

## The celiac disease: risk management in foodservice

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**Summary:** Celiac disease (CD) is one of the most common autoimmune disease that occurs in susceptible individuals after the gluten ingestion, triggering chronic inflammation of the duodenum mucous membrane. In Italy celiac disease it is the most common food intolerance with an estimated prevalence of about 1%, considering both the adults and children category. Currently the only available therapy for celiac disease is the exclusion from the diet of all foods containing gluten and is therefore essential to prevent any contamination. The Italian national legislation (Law no. 123 of 4 July 2005) recognizes celiac disease such as a social disease and prepare interventions for private and public foodservice. Given the importance and spread of CD the Piedmont Region has funded several research projects (in 2013) in collaboration with some Hospital departments (Complex Structure of Aliments Hygiene and Nutrition (SCIAN)), and contributing to the development of a “Projects for the development of the measures implemented by the SCIANs to protect the patients with celiac disease. “. Among the various activities planned in this project there was monitoring of gluten-free meals in the province of Turin (from local health authority called ASL TO5). Specifically, in this study, we verified the canteens of some food service structures, as regards the risk of gluten contamination, during all phases of food processing and preparation (supply, storage, preparation and administration). The analysis and comparison of all monitored structures revealed that school canteens would seem more attentive to the management of the gluten-free meal. Nevertheless, in the canteens of other structures monitored there has been an improvement in the management of the gluten-free meals after the local health authority interventions (ASL TO5), demonstrating the effectiveness of information and education carried out by health staff on the territory.

**Key words:** celiac disease, autoimmune disease, foodservice.

### Introduction

Celiac disease (CD) is a permanent autoimmune food intolerance, whose development determined by a combination of genetic and environmental factors (1). It is defined as a chronic intestinal disease, immune-mediated and induced by the ingestion of gluten, which manifested by various clinical symptoms in genetically susceptible subjects (2, 3).

The immune response that is caused in predisposed individuals after the gluten digestion, in par-

ticular to the gliadin protein fractions (4) and glutenin present in wheat, barley and rye, triggers chronic inflammation of the duodenum mucous membrane: the result is a reduction of the intestinal villous and the development of hyperplastic intestinal crypts, that can lead to the complete villous atrophy (5-9). The critical role played by gluten is demonstrated by the fact that in celiac patients subject to gluten-free diet clinical symptoms of the disease disappear, anti-transglutaminase 2 (serological markers of the disease) are normalized and villous atrophy recedes. As regards, in-

stead, the role of genetic factors, it has been shown that the development of celiac disease is strongly associated with HLA-DQ2 and HLA-DQ8 molecules of class II (MHC) of the major histocompatibility complex (10). In fact, all celiac patients express at least one of these molecules, while in the general population only 30-35% presents the molecules HLA-DQ2 or HLA-DQ8.

Initially considered only as a disease of the gastrointestinal tract, the celiac disease is now recognized as the most common autoimmune conditions and is considered unique among them, because the environmental trigger of the destructive immune response (gluten ingestion) is well known; moreover, for the majority of patients, the removal of such trigger through a gluten-free diet leads to the resolution of the intestinal mucosa damage and prevents complications (11-14). Therefore, the gluten-free diet (GFD), observed rigorously throughout life, it is currently the only therapy available for the treatment of CD. Gluten should be excluded from the diet in an absolute and permanent way, in fact, taking even small amounts of gluten, due to accidental contamination, can cause damage to the celiac (15,16).

The gluten contamination risk in celiac diet is manageable by implementing simple rules that are applied on a daily basis both in industrial production and in the preparation of meals. In particular, the information that is provided to operators involved in the production of foodservice gluten-free are based on risk analysis and procedures for prevention, which are applied in these areas to control allergens and contamination in general (microbiological, chemical, physical) (17,18). As for the gluten, it must be guaranteed the respect of the concentration of below 20 ppm.

## Material and methods

The sample subject of study consists of 70 foodservice canteens that, in the period between October 2013 and August 2014, were evaluated on the structural and management requirements necessary to provide gluten-free meals, and the adequacy of the relative hygienically-healthy self-control plans, commonly called HACCP plans (Hazard Analyses and Critical

Control Points). The audit was carried out with the support of the medical staff of a local health authority called ASL TO5 (in Nichelino city, in Turin Province).

The 70 foodservice canteens, located within the 40 municipalities of ASL TO5 competence, were divided as follows:

- 46 school canteens (66%);
- 20 social assistance center canteens (28%);
- 4 hospitals canteens (6%).

Among the 46 school facilities inspected were present nurseries, kindergartens, primary schools and secondary schools; the social assistance center monitored consisted of nursing homes, retirement homes and day care centers.

The examined structures canteens could be with a cooking center inside, so in this case the meal preparation was done in loco, or the meals were provided by cooking centers outside the structure. In particular, of the 46 school canteens, 16 had the inner cooking center (35%), and in the remaining 30 canteens school the meals were provided by outdoor cooking centers (65%).

Of the 20 examined social assistance center canteens, 15 possessed inner cooking center (75%) and 5 were provided by outdoor cooking centers; finally, of the 4 monitored hospitals canteens, 1 had the inner cooking center, while in the remaining 3 canteens meals were provided by outdoor cooking centers. In all the 70 structures they were made at least two visits by health staff: initial consultation, where it has examined the process of gluten-free meals preparing and serving, and a final verification of the effectiveness of counseling effected (between the first and the second visit is spent at least a month).

## Checklist

For the risk evaluation and categorization of gluten contamination at various stages of the meals dedicated to celiac disease management, during the visits we used a checklist, validated by medical personnel and workplace technicians, and by the dieticians of the Regional Health Service, called "Evaluation Board of gluten-free meal Management." The checklist was used to guide the assessment of all 70 facilities, both during the initial consultation and during the final

verification; therefore, they were collected in total 140 evaluation documents (one initial and one final for each structure).

Each section of the checklist includes closed questions to which it is assigned a grade. The sum of the grades of the individual questions in each section determines a total numerical result that can correspond to three different overall judgment: “inadequate, adequate and good”. Depending on the score achieved for each of the phases of gluten-free meal management, the facilities could fall into three different risk class (Table 1).

The checklist, specifically, is divided into sections that guide the examination of the various phases of the gluten-free meal management:

- **Gluten-free products’ supply** (Table 2): this set of points of the checklist is used to verify that the transport of raw materials takes place in a way that does not create a contamination risk and assessing whether the gluten-free products are suitable and if :

- are placed on the National Register, and are in accordance with Regulation (EC) No. 41/2009 (19);
- are mentioned in the AIC manual (Italian Celiac Association) of Food;
- present the brand Barred Spike.

In this section, an inadequate evaluation corresponds to a score of less than 4, an adequate evaluation corresponds to a score equal to 4 and less than 6, while a score greater than or equal to 6 corresponds to a good judgment.

**Table 1.** Risk categorization

Risk categorisation to assess the proper gluten-free meal management		
LOW RISK when you get a judgment “GOOD”	AVERAGE RISK when you get a judgment “ADEQUATE”	HIGH RISK when you get a judgment “INADEQUATE”

**Table 2.** Section of the checklist used: gluten-free products’ supply.

Gluten-free products supply	SCORE	
1. Transport Purchase of gluten-free products takes place in a way that does not create a risk of contamination?		
- YES	<input type="checkbox"/> (+2)	
- NO		
2. Food derived from flour (bread, pasta and substitutes), are: (see 1 random product)		
- Notified and included on the National Register	<input type="checkbox"/> (+2)	
- Compliance to regulation CE n° 41/2009	<input type="checkbox"/> (+2)	
- Be in the AIC food handbook	<input type="checkbox"/> (+2)	
- Crossed ear of wheat brand	<input type="checkbox"/> (+2)	
a. None of the above	<input type="checkbox"/> (-4)	
3. Risk foods (eg. jams, mayonnaise, chocolate, yogurt and puddings) are: (see 1 random product)		
a. Compliance to regulation CE n° 41/2009	<input type="checkbox"/> (+2)	
b. Be in the AIC food handbook	<input type="checkbox"/> (+2)	
c. Crossed ear of wheat brand	<input type="checkbox"/> (+2)	
d. None of the above	<input type="checkbox"/> (-4)	
4. Salumi are: (see 1 random product)		
a. Compliance to regulation CE n 041/2009	<input type="checkbox"/> (+2)	
b. Be in the AIC food handbook	<input type="checkbox"/> (+2)	
c. Crossed ear of wheat brand	<input type="checkbox"/> (+2)	
d. None of the above	<input type="checkbox"/> (-4)	
	TOTAL	
INADEQUATE <4	ADEQUATE 4	GOOD=0> 6

**Storage** (Table 3): This section of the checklist guide verification that gluten-free foods are stored properly, and are not contaminated with gluten-containing products. For example, it checks the presence for containers, cabinets and pantries dedicated to gluten-free and will assess whether there is a fridge to store exclusively gluten-free foods. In this case, a judgment inadequate corresponds to a score lower than 5, a judgment adequate corresponds to a score equal to 5 and less than 6, and finally a good judgment corresponds to a score equal to or greater than 6.

**Initial analysis of the preparation process** (Table 4): with this section it is evaluated whether the preparation and cooking processes of food are suitable and if are, therefore, minimized the contamination risks. The judgment inadequate is determined by a score less than 7, the judgment adequate by a score equal to 7 and less than 10, and the good judgment by a score equal to or greater than 10.

**Checking tools used for the preparation** (Table 5): This part of the checklist occurs if the work surface, utensils and all equipment used in the gluten-free meals preparation are dedicated or otherwise, if they are cleaned adequately. The judgment inadequate is determined by a score less than 6, judgment adequate corresponds to a score equal to 6 and less than 8, and

finally the good judgment is determined by a score equal to or greater than 8.

**Packaging and transportation** (Table 6): it occurs that the dishes used to trays transport with gluten-free meal are stored separately from the other, or at least away from sources of contamination, and it verifies that the gluten-free meal is properly preserved and transported. In this section an overall score less than 4 determines a judgment inadequate, a score equal to 4 and less than 5 corresponds to a judgment adequate, while a score equal to or greater than 5 results in good judgment.

**Administration** (Table 7): this section helps the exam that all the necessary measures to serve safely the gluten-free meal are applied. For example, it is checked whether the dishes dedicated to gluten-free are stored separately from the others, if the trays for gluten-free are identified, if the gluten-free bread is distributed sealed or kept separately from those with gluten and, still, there is the presence of an oven dedicated to heat gluten-free meals. In this section a score of less than 7 determines an evaluation inadequate, a score equal to 7 and less than 8 corresponds to a rating adequate, while a score equal to or greater than 8 corresponds to a rated good.

**Hygienical-healthy self-control plan** (Table 8): this section helps the exam of the manual for the plan of self sanitation management (HACCP) and if is provided the section dedicated to gluten-free and, there-

**Table 3.** Section of the checklist used to examine the storage phase

STORAGE	SCORE
1. For gluten-free products (bread, pasta, flour, etc...) is available an area or container or cabinet or separate pantry from food with gluten	
YES	<input type="checkbox"/> (+2)
NO	<input type="checkbox"/> (-4)
2. The area or container or cabinet or separate pantry for gluten free products is indicated	
YES	<input type="checkbox"/> (+2)
NO	<input type="checkbox"/> (0)
3. There are a refrigerator/freezer for gluten free products	
YES	<input type="checkbox"/> (+2)
NO but gluten free products are stored in the upper part of the fridge or in a sealed box	<input type="checkbox"/> (+2)
NO and the gluten free products' storage is not safe	<input type="checkbox"/> (-4)
4. Flour with gluten are stored in a way that may be a contamination risk with food that can also be used for gluten-free meal (eg. Oil, peeled tomatoes, etc...)	
YES	<input type="checkbox"/> (-4)
NO	<input type="checkbox"/> (+2)
	TOTAL.
INADEQUATE < 5	ADEQUATE 6
	GOOD > 6

**Table 4.** Section of the checklist used to examine the meals preparation.

PREPARATION PART 1: PROCESS ANALYSIS	SCORE
1 Staff change uniforms or wearing another one on top (also a disposable one), for cover well the uniform below before preparing gluten free meal	
YES	<input type="checkbox"/> (+2)
NO	<input type="checkbox"/> (-4)
2. It's planned hand washing before beginning gluten free preparations	
YES	<input type="checkbox"/> (+2)
NO	<input type="checkbox"/> (-4)
3. Spices and salt are planned for gluten free preparations	
YES	<input type="checkbox"/> (+2)
NO	<input type="checkbox"/> (-4)
4. It may happen that the simultaneous manipulation of food (as flour) with gluten and without gluten in the same working area (nearby)	
YES	<input type="checkbox"/> (-4)
NO	<input type="checkbox"/> (+2)
Not applicable	<input type="checkbox"/> (+2)
5. Preparations with gluten and without gluten are cooked/fried in the same oil	
YES	<input type="checkbox"/> (-4)
NO	<input type="checkbox"/> (+2)
6. During the preparation stuffs and tools are used promiscuously both for gluten meal and gluten free meal (eg. spoon used to turn the pasta with and without gluten)	
YES	<input type="checkbox"/> (-4)
NO	<input type="checkbox"/> (+2)
	TOTAL
INADEQUATE <7	ADEQUATE 7
	GOOD = o > 10

fore, assess whether is considered the contamination risk. Moreover, it occurs if the staff has been trained and, therefore, whether it has took part to education course on the gluten-free cooking. A score less than 4 determines a judgment inadequate, a value equal to 4 and less than 5 corresponds to a judgment adequate and a higher score of 5 corresponds, instead, to a good judgment.

#### *Statistical analysis*

The data obtained in this study were evaluated by the statistical point of view with the Epi Info 4.6 software (Centers for Disease Control and Prevention, Atlanta, Georgia, USA). The variables considered were evaluated using the Fisher's exact test, considering the level of statistical significance at 0.05; for these associations it was evaluated the Odds Ratio and 95% confidence interval.

## **Results**

The data collected were evaluated by analyzing individually the three different types of facilities of public foodservice examined. It was, therefore, possible to analyze, for each group of structures, which were the most problematic steps in the gluten-free meal management and, therefore, in which of the different phases was possible to find canteens with a high risk of gluten contamination. Are be analyzed the data collected through questionnaires, both for the initial consultation and for the final verification.

As for schools (Figure 1) were, first of all, considering the 16 schools canteens with the inner cooking center, in which it was possible to evaluate all phases of the gluten-free meal management. During the initial consultation, in these structures, during storage was a high risk of contamination in 75% of monitored canteens. In addition, it has been found a high risk of

**Table 5.** Section of the checklist used to examine the tools verification.

PREPARATION PART 2: CHECKING TOOLS	SCORE
7. Cookware and tools for gluten free meals are clean/dedicated	
YES they are clean and dedicated	<input type="checkbox"/> (+3)
YES they are clean but not dedicated	<input type="checkbox"/> (+2)
NO	<input type="checkbox"/> (-4)
8. Cookware and tools for gluten free meals are stored away from contamination (gluten)	
YES	<input type="checkbox"/> (+2)
NO	<input type="checkbox"/> (-4)
9. There are "multicooking" baskets use both for gluten and gluten free preparations, in the same production cycle o in the same water	
YES	<input type="checkbox"/> (-4)
NO	<input type="checkbox"/> (+2)
10. There is an oven dedicated for gluten free meal	
YES	<input type="checkbox"/> (+2)
NO	<input type="checkbox"/> (0)
if NO:	
10.1 The cleaning procedure is performed before using tools for the gluten free preparation	
YES	<input type="checkbox"/> (+0.5)
NO	<input type="checkbox"/> (-1)
10.2 Gluten free cooking takes place in cover cookware	
YES	<input type="checkbox"/> (+0.5)
NO	<input type="checkbox"/> (-1)
10.3 Gluten free cooking may takes place at the same time with the gluten cooking	
YES	<input type="checkbox"/> (-2)
NO	<input type="checkbox"/> (+0.5)
11. Kitchen table is dedicated for gluten free meal	
YES it's dedicated and it's sanitized before use	<input type="checkbox"/> (+2)
YES it's dedicated but it's NOT sanitized before use	<input type="checkbox"/> (+1)
It's NOT dedicated and it's always sanitized before use	<input type="checkbox"/> (+1)
It's NOT dedicated e it's not sanitized before use	<input type="checkbox"/> (-4)
	TOTAL
INADEQUATE <6	ADEQUATE 7
	GOOD= > 8

contamination in 6% of canteen for the preparation phase. For the supply phase of gluten-free products was found a medium risk in 32% of the structures.

As for the stages of the meals administration and the self-control plan, are considered the 30 schools where meals were provided by cooking centers outdoor; therefore, for these two phases could be evaluated all 46 school canteens. Specifically, it was found that 22% of the canteens presents a high risk of gluten contamination during the meals administration, while in 52% of the structures was detected a high risk as regards the self-control plan management.

For these same structures were analyzed data collected during the final verification and it was possible to assess whether there had been improvements and, therefore, if the canteen percentage with high contamination risk at various stages was decreased. In particular, in the final verification of the stages of meals storage, preparing and serving there has been an improvement of 100%; in fact, all the facilities that in the initial consultation had obtained a judgment inadequate in these phases, and thus had a high risk of contamination, in the final verification they got a good judgment and, therefore, were part of a low risk of contamination.

**Table 6.** Section of the checklist used to examine the packaging and transportation phases.

PACKAGING AND TRANSPORTATION	SCORE	
1. The cold or hot conservation of gluten-free dishes, takes place in containers/dishes covered		
YES	<input type="checkbox"/> (+2)	
NO	<input type="checkbox"/> (-4)	
Not applicable date	<input type="checkbox"/> (+2)	
2. The dishes for the tray preparation of the gluten-free (dishes, glasses, silverware, napkins, etc...) are stored separately from others		
YES	<input type="checkbox"/> (+2)	
NO	<input type="checkbox"/> (0)	
2.1 If NO, are kept away from contamination sources (eg. breads, flour)		
YES	<input type="checkbox"/> (+2)	
NO	<input type="checkbox"/> (-4)	
3. The gluten-free transport is carried in containers		
Separated	<input type="checkbox"/> (+2)	
Not separated but protected from gluten contamination	<input type="checkbox"/> (+1)	
Not separated and not protected	<input type="checkbox"/> (-4)	
Not applicable date	<input type="checkbox"/> (+2)	
<b>TOTAL</b>		
INADEQUATE <4	ADEQUATE 4	GOOD=0 > 5

tion. They are, however, remained the same structures that had an average risk in the procurement phase, in fact, even in the final verification, the percentage has remained the same at 32%.

The examination of the self-control plan found that the structures that had a high risk increased from 52% in the initial consultation to 22% in the final verification; therefore, even at this stage it was possible to see an improvement in the second inspection (Fig. 1).

As for the social assistance center (Figure 2) were analyzed data on 15 canteens with inner cooking center. In 5 canteens where food were provided by outdoor cooking centers were analyzed only the phases of meals administration and the suitability of the self-control plan. The initial consultation showed that in the 80% of the 15 canteens there is a high risk of gluten contamination during storage phase; furthermore, it has been found a high risk of contamination, as regards the preparation phase, in 40% of canteens examined and it was found a medium risk of contamination in 60% of the structures for the supply phase of the products. As for the stages of meals administration and the conformity of the self-control plan were analyzed data collected for all 20 social assistance centers canteens. In particular, it was found that in 10% of the structures

there is a high risk of contamination during the meals administration phase, while in 85% of the structures there is a high risk of failure of the self-control plan.

There were subsequently analyzed collected questionnaire data during the final verification. The analysis showed that the structures that had a high risk during storage phase it decreased by 80%, in the initial consultation, to 27% in the final verification; those which, instead, they had a high risk in the preparation phase has decreased from 40% to 13%. As for the step of administration there was a net improvement, in fact, also the two structures that had obtained a judgment inadequate in the initial consultation, and therefore presenting a high risk of gluten contamination, in the final verification have then obtained a good judgment. The structures that had a high risk because of the failure of the self-control plan decreased from 85% in the initial consultation, to 80% in the final verification, therefore, there was an improvement not particularly relevant. The structure with an average risk in the supply phase are unchanged; it wasn't, therefore, found for this phase no improvement during the final verification (Fig. 2).

From analysis of data on Hospital canteens (Fig. 3) showed that the only Hospital with the inner cooking center presents a high risk in the preparation phase.

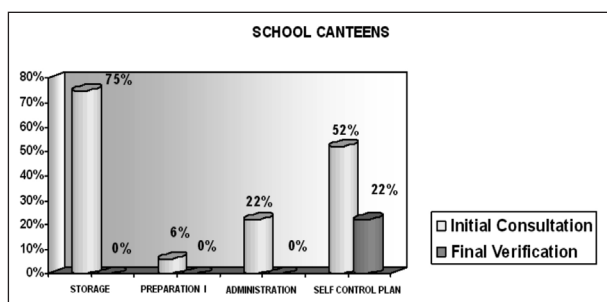
**Table 7.** Section of the checklist used to verify the administration.

ADMINISTRATION (see Regional Classification)	SCORE	
1. For hand-washing, there is a sink in the administration room or in an adjacent room		
YES	<input type="checkbox"/> (+2)	
NO	<input type="checkbox"/> (-4)	
2. The gluten-free dedicated dishes (trays, dishes, glasses, silverware, napkins, etc ...) are stored separately		
YES	<input type="checkbox"/> (+2)	
NO	<input type="checkbox"/> (0)	
If NO, they are kept away from contamination sources (eg. bread)		
YES	<input type="checkbox"/> (+2)	
NO	<input type="checkbox"/> (-4)	
3. The gluten-free bread is distributed sealed / stored separately from those with gluten		
YES	<input type="checkbox"/> (+2)	
NO	<input type="checkbox"/> (-4)	
4. The gluten-free tray/dish is identified		
YES	<input type="checkbox"/> (+2)	
NO	<input type="checkbox"/> (-4)	
5. Is provided the use of an oven to heat the gluten-free dishes		
YES	<input type="checkbox"/> (0) NEUTRAL ANSWER that leads to the question 5.1)	
NO	<input type="checkbox"/> (0) NEUTRAL ANSWER: do not you go on)	
IF YES:		
5.1 There is a dedicated oven to heat the gluten-free dish		
YES	<input type="checkbox"/> (+2)	
NO	<input type="checkbox"/> (0)	
If NO		
5.1.1 It is cleaned before the use for the gluten-free meal		
YES	<input type="checkbox"/> (+0.5)	
NO	<input type="checkbox"/> (-1)	
5.2.1 The heating is done with the gluten-free product covered		
YES	<input type="checkbox"/> (+0.5)	
NO	<input type="checkbox"/> (-1)	
5.3.1 It may be heating simultaneously with gluten-free products		
YES	<input type="checkbox"/> (-2)	
NO	<input type="checkbox"/> (+0.5)	
6. Is provided the "heating oven for temperature maintaining" of the gluten-free dishes (eg. bain-marie, etc.)		
YES	<input type="checkbox"/> (0) NEUTRAL ANSWER that leads to the question 6.1)	
NO	<input type="checkbox"/> (0) NEUTRAL ANSWER: do not you go on)	
If YES,		
6.1 It is kept warm so that there can not be contamination from foods containing gluten		
YES	<input type="checkbox"/> (+2)	
NO	<input type="checkbox"/> (-4)	
	TOTAL	
INADEQUATE <7	ADEQUATE =7 o <8	GOOD=0> 8

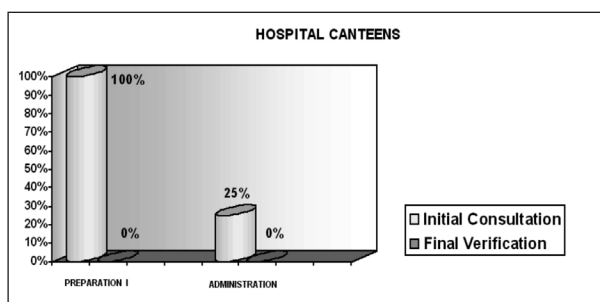


**Table 8.** Section of the checklist used to examine the hygienically-healthy self-control plan.

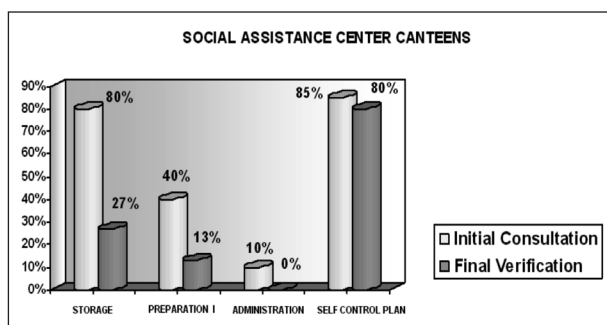
HYGIENICAL-HEALTHY SELF-CONTROL PLAN		SCORE
1. The HACCP manual takes into account the danger "gluten contamination"		
YES		□ (+2)
NO		□ (-4)
2. The HACCP manual is provided the procedure of preparation and / or distribution of gluten-free food		
YES		□ (+2)
NO		□ (-4)
3. The staff has attended education courses on gluten-free cooking		
YES		□ (+2)
NO		□ (-4)
If YES specify the attendance year of last course		
		TOTAL
INADEQUATE <4	ADEQUATE 4	GOOD > 5



**Figure 1.** Percentages of school canteens that fall in the range of high risk of gluten contamination.



**Figure 3.** Percentages of hospital canteens that fall in the range of high risk of gluten contamination



**Figure 2.** Percentages of social assistance center canteens that fall in the range of high risk of gluten contamination

During the final verification, however, the structure also obtained by this phase a good judgment and, therefore, the risk of gluten contamination becomes low.

As for the step of meals administration, considering also the three hospitals canteens when meals were

provided by outdoor cooking centers, it was found a judgment inadequate and, therefore, a high risk of contamination in a canteen in four. Questionnaires relating to final assessment showed that, for both the preparation phase and meals administration the structures that had obtained a negative result in the initial consultation have reached a good judgment at the moment of final verification. Therefore, there has been an improvement of 100%, since all structures that had a high risk of gluten contamination in the initial consultation have passed, then, to record a low risk.

It was then assessed which of the three types of foodservice structures examined was the one with the most critical at various stages of the gluten-free meal management, and if the associations found were statistically significant, or rather due to chance. The comparison with the hospital canteens was not con-

sidered given the low number of structures involved. Comparing the different operating phases examined in schools and social assistance centers showed that:

- For the storage phase the OR is 1.08 ( $p > 0.05$ );
- For the preparation phase the OR is 0.16 ( $p < 0.05$ );
- For the administering phase the OR is 2.50 ( $p > 0.05$ );
- For the analysis of the conformity of the self-control plan the OR is 0.61 ( $p < 0.05$ ).

## Discussion

The study aimed to assess, for each of the three types of structures, how many canteens have some critical point and, therefore, fall within the range of high risk for the different stages of the gluten-free meals management. It is therefore wanted to compare the results obtained from at least two audits to the three different groups of structures, with the aim of highlighting which of them proves more problematic and less attentive to the protection of the celiac health, and at what phase (20, 21).

In the initial consultation carried out in school canteens and those of social assistance centers, critical phases were found to be those of meals storage, preparation, administration and the self-control plan; hospitals canteens resulted in two critical phases, namely that of the preparation and the administration. We were then analyzed data on final verification, conducted after the consultation of the Health Service, for the three different groups of structures. In the schools the storage, preparation and administration phases no longer be critical, in fact no structure falls within the range of high risk, there was a 100% improvement, going from high to low risk of contamination. There remains critical the self-control plan management for which there is, however, a good improvement; the percentage of structures that fall in the band of high risk reduced from 52% to 22%.

In the social assistance canteens, however, during final verification, the storage and preparation phase and that of the plan of self-control, are still critical, although it can still see an improvement. Specifically pass to have a low risk of contamination, in the storage 67% of the structures, and in the preparation

phase 2/3 of the structures (67%). Instead, examination of the conformity of the self-control plan, the percentage of facilities that improve is only 6%. This analysis shows that school canteens than those of social assistance centers would seem less problematic in relation to the gluten-free meals management, and also seems to have responded better to the intervention carried out by ASL, because in the final verification the improvements in school facilities are more important than those obtained from social assistance centers. These differences may be related to increased attention that is given in schools to protect the health of children and young people with celiac disease, mainly due to the interest of teachers and parents.

Later, it was conducted a statistical analysis of the data starting from the frequencies of schools and social assistance centers that were within the range of high risk of contamination. The comparison with hospitals was not considered given the low number of hospitals examined. The analysis made it possible to determine whether, in the individual phases considered, the observed differences were due to chance or if it was, however, possible to identify a statistically significant association.

The comparison has been made possible to highlight some statistically significant associations. In particular, in the preparation phase, the statistical analysis of the data showed that schools are less likely to record non-compliance in relation to the gluten-free meals management respect the social assistance centers (OR = 0.16  $p$ -value  $< 0.05$ ). Even for the relative phase of the plan of self-control examination showed that school canteens are less likely to record non-compliance with the social assistance center canteens (OR = 0.61,  $p$ -value  $< 0.05$ ). For the storage phase, however, it was not possible to find any statistically significant association (OR = 1.8,  $p$ -value  $> 0.05$ ). Finally, as regards the phase of administration, the only one in which schools have shown more critical point respect to the social assistance centers, statistical analysis allowed to highlight only a trend of association which is not found to be statistically significant (OR = 2.17,  $p$ -value  $> 0.05$ ).

The training took place on the territory by medical staff, prevention technicians, and dieticians from the Regional Health Service to teachers and restaura-

teurs have improved the management of the gluten-free meals in all the structures involved in the project.

The study conducted, finally, allowed to emerge on which aspects of such structures, in particular, it will be necessary to act in the future with other preventive intervention even more targeted, in order to control and reduce, as much as possible, the risk of gluten contamination and optimize, therefore, the services available to celiac patients, protecting in this way the health (22, 23).

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