

FOOD SERVICE OPERATORS BEHAVIOR AND KNOWLEDGE ON GLUTEN-FREE MEALS AND REQUIREMENTS OF PUBLIC CANTEENS

M. TAMBURRO¹, M.L. SAMMARCO¹, L. DI ELEONORA² and G. RIPABELLI^{*1}

¹Department of Medicine and Health Sciences "Vincenzo Tiberio", University of Molise, Campobasso, Italy

²Food and Nutrition Hygiene Unit, Local Health Institution Umbria n. 2, Umbria region, Terni, Italy

*Corresponding author: ripab@unimol.it

ABSTRACT

This study provides a summary of Celiac Disease (CD) epidemiology in Italy, canteens distribution and training courses for food service operators (FSOs) analyzing 2007-2017 data. Furthermore, behavior and knowledge of FSOs and organizational requirements for gluten-free (GF) meals in school and hospital canteens in central Italy were investigated. In parallel to an increased CD occurrence at national level, GF foods demand is significantly growing. Our survey in 20 inspected canteens revealed important knowledge and awareness gaps among FSOs, as well as lack of procedures and structural requirements for safely providing GF meals, underlining the need to improve education on topic.

Keywords: celiac people, central Italy, gluten contamination, public food supply, food preparation, training

1. INTRODUCTION

Celiac Disease (CD) is a chronic small intestinal immune-mediated enteropathy with a spectrum of disorders related to the trigger of gluten ingestion in susceptible individuals (GULINO *et al.*, 2016; DEGEORGE *et al.*, 2017; LEBWOHL *et al.*, 2018). Generally, CD clinical presentation encompasses classic gastrointestinal or malabsorption symptoms, such as chronic diarrhea, weight loss, bloating, flatulence, and abdominal pain (LUDVIGSSON *et al.*, 2013; DOWNEY *et al.*, 2015; ELLI *et al.*, 2015). Because of the most recent epidemiological shift, non-classical symptoms are becoming frequent either in childhood or in adulthood, and commonly include iron deficiency anemia, abnormal liver functions, bone disease, and skin disorders (RUBIO-TAPIA *et al.*, 2013; LEBWOHL *et al.*, 2018).

During the latest 10 years, CD has become a significant public health concern globally (SAPONE *et al.*, 2012; SINGH *et al.*, 2018), primarily involving the areas of the world characterized by high wheat consumption. A recent meta-analysis estimated a pooled global CD seroprevalence and biopsy-confirmed CD prevalence of 1.4% and 0.7%, respectively, with the highest prevalence in Europe (0.8%) and Oceania (0.8%), and the least in South America (0.4%) (SINGH *et al.*, 2018). Furthermore, biopsy-confirmed CD prevalence was reported to be 1.5 times more common in females than in males, and approximately twice more common in children than in adults (SINGH *et al.*, 2018).

The high CD prevalence has been mostly associated to the widespread consumption of gluten containing cereals, and to occurrence of Human Leucocyte Antigen (*HLA*) *DQ2* and *HLA DQ8* predisposing alleles in the global population, ranging 0-28% and 1-9%, respectively (LIONETTI and CATASSI, 2014). Although both required, these factors are not sufficient for clinical CD development, since only 30% of subjects eventually develop the disease (LIONETTI *et al.*, 2015). CD almost affects about 1% of the European population (RUBIO-TAPIA *et al.*, 2012; CHOUNG *et al.*, 2017), even though a large proportion of undiagnosed and consequently untreated subjects has been estimated (ELLI *et al.*, 2015). Furthermore, there are huge differences in CD prevalence that could be not explained only by genetic and environmental risk factors. For example, Germany has the lowest CD prevalence than other European countries, whilst Sweden and Finland the highest (MUSTALAHTI *et al.*, 2010).

In Italy, the revision of the “Essential Levels of Care” (Italian Ministerial Decree 12/01/2017) involved the shift of CD and its clinical variant of dermatitis herpetiformis in the list of chronic disabling diseases. The transition was considered as necessary because both clinical forms could not be longer included within the prevalence limits of the rare diseases established below 5/10,000 inhabitants at European level.

Furthermore, the Italian Law n. 123/2005 on “Rules for the protection of CD people” has recognized CD as a social disease and promoted adoption of measures for these patients (Legge 4 luglio 2005, n. 123; CAPUOZZO *et al.*, 2013). Indeed, the National Government assigns annually dedicated resources to the Regions, and authorizes public money spending for gluten-free (GF) meals distribution in the school, hospital and public canteens, as well as for professional training for food service operators (FSOs). In particular, according to the Law 123/2005, school (public and private) and hospital (public and private hospitals, hospices and public nursing homes, institutional care and private nursing homes) canteens, as well as those attached to public facilities (public institutes and administrations) must guarantee GF meals for CD people who request it.

At present, a balanced GF diet based on the combination of naturally and certified processed GF food represents the only effective treatment for celiac people (LA VIEILLE *et*

al., 2014; GULINO *et al.*, 2016; BASCUÑÁN *et al.*, 2017), providing a rapid improvement and resolution of symptoms.

Although the effectiveness of gluten sources elimination in an absolute and permanent way is proved, numerous difficulties could affect a complete adherence to GF diet, including costs of GF food, variable quality of information regarding the status of ingredients, and potential gluten exposure when travelling or eating out (BARRATT *et al.*, 2011; RUBIO-TAPIA *et al.*, 2013). The threshold below which gluten is safe is unknown; however, the available evidences advised that exposure to less than 10 mg/day is unlikely to cause histological changes to the intestinal mucosa for CD individuals (BOLD and ROSTAMI, 2011; LA VIEILLE *et al.*, 2014, 2016). Indeed, according to the international food standards Codex Alimentarius, gluten level in GF food may not exceed 20 parts per million (ppm), which corresponds to 20 milligrams of gluten per kilogram, or per liter of product (RUBIO-TAPIA *et al.*, 2013; FARAGE *et al.*, 2017a; Standards CODEX ALIMENTARIUS FAO-WHO; EU law-EUR-Lex). Of concern, it should be considered that cross-contamination could frequently occur when GF food come in contact with gluten-containing grains and their derivatives during any stage of food preparation process, or if the same equipment/utensils handling food products or surfaces are used (KOERNER *et al.*, 2011; FARAGE *et al.*, 2017a; ROSTAMI *et al.*, 2017; VERMA *et al.*, 2017).

Therefore, avoiding cross-contamination during meals preparation, especially in restaurants and public canteens, is the key factor to ensure the quality of GF food for CD people. However, having a meal out could represent a serious risk concern when there is a lack of knowledge regarding GF food by the staff involved (FARAGE *et al.*, 2014). In order to contribute to a better quality of life for CD patients, it is important to establish effective strategies to prevent contamination and enable safe production of GF food (FARAGE *et al.*, 2017a). These perspectives clearly include the development of appropriate instruments or approaches for verification *in loco* of non-conformities related to the potential cross-contamination in the production process (FARAGE *et al.*, 2017b), and the improvement of professional training, being awareness of CD related issues among chefs and cooks highly dependent by the education level (SCHULTZ *et al.*, 2017).

This study aims to describe the state of the art and the epidemiological background regarding CD occurrence in Italy, as well as an overview of the public canteens administrating GF meals and training on this issue by examining all available data at national level. Furthermore, the results of a survey conducted among FSOs of hospital and school canteens in Terni province, Umbria region, central Italy, are reported. In particular, the investigation explored about FSOs knowledge and behaviors related to CD issues, as well as on the structural and organizational requirements for GF meals preparation and administration, and measures developed and in place established to minimize the likelihood of gluten contamination.

2. METHODS

2.1. Epidemiological data on CD, canteens mapping and training

In Italy, the General Directorate for Hygiene and Food Safety and Nutrition of the Ministry of Health releases an annual census to the Parliament on CD (www.salute.gov.it/portale/documentazione/). By searching in the thematic area of "Nutrition" and the publication years, annual reports to the Parliament on CD items were available since 2007. Indeed, data on CD prevalence, distribution of public canteens

involved in GF meals administration, and specific training for FSOs in relation to 2007-2017 reference period were pooled and analyzed (GUIDARELLI *et al.*, 2008, 2009, 2010; DE STEFANO and SILANO, 2011, 2012, 2016, 2018, 2019; DE STEFANO *et al.*, 2015, 2016).

2.2. Setting of the survey involving FSOs

The survey involved 20 public canteens located in Terni province, Umbria region, central Italy. Particularly, 14 nursery school, 4 primary school and 2 hospital canteens were included, being involved in the production and/or administration and/or sale of GF products to consumers at time of the study. The canteens were inspected by Technicians of the prevention in the environment and the workplace of the Food and Nutrition Hygiene Unit, Department of Prevention of Umbria region, Local Health Institution n. 2.

2.3. Survey tools for data collection

Data were collected during the regular inspection activities using two different approaches, an interview and a checklist, which were both administered to 20 FSOs (one for each inspected canteen) in charge of the entire food processing. Hence, FSOs were *face-to-face* interviewed by Technicians to ascertain their knowledge about CD and gluten-related aspects and their behavior for the control of gluten contamination risk. Similarly, a checklist was completed by FSOs to verify the structural and organizational requirements for GF food preparation and administration.

In details, the interview was structured in two sections concerning knowledge and behavior. The knowledge section was composed of five questions concerning general and theoretical aspects on CD, particularly referring to food permitted and forbidden (list of 20 food types) in the diet for celiacs, and specific precautions. The section referred to behavior was structured in seven questions in order to investigate about their attitudes in the management and control of the entire GF food processing. In particular, the checklist was structured into six areas, reflecting different stages of GF food production, preparation and administration to verify the compliance with procedural, structural and organizational requirements for control of gluten contamination risk. Hence, the checklist included 24 questions concerning Hazard Analysis and Critical Control Points (HACCP) plan; purchase and storage of raw food materials and available equipment (control procedures for raw ingredients; storage and equipment/utensils for food preparation and manipulation); food preparation and cooking (areas, practices, equipment); food administration; staff hygiene and procedures (clothing); personnel training (food hygiene and CD issues).

2.4. Data analysis

CD prevalence, public canteens involved in GF meals administration, and specific courses for FSOs obtained by reports to Italian Parliament from 2007 to 2017 were analyzed in terms of temporal trend, and through descriptive statistics (mean \pm standard deviation and median encompassing all the reference period).

The overall data from the interview and checklist were collected and analyzed using Statistical Package for Social Science (SPSS) software version 25.0. To each item from both the interview and the checklist, 1-point level was assigned when a correct answer was provided, whilst 0-point if FSOs erroneously or not answered.

Therefore, results from the interview were evaluated compared to the maximum achievable score of 31, comprised of 24 plus 7-points of knowledge and behavior questionnaire sections, respectively, while the score for checklist varied between 0 and 23-points.

3. RESULTS

3.1. CD prevalence, GF meals canteens and training courses, Italy, 2007-2017

In Italy, according to the last epidemiological mapping and 2017 annual census on CD by Ministry of Health, 206,561 celiacs have been diagnosed, for a mean prevalence of 0.34% (DE STEFANO and SILANO, 2019), with a percentage increment of 4.1% compared to the previous year (Fig. 1). From 2007 to 2017, a steady increase of the number of diagnosed cases was observed (mean number of CD subjects= $144,389 \pm 46,330$ (SD), median= $148,662$), which along the whole period corresponded to +220.8% increase of diagnoses, ranging from 64,398 in 2007 to 206,561 cases in 2017 (Fig. 1). During 10 years, the highest variation occurred between 2007 and 2008 (+27.2%), and between 2008 and 2009 (+34.9%), while lowest variations were found in the most recent years (Fig. 1), although with a high number of new diagnoses. Additionally, two third of CD population were females (145,759 *vs* 60,802 males) with a 1M:2F mean proportion (DE STEFANO and SILANO, 2019), and this trend has been constantly observed in the last decade (Fig. 2). During 2007-2017 period, CD cases were on average $98,849 \pm 35,771$ (median= $104,334$ cases; range: 35,017-145,759) among females, and $42,017 \pm 14,479$ (median= $44,253$ cases; range: 16,239-60,802) among males, respectively.

The age group in which CD was prevalently registered corresponded to 19-40 years with 71,371 individuals (34.5%) (DE STEFANO and SILANO, 2019).

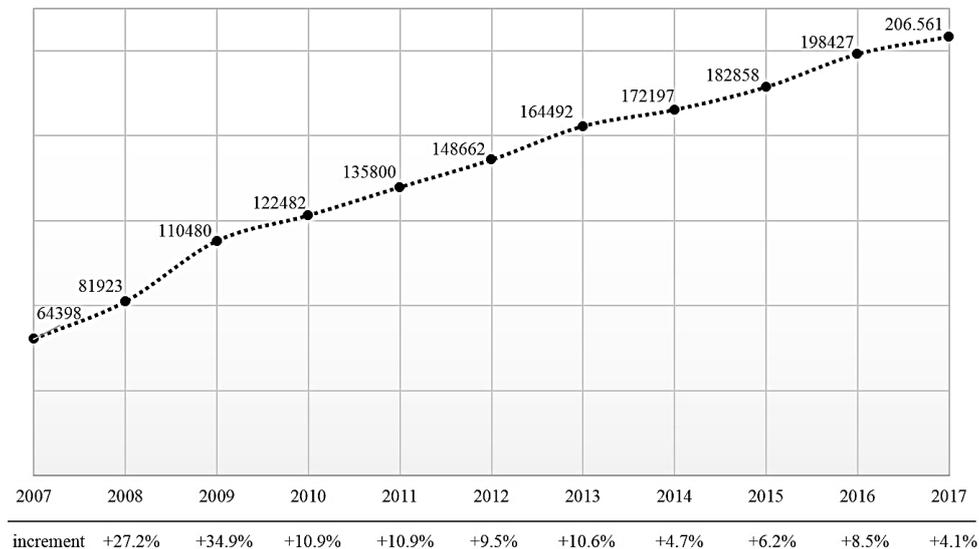


Figure 1. Number of CD cases, Italy, 2007-2017.

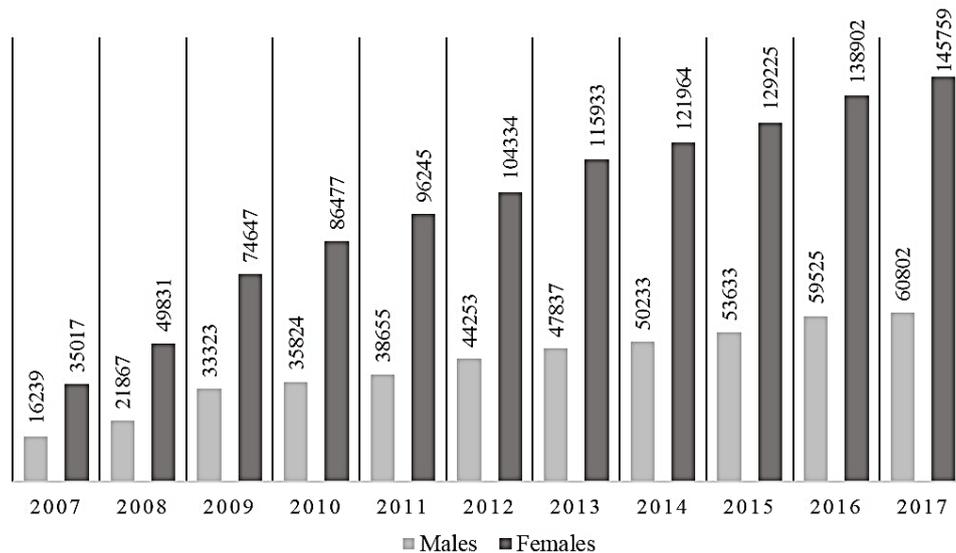


Figure 2. Number of CD cases stratified by gender, Italy, 2007-2017.

In 2017, the National Health Service has provided an amount of 320,111.59€ to the Italian Regions in order to guarantee GF food and 534,427.43€ for training courses to FSOs (DE STEFANO and SILANO, 2019). To support GF diet, almost 250 million euros have been spent for GF products, with an annual national average of 1,200.00€ per capita (DE STEFANO and SILANO, 2019).

Data from the regional registry offices in 2017 reported that 42,814 canteens covered the scope of Law 123/2005: 28,718 (67%) were school, 7,997 (19%) hospital and 6,099 (14%) of public organizations. During 2007-2017, a significant increase of the number of canteens was observed (mean±SD=39,761±3,040; median=39,110), with the highest prevalence of school canteens in the national territory (Fig. 3) (DE STEFANO and SILANO, 2019). In the overall period, school, public and hospital canteens were 28,103±1,704 (median=28,248; range: 24,693-30,810), 7,029±1,778 (median=6,410; range: 6,032-9,301), and 4,506±2,031 (median=3,823; range: 4,320-9,301), respectively.

From 2017 data, 755 specific training courses with an average of 5 hours for each course were activated (Fig. 4) in the national territory, involving 19,068 FSOs.

Since 2017, the number of courses was increased compared to the latest two years. In the whole period, on average, 669±362 (median=645) specific courses were managed, involving 15,120±5,403 (median=15,968) FSOs, with high participation since 2010.

3.2. Interview to FSOs

Among various listed food, all FSOs demonstrated to know that bread, pasta and cutlet are forbidden food in the diet for CD individuals, whilst 15% (n=3) and 20% (n=4) erroneously answered that cookies and barley coffee can be consumed, respectively (Fig. 5).

Other permitted food categories in the diet for celiacs were correctly identified, such as cooked vegetables, olive oil, tomato paste, eggs, meat, fish, sugar, honey, and coffee. Conversely, only 80% (n=16), 85% (n=17), and 55% (n=11) knew that consumption of milk, rice and strawberries are allowed in GF diet, respectively. In addition, raw ham was

improperly considered as forbidden in CD diet by 25% (n=5), as well as natural yoghurt (without cereals) and butter by 15% (n=3) and 10% (n=2), respectively (Fig. 5).

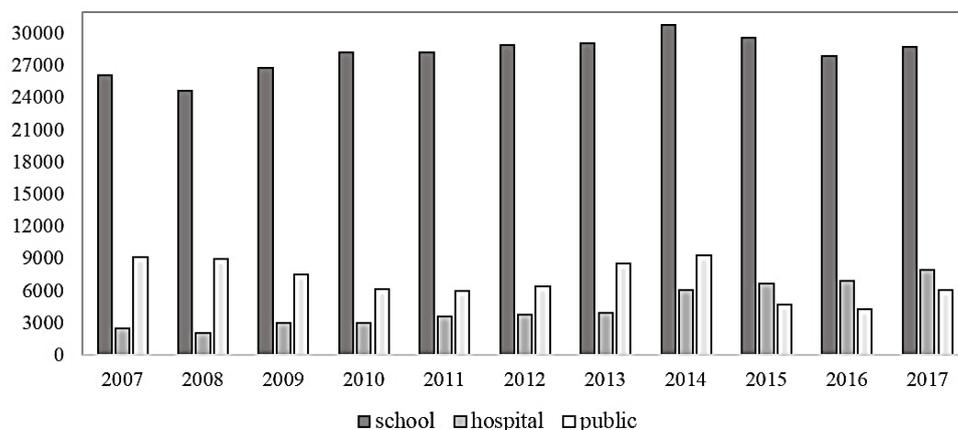


Figure 3. Number of school, hospital and public canteens administering GF food, Italy, 2007-2017.

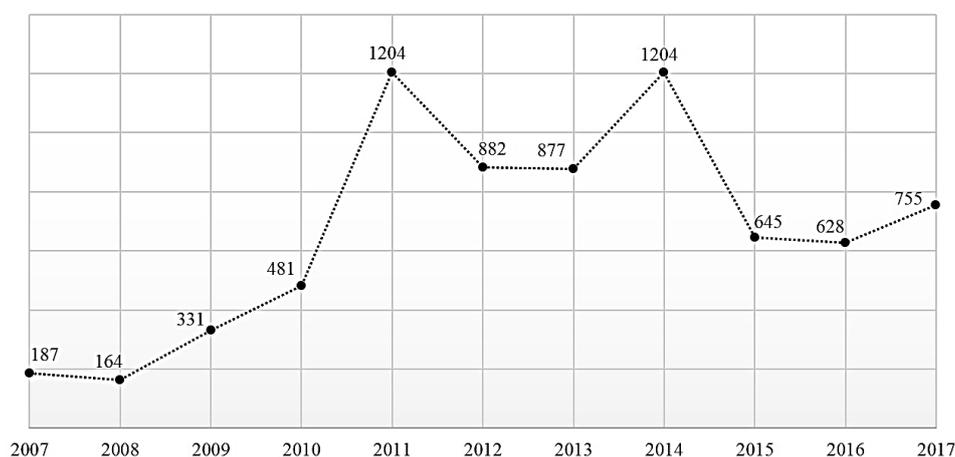


Figure 4. Courses on CD and GF food for FSOs, Italy, 2007-2017.

Furthermore, 30% (n=6) erroneously stated that CD patients can introduce small amounts of gluten with diet, and only 75% (n=15) proved to be aware that gluten is not removed by cooking foods (Table 1).

About management and control of gluten contamination risk in food preparation and administration, 20% (n=4) of FSOs did not know that GF food should be stored in clearly identified and separated areas.

Furthermore, GF food preparation should occur in a well-identified area and separated kitchen for 30% (n=6). Only 25% (n=5) of FSOs knew that equipment (i.e. oven, deep fryer, plates, etc.) and utensils (i.e. cookware, tableware, etc.) should be used exclusively for GF food preparation (Table 1).

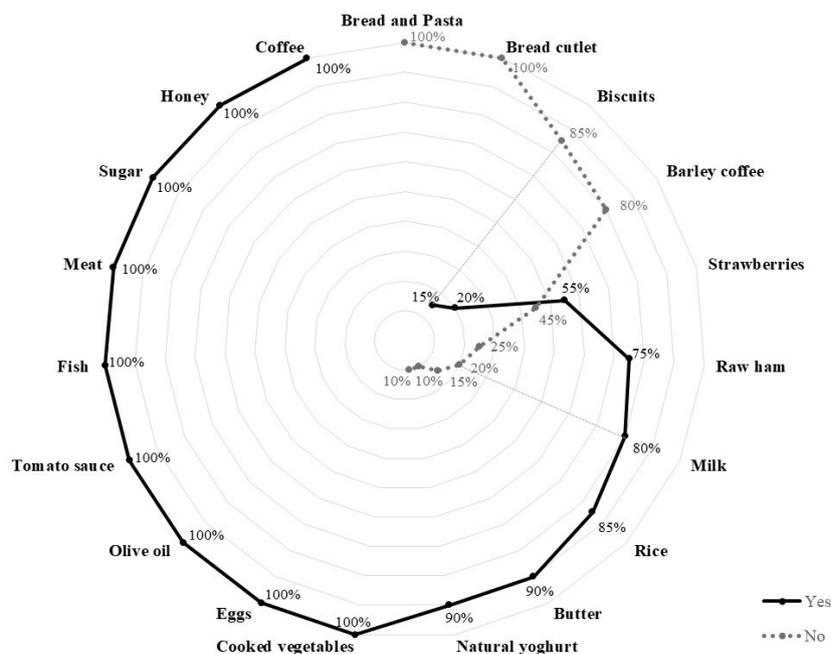


Figure 5. Are the following food categories permitted in the diet for CD individuals?

All FSOs demonstrated to know that, if lacking a double equipment for celiac and non-celiac people, it is a prerequisite to separate their use in time, ensuring satisfactory cleaning conditions prior to use. All FSOs proved to be aware that hand washing and control of clothing are measures highly required in the meal service, as well as the proper identification of dishes for CD consumers to avoid a promiscuous service. However, a special coat when preparing GF meals should be used by 30% (n=6) of FSOs (Table 1). Based on the answers provided, only 6 (30%) FSOs scored 24-points being the maximum level of knowledge, while the remaining scored 18-23-points. Regarding skills related to GF meals, the maximum level was reached only for two FSOs, while the remaining ranged as 4-6, and more often (65%) with a 5-points score. Largely, the inadequate response was related to the equipment dedicated for GF food because considered unnecessary. By pooling data, none of the FSOs had the ideal level (maximum score=31) of knowledge and behavior, and only eight showed a quasi-optimal score reaching 28-30-points, while the remaining scored in the intermediate range of 23-26-points.

3.3. Requirements for GF meals processing resulting from checklist

With respect to HACCP plan implemented in the inspected canteens, there was a specific section on gluten and management of critical control points (CCPs) to minimize and control the risk of accidental and/or cross-contamination only for 40% (n=8) (Table 2). Furthermore, there was no opportunity to appreciate the presence, in paper form or on-line, of the handbook of the Italian association for celiacs in 55% (n=11) of canteens. Before storage, control procedure for raw materials, semi-finished and finished food products at the reception were not available in 45% (n=9), and no specific procedure for non-conforming food was found in 60% (n=12) (Table 2).

Table 1. Knowledge on CD and GF food as reported by 20 FSOs through the interview.

Items	Correct answer	Yes N (%)	No N (%)
• CD subjects could introduce small amounts of gluten with diet	No	6 (30.0)	14 (70.0)
• Gluten is removed by cooking foods	No	5 (25.0)	15 (75.0)
• GF food must be provided by the consumers	No	4 (20.0)	16 (80.0)
• GF food should be stored in a separate and well identified area	Yes	16 (80.0)	4 (20.0)
• Preparation of GF meals must take place in a separate and well identified area	Yes	6 (30.0)	14 (70.0)
• Equipment and utensils must be dedicated for GF food preparation	Yes	5 (25.0)	15 (75.0)
• It is necessary prior sanitation and time differentiation when a double equipment is not available	Yes	20 (100)	0
• A dedicated coat should be used when preparing for CD subjects	Yes	14 (70.0)	6 (30.0)
• Hand washing and control of uniform must be regularly performed in food administration	Yes	20 (100)	0
• GF meals must be clearly identified to avoid promiscuous service	Yes	20 (100)	0

Table 2. Checklist on procedural, structural and hygienic requirements in GF meals preparation and administration.

Items	Correct answer	Yes N (%)	No N (%)
• A section for GF products is included in the HACCP plan	Yes	8 (40.0)	12 (60.0)
• In place availability of the Italian booklet of association for celiacs	Yes	9 (45.0)	11 (55.0)
• The control of any raw materials, semi-finished and finished products is performed before storage	Yes	11 (55.0)	9 (45.0)
• There is a procedure for discarding non-conforming products	Yes	8 (40.0)	12 (60.0)
• GF raw materials are stored in separate areas and in identifiable shelves	Yes	20 (100)	0
• GF food are stored in closed and identifiable containers	Yes	20 (100)	0
• GF food are identified and placed in separate containers in the fridge/freezer	Yes	13 (65.0)	7 (35.0)
• The storage of GF products takes place in a dedicated fridge/freezer	Yes	4 (20.0)	16 (80.0)
• There is a separate room/area for preparing GF food	Yes	4 (20.0)	16 (80.0)
• A temporal differentiation with previous sanitization is performed if a separate zone for GF food is not available	Yes	16 (80.0)	4 (20.0)
• A sanitation areas procedure is available	Yes	5 (25.0)	15 (75.0)
• The registration of the sanitization control is carried out	Yes	5 (25.0)	15 (75.0)
• There are equipment, tools and utensils dedicated for meals for CD people	Yes	4 (20.0)	16 (80.0)
• A temporal differentiation is performed with previous sanitation if utensils are used for gluten-containing foods	Yes	4 (20.0)	16 (80.0)
• There is a procedure for the sanitization of equipment and tools	Yes	5 (25.0)	15 (75.0)
• Presence of washbasins	Yes	7 (35.0)	13 (65.0)
• Hand washing and clothing control are regularly carried out	Yes	16 (80.0)	4 (20.0)
• The identification of the dishes for CD people and non-promiscuous service are always performed	Yes	19 (95.0)	1 (5.0)
• There is dedicated clothing that is placed in exclusive rooms	Yes	2 (10.0)	18 (90.0)
• A clothing and hygiene procedure for personnel is available	Yes	12 (60.0)	8 (40.0)
• A specific training on CD and related issues is regularly performed	Yes	11 (55.0)	9 (45.0)

Storage activities of GF raw materials were carried out in separate areas and in special shelves, as well as GF food preserved in closed and identifiable containers. However, well-defined local or area for preparing GF food, or utensils/equipment dedicated were not available for 80% (n=16) of the canteens, although a time differentiation for their use was performed, with prior sanitization (Table 2). Similarly, a fridge or freezer exclusively dedicated to store perishable GF food was not found in 80% (n=16) of canteens, although a separation from gluten-containing products was ensured in the 65% (n=13) of cases.

When locals and equipment/tools were shared and used for both GF and non-GF foods, a formal registration of the sanitation procedure before use was not present for 75% (n=15) of the facilities. Furthermore, 20% (n=4) of FSOs declared to do not regularly practice hand washing and control of the uniform in food administration, and 5% (n=1) stated to do not identify meals/dishes intended or not intended for CD consumers (Table 2).

Assessing hygienic practices and training, 90% (n=18) did not comply with the requirements of clothes dedicated for GF food and retained in distinct cabinets. Furthermore, 60% (n=12) did not have a formalized procedure on management of staff clothing, and washbasins were present in the 35% (n=7). At time of the inspection, 45% (n=9) of FSOs have not attended a certified training course on CD and issues related to GF preparation and administration (Table 2).

Based on the responses provided for the checklist, the score ranged between 6 and 19 (ideal score=23), and the majority scored 17 (n=4, 20%), followed by 10 and 7 (each n=3, 15%).

4. CONCLUSION

Health protection of CD individuals is an important goal, especially for most sensitive categories, such as children, patients admitted at hospitals, and people of school age who represent a vulnerable young-adult group (FORLEO *et al.*, 2017; TAMBURRO *et al.*, 2017). In this study, results from 20 FSOs revealed knowledge gaps on the basic and general theories about CD, as well as the lack of best practices for control risk of gluten contamination. Part of FSOs was not aware that consumption of some products could lead to high risk, while other naturally GF food were erroneously considered as forbidden. Similar findings were found in other studies (KARAJEH *et al.*, 2005; YOUNG and THAIVALAPPIL, 2018), reporting that food service personnel were less knowledgeable on CD than general population, underlining a paucity of tailored education that should be addressed through specific training. Furthermore, concerns emerged about the beliefs of some FSOs that CD subjects can introduce small amounts of gluten with diet that, however, it should not exceed 20 mg/kg (Regulation (EU) No 609/2013). Moreover, the protracted intake of products contaminated with gluten traces may cause persistent intestinal damage and symptoms in non-responsive CD patients, who fail to ever respond to GF diet, or have recurrence/relapse of symptoms despite the GF diet (HOLLON *et al.*, 2013).

While FSOs were aware of the importance to use equipment and utensils in different time for GF and gluten-containing food, inappropriate behaviors were observed for special coat in GF meals preparation. In fact, although kitchen equipment and utensils used for gluten-containing foods may not pose a high risk for CD patients, cross-contamination during food preparation or cooking can occur, and it should be avoided cleaning utensils, and washing hands/surfaces regularly (STUDERUS *et al.*, 2018).

The complete removal of gluten from diet is difficult, being a pervasive nutrient that may contaminate GF products along the production chain (LEE *et al.*, 2014). Recently, a systematic review on cross-contamination from gluten higher than 20 ppm in GF food in Europe (FALCOMER *et al.*, 2018) has revealed percentages of contamination ranging from 10%-13% in the United Kingdom and Sweden (STORSRUD *et al.*, 2003; MCINTOSH *et al.*, 2011) to 56%-70% in Finland and Spain (COLLIN *et al.*, 2004; HERNANDO *et al.*, 2008). One study conducted in Italy did not report gluten contamination among GF foods tested (MANFREDI *et al.*, 2015). Quantification of gluten is difficult, being a combination of different components (microheterogeneity) classified as gliadins, glutenins, globulins and albumins, whose measure is unpractical (VERMA *et al.*, 2017), especially in processed foods (DIAZ-AMIGO and POPPING, 2012). Nonetheless, several approaches for detecting gluten proteins are available, such as immunological tests mainly through ELISA kits, proteomic analysis with mass spectrometry, and DNA-based methods applying Polymerase Chain Reaction (HARASZI *et al.*, 2011). However, none of these methods is considered universally acceptable for a high sensitive detection, showing each technology advantages and disadvantages (SLOT *et al.*, 2016).

Our results from checklist showed a non-optimal compliance with structural and procedural requirements for warranting food safety value to CD subjects, as well as a lack of adherence to hygiene principles and in relation to a continuing education on GF diet, indicating that targeted and effective interventions are necessary. Like our survey, a retrospective study analyzing characteristics of the GF food chain in a school service in an Italian Region (BIOLETTI *et al.*, 2016) reported that 71% of sampled schools were inadequate for at least one of the production stages. Certainly, food separation for CD people has to be handled in order to reduce the chance of cross-contamination. At present, it is managed as strictly as for allergic subjects, and whether this approach is necessary remains to be tested in prospective studies. The same oven for gluten-containing and GF food can be used, as long as the two types are not baked at the same time (BIANCHI *et al.*, 2018); when specific requirements are complied, also the simultaneous cooking can be a safe procedure (VINCENTINI *et al.*, 2016).

Nearly half of recruited FSOs in our survey has not attended a training course on CD and related issues, similarly to another study reporting that half of chefs had not received formal training (SCHULTZ *et al.*, 2017). Indeed, a comprehensive and specialized training has been recommended for FSOs (LEE and XU, 2015; SHAFIE and AZMAN, 2015; RADKE *et al.*, 2016), and interventions to improve knowledge and practice of food service personnel should be implemented (YOUNG and THAIVALAPPIL, 2018). Moreover, to meet GF food quality specifications, compliance with basic food safety concepts at all stages of product life cycle is decisive for ensuring harmless foods for celiacs (BIOLETTI *et al.*, 2016), as well as appropriateness of a HACCP plan (PETRUZZELLI *et al.*, 2014).

In conclusion, our study remark the need to provide effective education and proper resources for food service establishment personnel to gain knowledge and strengthen awareness on GF foods, and improve or enhance practical skills, attending courses conceived to assess their ability for safely serving celiac consumers. In addition, good manufacturing practices have a positive effect on GF foods production, and are useful to identify priority areas for improving comprehension of CD issues and practices among FSOs, to prevent accidental gluten exposure. Although additional studies are needed to better estimate the likelihood of gluten cross-contamination in food service establishments and industries, it should be underlined that risk can be controlled implementing simple rules applied on a daily basis in both meals preparation and administration.

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