



Disponible en ligne sur
ScienceDirect
www.sciencedirect.com

Elsevier Masson France
EM|consulte
www.em-consulte.com

REVUE FRANÇAISE
D'**Allergologie**

Revue française d'allergologie xxx (2017) xxx–xxx

Original article

Evaluation of self-reported fish and shellfish allergy in schoolchildren in the Fez-Meknes Region and its relationship to breastfeeding

Évaluation de l'allergie autodéclarée des poissons et des fruits de mer dans la population scolaire de la région de Fez-Meknès et sa relation avec l'allaitement maternel

N. Mejrhit^a, O. Azdad^a, A. Bousfiha^a, A. Chokri^a, I. Ouahidi^b, L. Aarab^{a,*}

^a Laboratory of Bioactive Molecules (LMBSF), Faculty of Sciences & Techniques, University Sidi Mohamed Ben Abdellah, P.O. Box 2202, Road of Immouzer, Fez, Morocco

^b High Institute of Nursing and Technical Health, Ministry of Health, Fez, Morocco

Received 28 January 2017; accepted 7 June 2017

Abstract

Objective. – The aim of the present study was to evaluate the prevalence of self-reported allergy to fish and shellfish among school children and its relation to breastfeeding.

Patients and methods. – The study was based on a survey conducted between April 2014 and March 2015 in middle and high schools in Fez city and its surrounding areas. The total study population numbered 3010 people.

Results. – The results show that 9.5% of children reported an allergy to fish and shellfish. Of these, 7% reported an allergy to sardines, 2.5% to mackerel and 2.1% to shrimps. The most common clinical manifestations observed in this population were cutaneous reactions (80.1%). The study of the effect of breastfeeding on self-reported fish allergy showed that such allergies were more frequent among children who have not been breastfed than in those who had, for all the types of fish studied (15.4% vs. 7.3%; $P < 0.0001$).

Conclusion. – Self-reported allergy to fish and shellfish among schoolchildren, totalling 9.5%, indicates extensive sensitivity of school children to fish and shellfish. We showed that breastfed children were at lower risk of developing fish allergy than those who were not breastfed.

© 2017 Elsevier Masson SAS. All rights reserved.

Keywords: Self-reported allergy; Fish/shellfish; Sensitivity; School children; Survey; Clinical manifestations; Breastfeeding status

Résumé

Objectif. – Le but de cette étude était d'évaluer la prévalence de l'allergie autodéclarée aux poissons et aux fruits de mer des enfants scolarisés et sa relation avec l'allaitement maternel.

Méthodes. – L'étude était basée sur une enquête menée entre avril 2014 et mars 2015 dans les collèges et les lycées de la ville de Fès et ses environs. La population totale étudiée était de 3010 personnes.

Résultats. – Les résultats ont montré que 9,5 % des élèves avaient signalé une allergie aux poissons et aux fruits de mer. Parmi eux, 7 % ont signalé une allergie à la sardine, 2,5 % au maquereau et 2,1 % à la crevette. Les manifestations cliniques les plus remarquées dans cette population étaient des réactions cutanées (80,1 %). L'étude de l'effet de l'allaitement sur l'allergie rapportée aux poissons a montré qu'elle était plus fréquente chez les élèves qui n'étaient pas allaités que chez ceux qui avaient été, pour tous les types de poissons étudiés (15,4% vs 7,3%; $p < 0,0001$).

Conclusion. – L'allergie aux poissons et aux fruits de mer autodéclarée chez les enfants scolarisés, atteignant 9,5 %, indique une forte sensibilité de la population étudiante aux poissons et aux fruits de mer. Nous avons observé que les élèves qui ont été allaités avaient un risque réduit de développer une allergie au poisson par rapport à ceux qui n'étaient pas.

© 2017 Elsevier Masson SAS. Tous droits réservés.

Mots clés : Allergie ; Poissons/fruits de mer ; Sensibilisation ; Enfants scolarisés ; Enquête ; Manifestations cliniques ; Allaitement

* Corresponding author.

E-mail address: aarablmsf@gmail.com (L. Aarab).

1. Introduction

All over the world, food allergy affects up to 2.5% of the adult population and 6 to 8% of children under the age of three years and is associated with significant morbidity and mortality [1,2]. In Morocco, 9.5% of adults reported allergy to foods [3]. In atopic children, a sensitization to food was observed in 45% of the cases [4].

Fish and shellfish are important foods in the world including Morocco. While their consumption varies notably between coastal and inland regions, they are essential sources of animal proteins for the Moroccan population. However, fish and shellfish are identified as main allergenic foods in the world [5,6]. The estimated prevalence of fish and shellfish allergies is reported in numerous countries and was less than 2% for fish [7–9] and 18% for shellfish [9–13]. Furthermore, prevalence of self-reported allergy is thought to be more common in countries with higher fish and shellfish consumption. In children who went through allergy assessment, fish and shellfish were the third most common food sensitivity in Spain (after egg and cow's milk) [14] and the second most common one in Singapore [15].

The objective of the present work was to evaluate the prevalence of self-reported allergy to fish and shellfish in school age students, and then to study the effect of breastfeeding on self-reported fish allergy. The study was based on a survey, conducted between April 2014 and March 2015 in middle and high schools of Morocco Fez city, and its surroundings.

2. Methods

2.1. Selection of study population

We carried out a cross-sectional survey among students from Fez-Meknes region in the center of Morocco. The study was conducted between April 2014 and March 2015, by our laboratory members, in middle and high schools of Fez city and surroundings defined as rural areas of Sefrou, Immouzer, Boulemane, and Ifrane. Students aged from 12 to 18 years old were selected from public and private schools. The survey was conducted after approval by the Ethic Committee of University Hospital Center of Fez, and the local authorities of the Ministry of Education.

This population was surveyed using a questionnaire that was completed by the students in the presence of research and educational teams. This questionnaire was distributed in 16 schools from different areas of Fez-Meknes region targeting a total of 3010 students. Target schools comprised 8 high schools (6 in Fez and 2 in Fez region) and 8 middle schools (6 in Fez and 2 in Fez region).

2.2. Questionnaire

The questionnaire included demographic, social and health information about the students:

sex, age, educational level, area of residence, adverse reactions to food, type of food causing allergy (fish, milk, egg,

cereals, peanut, white bean, haricot, sesame, meat, chicken, almond, chocolate, strawberry);

- types of fish/shellfish allergic (sardine, mackerel, horse mackerel, Common Pandora, whiting, shrimps, squid. . .);
- breastfeeding status (breastfeeding means exclusive breastfeeding for at least 6 months after birth);
- presence of allergic clinical manifestations defined as: cutaneous reactions (urticaria, atopic dermatitis, or rash);
- respiratory reactions (asthma, rhinitis, wheezing, or nasal congestion) and gastrointestinal reactions (nausea, vomiting, diarrhea, or oral pruritus).

The students were also asked about their recent medical treatments and about their family allergy history.

2.3. Specific IgE determination

From the population studied, 135 blood samples of the students, who reported a fish/shellfish allergy, were collected and analyzed for specific IgE to sardine proteins. Specific IgE was determined by ELISA as described in [3,16]. Briefly, 100 μ l of sardine proteins (0.5 mg/mL) was deposited per well in 96 microplates and incubated for 60 min at 37 °C. Then, 200 μ l of 0.5% bovine serum albumin was added to every well for an hour at 37 °C. After removal of BSA, human sera were added (100 μ l/well) before incubation with anti-IgE peroxidase conjugate for 60 min at 37 °C. Anti-IgE fixed was revealed by adding 100 μ l of 0.05% OPD (orthophenylene-diamine). The reaction was stopped by adding HCl 3 M. Finally, absorbance was measured at 490 nm.

2.4. Statistical analysis

Descriptive statistics were presented as numbers with percentages or as average values. The Chi-square test analyze was used for statistical correlation determination. $P < 0.05$ was considered significant. All statistical analyses were performed using Epi Info™ version 7.2.0.1.

3. Results

A total of 3010 high and middle schools students were selected and surveyed in Fez-Meknes Region. Among them, only 2802 have correctly completed the questionnaire and are representative of school age students of Fez and its region. Respecting the representative's questionnaire criteria, our population was constituted by 50% boys and 50% girls. There were 57.7% students aged between 12 and 15 years, and 42.3% aged between 15 and 18 years. 77.4% were from urban area and 22.6% originated from rural areas (Table 1).

In this survey, self-reported food allergy was 28% ($n = 785$), which was significantly higher in girls than in boys (32.3% vs 23.8%; $P < 0.0001$), while no significant difference observed in prevalence of food allergy between urban and rural students ($P = 0.2$). The children aged 15 to 18 displayed a lower prevalence than the 12–15 group with statistically significant

Table 1

Demographic characteristic of the study population and self-reported food allergy according to these characteristics.

Demographic variable	Total samples	Reported food allergy	
	<i>n</i> (%)	<i>n</i> (%)	<i>P</i> -value
Sex			
Male	1401 (50)	333 (23.8)	<0.0001
Female	1401 (50)	452 (32.3)	
Age (year)			
12–15	1618 (57.7)	492 (30.4)	<0.001
15–18	1184 (42.3)	293 (24.7)	
Region			
Urban	2168 (77.4)	620 (28.6)	0.2
Rural	634 (22.6)	165 (26)	

difference ($P < 0.001$) (Table 1). Food allergy was mostly associated with eggs (10.6%) and fish/shellfish (9.5%), followed by milk (7.4%), and cereals (5.2%) (Fig. 1). In overall, self-reported food allergy was higher for animal foods (31.5%), in comparison with vegetal foods (18.4%).

Regarding the results of allergy to fish and shellfish (Table 2), we noticed a strong sensitivity of student population to these foods ($n = 266$). From the 9.5% who reported fish/shellfish allergy, 43% had multiple fish allergies. Prevalence according to fish species among fish allergic students was highest for sardine, reported as 74.1%. The later was followed by mackerel with 26.3%, and shrimps with 21.8%. The most frequent clinical signs of fish allergy were cutaneous reactions, followed by gastrointestinal reactions and respiratory symptoms (Table 2). From this population, 1.9% was treated by anti-histaminic drugs and 11.3% has an allergic history in his family.

Self-reported food allergy among students with breastfeeding status is shown in Table 3. The evaluation of the association between breastfeeding and prevalence of food allergy in students population showed that those who were breastfed (BF) had a reduced risk of self-reported food allergy compared with those who were not (NBF), the later ones showing a higher self-reported allergies (NBF = 39.7% vs BF = 26.6%, $P < 0.0001$). In addition, students who reported allergy to: fish, egg, cereals, milk, and white bean, had a significant correlation

Table 2

Distribution of fish allergy according to sex, age, region, fish/shellfish category and clinical manifestations.

Demographic variable	Prevalence of fish and shellfish allergy		
	<i>n</i>	%	<i>P</i> -value
Sex			
Male ($n = 1401$)	98	7	<0.0001
Female ($n = 1401$)	168	12	
Age (year)			
12–15 ($n = 1618$)	168	10.4	0.06
15–18 ($n = 1184$)	98	8.3	
Region			
Urban ($n = 2168$)	208	9.6	0.7
Rural ($n = 634$)	58	9.1	
Type of fish			
Sardine	197	74.1	
Mackerel	70	26.3	
Shrimps	58	21.8	
Whiting	48	18.0	
Clinical manifestations			
Digestive manifestations	73	27.4	
Cutaneous manifestations	213	80.1	
Respiratory manifestations	39	14.7	

to breastfeeding status (Table 3). This correlation was most significant with fish, eggs and cereal (fish: 15.4% vs 7.3%; cereals: 9.2% vs 3.8%; egg: 16.2% vs 8.5%) ($P < 0.0001$).

Fig. 2 shows the self-reported fish allergy by fish type in relation with breastfeeding. The results showed that, for all studied fish species, the breastfed population had a lower sensitivity. The fish type correlation with breastfeeding status was significantly higher for sardine (NBF = 11.4% vs BF = 5.6%, $P < 0.001$) followed by mackerel. No significant correlation was found for others types of fish.

Furthermore, students who were not breastfed reported more cutaneous and respiratory symptoms due to fish allergy (cutaneous reactions: NBF = 11.4% vs BF = 5.7%, $P < 0.001$; respiratory manifestations: NBF = 3.7% vs BF = 1.0%, $P < 0.001$) compared to students with digestive reactions to fish (NBF = 2.6% vs BF = 2.8%, $P > 0.05$).

The relation between breastfeeding status and sex (Table 4) showed that self-reported fish allergy was more frequent in

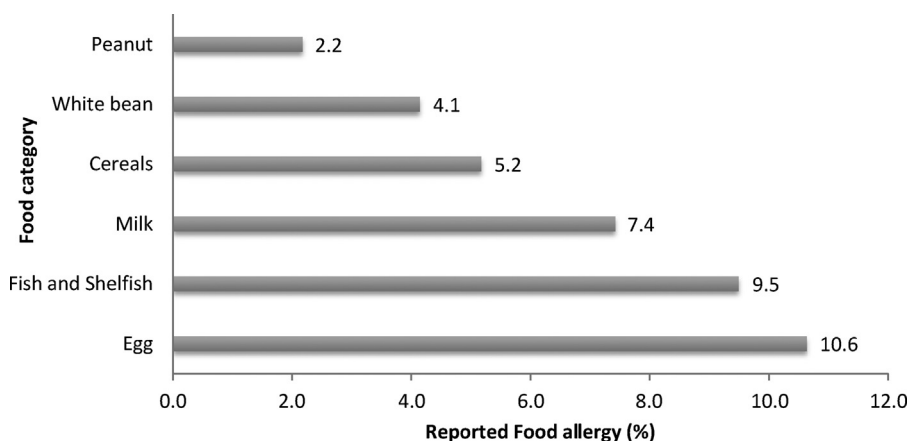


Fig. 1. Prevalence of self-reported food allergy.

Table 3
Self-reported food allergies among students according to breastfeeding status.

	Breastfed population (n = 1761)		Not breastfed population (n = 272)		P-value
	n	%	n	%	
All allergens	469	26.6	108	39.7	<0.00001
Fish/shellfish	129	7.3	42	15.4	<0.00001
Cereals	67	3.8	25	9.2	<0.0001
Eggs	149	8.5	44	16.2	<0.0001
Milk	102	5.8	30	11.0	<0.01
White bean	65	3.7	18	6.6	<0.05
Peanut	23	1.3	7	2.6	0.10

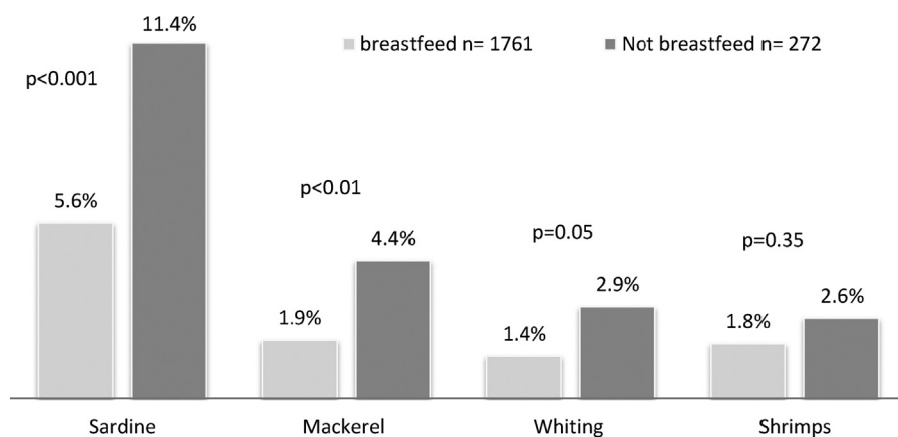


Fig. 2. Self-reported fish/shellfish type allergy according to breastfeeding status.

girls than in boys ($P<0.0001$). We observed significant differences in boys and girls depending on breastfeeding status (girls: NBF = 17.1% vs BF = 9.4%, $P<0.01$; boys: NBF = 13.2% vs BF = 5.4%, $P<0.01$). This correlation was more statistically significant for sardine than whiting and shrimps.

As for fish allergy prevalence between urban and rural regions (Table 5), we noted that the breastfeeding reduced fish allergy by more than 50% in urban students (NBF = 16.5% vs BF = 7.1%, $P<0.0001$). However, the impact of breastfeeding was not observed in rural population (NBF = 9.5% vs BF = 8%, $P=0.7$).

In our study, the total number of students tested for specific IgE to fish was 135 students: 33 boys (24%) and 102 girls (76%). Dosage of IgE specific to sardine proteins indicated that 50.4% of the students present values higher than 20 UI/mL (Table 6). Moreover, allergy to sardine was more reported in students with higher values (14.7%) than in those with values lower than 20 UI/mL (2.9%), with a statistically significant correlation

between self-reported fish allergy and the level of specific IgE ($P<0.05$).

4. Discussion

The aim of this study was to first evaluate the prevalence of self-reported allergy to fish and shellfish of school age students, and then to study the effect of breastfeeding on self-reported fish allergy. Based on a survey, this study was conducted between April 2014 and March 2015 in middle and high schools of Fez city and its region. A total of 3010 students aged between 12 and 18 years, from 16 different schools in the region, were surveyed using a questionnaire in the presence of research and educational teams. A total of 2802 correctly completed questionnaires were considered to be representative of school age students of Fez and its surroundings.

Table 4
Breastfeeding status for boys and girls according to self-reported fish allergy.

	Girls n (%)			Boys n (%)		
	Breastfed (n = 837)	Not breastfed (n = 158)	P-value	Breastfed (n = 924)	Not breastfed (n = 114)	P-value
Fish/shellfish	79 (9.4)	27 (17.1)	<0.01	50 (5.4)	15 (13.2)	<0.01
Sardine	61 (7.3)	21 (13.3)	0.01	38 (4.1)	10 (8.8)	0.03
Whiting	13 (1.6)	6 (3.8)	0.06	11 (1.2)	2 (1.8)	0.61
Shrimps	16 (1.9)	4 (2.5)	0.61	15 (1.6)	3 (2.6)	0.44

Table 5
Distribution of fish allergy between urban and rural regions with breastfeeding status.

	Urban <i>n</i> (%)			Rural <i>n</i> (%)		
	Breastfed (<i>n</i> = 1346)	Not breastfed (<i>n</i> = 230)	<i>P</i> -value	Breastfed (<i>n</i> = 415)	Not breastfed (<i>n</i> = 42)	<i>P</i> -value
Fish/shellfish	96 (7.1)	38 (16.5)	<0.00001	33 (8)	4 (9.5)	0.72
Sardine	75 (5.6)	28 (12.2)	<0.001	24 (5.8)	3 (7.1)	0.72
Whiting	19 (1.4)	7 (3)	0.07	5 (1.2)	1 (2.4)	0.52
Shrimps	22 (1.6)	7 (3)	0.14	9 (2.2)	0	0.33

Table 6
Prevalence of self-reported sardine allergy according to the level of specific IgE.

Specific IgE level (UI/mL)	Reported sardine allergy <i>n</i> (%)	Not reported sardine allergy <i>n</i> (%)	<i>P</i> -value
< 20 UI/mL (<i>n</i> = 67)	2 (2.9)	65 (97.1)	0.01
> 20 UI/mL (<i>n</i> = 68)	10 (14.7)	58 (85.3)	

In our study, we observed that self-reported adverse reactions to food in school age students were 28%, which was significantly higher in girls than in boys (32.3% vs 23.8%; $P < 0.0001$). Distribution of these food reactions was constituted by fish/shellfish (9.5%), eggs (10.6%), milk/dairy products (7.4%) and cereals (5.2%) as the most commonly reported allergenic foods in our population. Concerning other studies, a multicenter study conducted in Europe showed that food allergy perception index varies significantly between countries [17]. Some investigators have reported over 20% prevalence for children in some regions: 35.9% in Iran [18], 29.7% in China [11] and 40% in South Africa [19], while others have shown a lower prevalence: 8% in USA [8] and 8.9% in France [20]. For Canada, estimated prevalence of 7.14% was reported in children for milk, peanut, and tree nut which were the most common allergens [7]. In Colombia, a value of 12.6% was reported for children aged from 9 to 16 years [21]. In Hong Kong, a study involving 884,300 children showed that 4.8% of this population had adverse reactions to foods. Among them, shellfish was the top allergen accounted for more than a third of all reactions, followed by egg (14.5%), and cow's milk/dairy products (10.8%) [22]. In Ghana, Obeng et al. reported that 11% of children were allergic [23]. In Morocco, Ghadi et al. showed that 45% of 160 atopic children have a sensitization to food [4]. Although the worldwide variation in the prevalence of food allergy could possibly be due to methodological differences, demographic and cultural conditions related to food consumption habits must be considered.

We also identified sex and age as factors associated with food allergy in our population. Some studies have documented the predominance of food allergy in females [21,24] as in our study, while others have observed this predominance in males [8,25].

Regarding fish and shellfish, we noted that it was significantly more frequent in girls than in boys (12% vs 7%; $P < 0.0001$) with a sex ratio of 0.56 as observed by Sicherer et al. in USA by random telephone survey on seafood allergy [26]. In addition, we found sardine to be the most common species causing adverse reactions in our population, followed by mackerel, shrimps and whiting. Different dietary habits and the relatively

large consumption in our population may explain the rather high reaction frequency to fish and shellfish.

In comparison to other studies, developed countries showed low values prevalence of fish and shellfish for children, with a prevalence of 1.4% for shellfish and 0.5% for fish in the United States [8], 0.18% for fish and 0.55% for shellfish in Canada [7], 0.09% for fish and 0.14% for shellfish in Japanese infants and children aged between 1 and 6 years [27]. For emerging countries contrarily, we observed high children allergy prevalence of fish and shellfish in numerous countries. In Mexico, it was reported as 12% for fish and 6.5% for shellfish [10]. In China, shellfish was the most self-reported allergy with 16.7%, while fish was reported as 2.0% [11]. In Singapore and the Philippines, the shellfish allergy was reported, respectively as 5.2 and 5.1% for children aged from 14 to 16 years [28] and, in South African children, the estimated prevalence of fish allergy was 3% [29]. Moreover, fish and shellfish have been reported more allergenic in less developed countries such as Mozambique with a value of 19.1% [12].

The difference in reporting fish and shellfish allergy between developed and less developed countries is thought to be related to the quality of fish products and their freshness related to histamine content. Thus, higher self-reported allergy prevalence in less developed countries could be explained by the effect of histamine content in those products.

Furthermore, fish and shellfish allergies were associated with severe reactions in our population. Cutaneous reactions were the most frequent ones (80.1%), followed by gastrointestinal (27.4%), and respiratory symptoms (14.7%). A similar study by Marrugo et al. found that the most frequent self-reported symptoms were skin reactions (61.4%), gastrointestinal (29.1%), and respiratory symptoms (8.6%) [21]. Interestingly, Rance et al. found similar allergic symptoms distribution in France for fish and Shellfish: clinical signs were mostly cutaneous (62.7%), then came the digestive (30.3%) and respiratory symptoms (6.9%) [20].

The study of the effect of breastfeeding on self-reported fish allergy in our population pointed out a lower self-reported

fish allergy in students who were breastfed than in those who were not. NBF students exhibited a higher self-reported allergies (NBF 15.4% vs BF 7.3%; $P < 0.0001$) for all types of fish. Correlation with breastfeeding, for different fish species, was significantly higher for sardine and mackerel. In addition, we observed a reduced risk of cutaneous and respiratory symptoms of fish allergy for students who were breastfed.

However, studies on the effect of breastfeeding on the development of allergy have yielded controversial results, with some studies indicating an allergy-prevention effect [30,31], while others could not confirm this [32,33]. A study by Kull et al. targeting 3825 Swedish children followed from birth, found that exclusively breastfed children for 4 months or more had a reduced risk of asthma and sensitization to common food allergens (fish, cow's milk, egg, and peanut) during the first 8 years of life compared with a shorter duration of breastfeeding [34]. Moreover, Friedman et al. showed that it is also biologically plausible that exclusive breastfeeding for the first months after birth may reduce the risk of asthma and allergy due to the fact that breast milk contains components which are beneficial to the infant's immune system such as high amounts of IgA, cytokines, and prebiotics [35].

5. Conclusion

In conclusion, our results showed that self-reported allergy to fish and shellfish of school age students was 9.5%, indicating an important sensitivity of student population to fish and shellfish. The most common clinical manifestations observed in this population were cutaneous reactions (80.1%). As for the relation between breastfeeding and self-reported allergy, we showed that students who were breastfed have a reduced risk of fish allergy and that this risk was lower for all types of fish.

Ethics

This study was approved by the ethics committee of University Hospital Centre of Fez, and the local authorities of the Ministry of Education.

Disclosure of interest

The authors declare that they have no competing interest.

Acknowledgements

This work was supported by grants of the Moroccan National Center for Scientific and techniques Research (CNRST) to Najlae MEJRHIT. We would like to thank the University Hospital Center of Fez and the Local authorities of Educational Ministry as well as all directors and all teachers of schools of Fez-Meknes region for their help.

References

- [1] Sampson HA. Food allergy, part 2: diagnosis and management. *J Allergy Clin Immunol* 1999;103:981–9.
- [2] Bock SA. Prospective appraisal of complaints of adverse reactions to foods in children during the first 3 years of life. *Pediatrics* 1987;79:683–8.
- [3] Ouahidi I, El Hamsas AEY, Aarab L. Modulation of egg white protein allergenicity under physical and chemical treatments. *Food Agric Immunol* 2011;22(1):57–68.
- [4] Ghadi A, Dutau G, Rance F. A sensitization study of atopic children in Marrakech. A prospective study of 160 children between 2002 and 2005. *Rev Fr Allergol Immunol Clin* 2007;47(6):409–15.
- [5] Aas K. Fish allergy and the cod fish allergen model. In: Brostoff J, Challacombe SJ, editors. *Food allergy and intolerance*. London: Bailliere Tindall; 1987. p. 356–66.
- [6] Sampson HA. Update on food allergy. *J Allergy Clin Immunol* 2004;113:805–19.
- [7] Soller L, Ben-Shoshan M, Harrington DW, Frapagane J, Joseph L, Pierre YS, et al. Overall prevalence of self-reported food allergy in Canada. *J Allergy Clin Immunol* 2012;130(4):986–8.
- [8] Gupta RS, Springston EE, Warrier MR, Smith B, Kumar R, Pongracic J, et al. The prevalence, severity, and distribution of childhood food allergy in the United States. *Pediatrics* 2011;128:9–17.
- [9] Rona RJ, Keil T, Summers C, Gislason D, Zuidmeer L, Sodergren E, et al. The prevalence of food allergy: a meta-analysis. *J Allergy Clin Immunol* 2007;120:638–46.
- [10] Sáncheza J, Sáncheza A. Epidemiology of food allergy in Latin America. *Allergol Immunopathol (Madr)* 2013;546:11.
- [11] Kim JS, Ouyang F, Pongracic JA, Fang Y, Wang B, Liu X, et al. Dissociation between the prevalence of atopy and allergic disease in rural China among children and adults. *J Allergy Clin Immunol* 2008;122:929–35.
- [12] Lunet N, Falcao H, Sousa M, Bay N, Barros H. Self-reported food and drug allergy in Maputo, Mozambique. *Public Health* 2005;119:587–9.
- [13] Zuberbier T, Edenharter G, Worm M, Ehlers I, Reimann S, Hantke T. Prevalence of adverse reactions to food in Germany: a population study. *Allergy* 2004;59:338–45.
- [14] Pascual CY, Reche M, Fiandor A, Valbuena T, Cuevas T, Martin-Esteban MM. Fish allergy in childhood. *Pediatr Allergy Immunol* 2008;19:573–9.
- [15] Chiang WC, Kidon MI, Liew WK, Goh A, Tang JPL, Chay OM. The changing face of food hypersensitivity in an Asian community. *Clin Exp Allergy* 2007;37:1055–61.
- [16] Bousfiha A, Aarab L. Effect of heat and enzymatic treatments on human IgE and rabbit IgG sensitivity to white bean allergens. *Iran J Allergy Asthma Immunol* 2013;12(4):304–11.
- [17] Woods RK, Abramson M, Bailey M, Walters EH. International prevalence of reported food allergies and intolerances. Comparisons arising from the European Community Respiratory Health Survey (ECRHS) 1991–1994. *Eur J Clin Nutr* 2001;55:298–304.
- [18] Nabavi M, Hoseinzadeh Y, Ghorbani R, Nabavi M. Prevalence of food allergy in asthmatic children under 18 years of age in Semnan-Iran in 2007–2008. *Koomesh* 2010;11:162–9.
- [19] Gray CL, Levin ME, Zar HJ, Potter PC, Khumalo NP, Volkwyn L, et al. Food allergy in South African children with atopic dermatitis. *Pediatr Allergy Immunol* 2014;25(6):572–9.
- [20] Rance F, Grandmottet X, Grandjeanw H. Prevalence and main characteristics of schoolchildren diagnosed with food allergies in France. *Clin Exp Allergy* 2005;35:167–72.
- [21] Marrugo J, Hernández L, Villalba V. Prevalence of self-reported food allergy in Cartagena (Colombia) population. *Allergol Immunopathol* 2008;36(6):320–4.
- [22] Ho MH, Lee SL, Wong WH, Patrick IP, Lau YL. Prevalence of self-reported food allergy in Hong Kong children and teens—a population survey. *Asian Pac J Allergy Immunol* 2012;30(4):275.
- [23] Obeng BB, Amoah AS, Larbi IA, Yazdanbakhsh M, Van Ree R, Boakye DA. Food allergy in Ghanaian schoolchildren: data on sensitization and reported food allergy. *Int Arch Allergy Immunol* 2010;155:63–73.
- [24] Vierk KA, Koehler KM, Fein SB, Street DA. Prevalence of self-reported food allergy in American adults and use of food labels. *J Allergy Clin Immunol* 2007;119:1504–10.
- [25] Pelé F, Bajeux E, Gendron H, Monfort C, Rouget F, Multigner L, et al. Maternal fish and shellfish consumption and wheeze, eczema and food

- allergy at age two: a prospective cohort study in Brittany, France. *Environ Health* 2013;12:102.
- [26] Sicherer SH, Mun-Furlong A, Sampson HA. Prevalence of seafood allergy in the United States determined by a random telephone survey. *J Allergy Clin Immunol* 2004;114:159–65.
- [27] Noda R. Prevalence of food allergy in nursery school (nationwide survey). *Jpn J Food Allergy* 2010;10:5–9.
- [28] Shek LPC, Cabrera-Morales EA, Soh SE, Gerez I, Ng PZ, Yi FC, et al. A population-based questionnaire survey on the prevalence of peanut, tree nut, and shellfish allergy in 2 Asian populations. *J Allergy Clin Immunol* 2010;126:324–31.
- [29] Gray C, Kung SJ. Food allergy in South Africa: joining the food allergy epidemic? *Curr Allergy Clin Immunol* 2012;25(1):24–9.
- [30] Saarinen UM, Kajosaari M, Backman A, Siimes MA. Prolonged breast-feeding as prophylaxis for atopic disease. *Lancet* 1979;2(8135):163–6.
- [31] Oddy WH, Holt PG, Sly PD, Read AW, Landau LI, Stanley FJ, et al. Association between breast feeding and asthma in 6 year old children: findings of a prospective birth cohort study. *BMJ Clin Res* 1999;319(7213):815–9.
- [32] Wetzig H, Schulz R, Diez U, Herbarth O, Viehweg B, Borte M. Associations between duration of breast-feeding, sensitization to hens' eggs and eczema infantum in one and two year old children at high risk of atopy. *Int J Hyg Environ Health* 2000;203(1):17–21.
- [33] Bergmann RL, Diepgen TL, Kuss O, Bergmann KE, Kujat J, Dudenhausen JW. Breastfeeding duration is a risk factor for atopic eczema. *Clin Exp Allergy* 2002;32(2):205–9.
- [34] Kull I, Melen E, Alm J, Hallberg J, Svartengren M, van Hage M, et al. Breast-feeding in relation to asthma, lung function, and sensitization in young schoolchildren. *J Allergy Clin Immunol* 2010;125:1013–9.
- [35] Friedman NJ, Zeiger RS. The role of breast-feeding in the development of allergies and asthma. *J Allergy Clin Immunol* 2005;115:1238–48.