meal components wasted were fish and vegetables. It will be necessary to adjust portions indicated by Ministry of Education in order to comply with recommendations and reduce food waste.

**Keywords**—Portions, waste, nutritional adequacy, school meals.

## I. INTRODUCTION

PAST published data in Portugal indicate that in the school year of 2009/2010 approximately 500.000 students attended to primary education and approximately 80% of them had lunch at school [1]. School meals must supply a balanced diet considering the school population needs and following recommendations from Portuguese Ministry of Education [2].

A considerable number of students spend most of the day at school and some of them have as the only hot meal the one supplied at the school canteen [3]-[6].

Food consumed at school is an important source of energy and nutrients, giving to school foodservice an important role on children's nutritional intake and wellbeing, reinforcing family responsibility [2], [5], [7]-[9].

Several studies have been developed in order to evaluate the nutritional quality of meals served at school canteens [10]-[12], aiming to improve quality by applying strategies associated with nutritional education [13]. Nevertheless this kind of intervention does not account the eventual food waste caused by food rejection by children.

At the present time no information is available concerning

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food effectively consumed at Portuguese school canteens. Few studies focusing the evaluation of waste are available on this context, meaning that wrong conclusions may be obtained if only the availability of food at school meals are considered, allowing overestimating intake. Additionally, food waste contributes to meals cost as well environmental and social impact due to increased production of organic residues [14].

Quantification of food waste has been used to assess nutritional intake, as well as, foodservice quality and meals acceptance in several academic and medical facilities [12], [15]-[17].

Food waste may be influenced by error on menus planning, incorrect estimation of the number of meals as well as on food selection and planning portions [17].

The aim of this work was to evaluate the nutritional adequacy of meals served at primary schools at a Portuguese municipality considering the portions defined by the Ministry of Education.

## II. METHODS

A convenience sample was used including 41 students attending to the first year of primary school at a Portuguese municipality.

The study was performed between September 2010 and May 2011. Informed written consent from the Portuguese Ministry of Education was obtained.

All students with pathologies affecting food intake were excluded from the study.

Two weekly menus cycle were planned and meals were prepared and served to students following portions stated by Portuguese Ministry of Education.

Lunch was composed by vegetable soup, main dish (meat or fish, cereals, tubers or pulses and vegetables), fresh fruit and water.

A data base was elaborated and edible portions and yield of each component was registered using the Portuguese Food Composition Table [18]. Whenever yield was not available, food was weighed before and after cooking and yield was calculated. Each determination was performed in triplicate using the following formula:

$$\text{Yield} = (\text{raw food weight} / \text{cooked food weight}) \times 100$$

To evaluate adequacy of portions served at school lunch, all meal components offered and leftovers were weighed using a digital scale [19], [20]. The same procedure was repeated

during ten consecutive days at lunch time always by the same researcher. Plate waste (%) was calculated by the ratio of food discarded and food served to the children. Plate waste values below 10% were considered acceptable [19], [21], [22]. Waste

data was analyzed by gender and by food group. To ensure reproducibility and validity the same procedure was repeated one month later.

TABLE I  
NUTRITIONAL ADEQUACY OF MEALS SERVED CONSIDERING PORTIONS STATED BY PORTUGUESE EDUCATION MINISTRY

MEAL	Nutritional facts					Nutritional adequacy
	Lunch percent contribution to total daily intake (30a 35%)	Total daily intake (492-574 Kcal)	Protein (12.3-18.5g)	Fat (8.2-16.4g)	CHO (67.7-92.3g)	
1	42.8	701.8	36.3	28.6	75.4	High Energy, fat and protein dense; Adequate CHO content
2	34.6	567.2	25.6	11.2	89.5	Adequate in Energy, CHO and fat; High protein dense
3	38.2	626.8	38.1	16.5	76.9	High Energy and protein dense; Adequate CHO and fat contents.
4	27.7	454.6	29.9	6.0	69.8	Low in Energy and fat; High protein dense; Adequate CHO content
5	37.2	609.4	39.2	14.6	78.9	Adequate in Energy, CHO and fat; High protein dense.
6	37.0	607.5	39.1	14.6	78.6	Adequate in Energy, CHO and fat; High protein dense.
7	24.6	403.9	28.4	4.7	62.0	Low in Energy and fat; High protein dense; Adequate in CHO content
8	40.7	666.8	37.2	13.9	79.9	High Energy and protein dense; Adequate CHO and fat contents
9	50.0	820.2	38.2	41.3	73.7	High Energy and protein dense; Adequate CHO and high fat content
10	27.6	453.4	36.4	8.5	56.5	Low in Energy and CHO; High protein dense; Adequate fat content.

Nutritional quality of meals was evaluated considering protein, carbohydrates and fat content as well as the percent contribution of lunch to the total daily energy intake.

Nutritional adequacy was performed considering recommendations from World Health Organization [23] and United States Department of Agriculture [24].

### III. RESULTS

Considering portions recommended by the Ministry of Education the 10 meals evaluated were classified as high

protein dense. 60% of meals served were also found to be high energetic density (Table I).

Meals n° 1 and 9 were also found to be high in fat and meals number 4, 7 e 10 were low in energy. The majority of meals (90%) had adequate carbohydrate content (Table I).

Average energetic contribution of meals to total energetic intake was higher than recommendations (Table II).

Considering plate waste of the main dish, it was observed that food waste was much higher than 10% in all food items. Gender did not significantly affected soup waste.

TABLE II  
AVERAGE CONTRIBUTION OF ENERGY AND NUTRIENTS COMPARED TO RECOMMENDATIONS

Menu	NUTRITIONAL FACTS					Nutritional Adequacy
	Lunch percent contribution to total daily intake (30- 35%)	Total daily intake (492-574 Kcal)	Protein (12.3-18.5 g)	Fat (8.2-16.4 g)	CHO (67.7-92.3 g)	
Mean	37.0	607.5	36.8	13.9	73.7	High Energy dense, high protein dense
(SD)	(12.0)	(197.2)	(10.9)	(10.8)	(22.3)	Adequate CHO and fat contents

Considering the amount of food waste an indicator of meal acceptance minced meat determined higher acceptance than whole meat by both genders. Plate waste for minced meat was 15.8% for boys and 14.4% for girls. Roasted pork loin was the meat menu less appreciated, noticeable by the highest plate waste value of 44.2% for boys and 57% for girls, which indicates a low consumption.

Plate waste was higher for fish menus than for meat ones. A low intake of fish was observed by both genders since plate waste was higher than 50% for all fish menus. From the initial average quantity offered, 105g, boys wasted 55.3% and girls 57.5%. The highest values of plate waste were found for vegetables (Table III).

TABLE III  
CHILDREN PLATE WASTE AT SCHOOL LUNCH BY SEX AND BY MEAL COMPONENTS

Variables	% PLATE WASTE						
	Soup	Main dish				Vegetables	Fruit
		Fish dishes	Meat dishes	Carbo hydrate sources			
Sex							
Male	0.5	55.3	31.3	44.4	64.1	23.9	
Female	0.1	57.5	32.2	46.5	65.8	23.9	

Eggs plate waste was lower than the one observed either for fish and meat menus, 14.6% for boys and 5.6% for girls.

Pasta was the side dish preferred by children, noticeable by the lowest plate waste values, 39.4% for boys and 37.2% for

girls when compared to rice and potatoes, nevertheless still presenting unacceptable high values.

It was observed that beans plate waste was 52.4% for boys and 69.1% for girls.

The intake of vegetables was very low. The highest plate waste was found for cauliflower (83.3%) by boys and for grated carrot (82.5%) by girls. Lettuce was the most appreciated vegetable, nevertheless still with high waste – 34.2% for boys and 32.1% for girls.

High acceptance was observed for all kind of fruits served on research days, namely banana that was consumed totally. Fruits with higher values of waste were pineapple (47.1%) and kiwi (53.3%) for both genders.

#### IV. DISCUSSION

No specific reference food waste indexes for food units serving children were found in the literature. The standard value used was 10% referred by Augustini [19] for food units serving healthy adults. Higher values usually indicate low integration with consumers, namely due to menus with low acceptance, poor sensory characteristics of meals or portions inadequacy. Data obtained in this study reveals that portions served to children are excessive. Food waste was much higher than 10% in all food items and in all menus evaluated.

According to Ricarte et al. it is possible to classify foodservice units according to the amount of food waste. If waste lies between 0-3.0% the service is considered “excellent”, between 3.1-7.5% “good”, between 7.6-10% “acceptable”, higher than 10% “inadequate” [21].

Foodservice in this study was classified as inadequate since all food items determined index values higher than 10%, data in line with results found by Sousa and Sousa in a Brazilian school food unit [25] as well as in Portugal in a study developed by Campos at primary schools with an average waste index of 31% [26].

The majority of children consumed all the soup served, a positive finding, since soup is an important source of fibre, vitamins and minerals [27], [28]. Nevertheless this data must be continuous monitored since it has been observed a tendency for decreasing soup consumption with age [29], [30].

Children wasted unacceptable amounts of meat in the majority of meals evaluated (waste index higher than 10%) [19], [21]. The menu that included minced meat was the one that showed higher acceptance, data in agreement with the study of Pérez-Rodrigo [31].

All meals with fish as protein source showed values of waste higher than 50% and higher than meat menus, which may determine insufficient protein intake [19], [21]. This fact is probably associated with local food habits where fish intake is low [32].

Egg plate waste was lower than meat and fish plate waste. All children consumed more than half of the quantity recommended by Regional Educational Directorate. Our results are in agreement with those found by Cunha [29].

Cunha compared rural (33.6%) and urban (24.0%) populations and also found that pulse intake is low in rural areas [29]. In the study developed by Camelo [30] 25.0% of respondents consumed pulses daily while 13.9% of girls and 12.5% of boys never eat this food item.

Pasta was the side dish with higher acceptance since presenting the lowest waste index, as already found by Camelo [30].

Vegetables were the food group with the highest waste index [33]. The low intake of vegetables has been associated with insufficient intake of vitamins, minerals and fiber and it is also correlated to the increase of obesity [34], [35]. On the study by Camelo [30] 45.6% of girls and 50.1% of boys consumed vegetables at least once a day.

Data from EPIPorto study showed that boiled vegetables are mostly consumed on soup and raw vegetables are mostly consumed as salads, with prevalence of lettuce [36], similar data was found on this study. High waste index of broccoli, cauliflower, and cabbage revealed low acceptability of cooked vegetables. Factors associated with this may be related to food habits, unknown taste and textures, or even inadequate food temperature, frequently associated to food rejection [37], [38].

A high acceptance of all fruit varieties was observed, data in agreement with others [29], [34].

Considering that food quantities served are adequate to children nutritional needs, our results may indicate that these children did not consume enough of nutrients at lunch time.

Nevertheless nutritional evaluation of meals showed that all were high in protein. The abusive intake of protein may present health risks, namely affecting kidney and bones [37].

Some meals evaluated presented an energetic value higher than recommended which may contribute to obesity [23]. Two meals had high fat content, which may be associated to increased risk of cardiovascular disease and also to obesity [32].

A similar study developed in a Portuguese university foodservice also found meals rich in fat, protein and energy and low in carbohydrates [12].

Considering that menus prepared for this study were elaborated based on guidelines for healthy eating stated on an official circular 14/DGIDC/2007 [2] it seems possible to conclude that the high index values of waste found in our study are mainly correlated to nutritional inadequacy of meals and excessive quantities served.

On the other hand, if portions recommended by Ministry of Education are balanced with children nutritional needs, our results indicate that children were insufficiently nourished.

#### V. CONCLUSION

Results obtained showed that portions recommended by Portuguese Ministry of Education are excessive determining considerable amounts of food waste (>10%). Positive findings are related to high intakes of fruit and soup and the main negative findings are related to low intake of fish, vegetables and pulses. School canteens are an integral part of the

academic environment and caretakers must develop strategies during meals to encourage consumption of less appreciated items such as fish, vegetables and pulses.

It will be necessary to adjust portions indicated by Education Ministry in order to comply with recommendations and reduce food waste, as well as helping to control meals cost and contributing to reduce negative impact of organic residues management and the social and environmental impact. Additionally general food waste may be probably significantly reduced by reducing portions, adjusting them to children nutritional needs and at the same time reduce social and environmental negative impacts.

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