

POSITION PAPER

EAACI Position Paper: Prevention of work-related respiratory allergies among pre-apprentices or apprentices and young workers

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Abstract

Apprenticeship is a period of increased risk of developing work-related respiratory allergic diseases. There is a need for documents to provide appropriate professional advice to young adults aiming to reduce unsuitable job choices and prevent impairment from their careers. The present document is the result of a consensus reached by a panel of experts from European and non-European countries addressed to allergologists, pneumologists, occupational physicians, primary care physicians, and other specialists interested in this field, which aims to reduce work-related respiratory allergies (rhinoconjunctivitis and asthma) among allergic or nonallergic apprentices and other young adults entering the workforce. The main objective of the document is to issue consensus suggestions for good clinical practice based on existing scientific evidence and the expertise of a panel of physicians.

Abbreviations

AMP, adenosine-mono-phosphate; BHR, bronchial hyperresponsiveness; CI, confidence interval; HMW, high molecular weight; HR, hazard ratio; LA, laboratory animals; LMW, low molecular weight; OA, occupational asthma; OR, occupational rhinitis; OHS, Occupational Health Services; PC₂₀, provocative concentration of methacholine/histamine causing a 20% fall in FEV₁; POA, probable occupational asthma; PPV, positive predictive value; PRR, prevalence rate ratio; PY, person years; RC, rhinoconjunctivitis; RUA, rat urinary allergen; SPT, skin prick test; SS, specific sensitization; WEA, work-exacerbated asthma; WRA, work-related asthma; WRNS, work-related nose symptoms; WRR, work-related rhinitis; WRRRA, work-related respiratory allergies; WRRS, work-related respiratory symptoms; WRS, work-related symptoms.

Occupational exposures account for a substantial proportion of adult asthma (1). The same is probably true for work-related rhinitis (WRR) that has been less investigated. Work-related respiratory allergies (WRRRA) are preventable diseases, and efforts should be made for effective prevention strategies. Sensitization to occupational agents precedes the development of allergic occupational rhinitis and asthma symptoms (2), and rhinitis symptoms precede the onset of asthma (3); therefore, prevention of sensitization and/or early identification of rhinitis represents a crucial point in the prevention of work-related asthma (WRA).

The increasing prevalence of allergy and asthma in childhood in the last decades has resulted in an increasing number of allergic and/or asthmatic young adults entering the workforce, producing new challenges for physicians.

Apprenticeship is a period of increased risk of developing WRR, and apprentices occupationally exposed to high molecular weight (HMW) agents are at higher risk than others working with the same agents (4). This occurrence may be related to insufficient preventive measures and information about risks and WRR in young people (5–8).

Allergologists can play a pivotal role in providing advice to young people and adolescents before a job choice is made. Nevertheless, there is a lack of documents specifically addressed to allergologists containing suggestions for professional advice to young adults to prevent unsuitable job choices or impairment of future careers. Moreover, young asthmatic adults have little awareness of potential work effects on asthma (9) and a long interval often elapses between the onset of work-related respiratory symptoms (WRRS) and primary care physician consideration of WRA (10, 11). Therefore, adequate information about risks and WRR should also target primary care physicians.

The aim of this document is to issue consensus suggestions for good clinical practice among allergologists, pneumologists, occupational physicians, and primary care physicians to improve prevention of WRR among apprentices and other young adults entering the workforce.

Methods

This consensus document was prepared by a EAACI Task Force consisting of an expert panel of allergologists, pneumologists, and occupational physicians and was reviewed and accepted by the EAACI Executive Committee.

The literature was reviewed by the panel members for each section, using a Medline search. A meeting was held to review the findings and reach informal consensus. Further consensus was reached by an informal iterative process by input of all panel members into the drafts of the document. The original aim of the Task Force was to advance recommendations using an evidence-based system. However, it was recognized that the quality of published studies in this area would be graded as low, based on case series and unmatched cohort studies. Therefore, no evidence-based recommendations could be provided, and instead 'key messages' (See Key Messages Box) or 'suggestions' are provided based on consensus of the expert panel members.

The document is not intended to be a formal evidence-based guideline, but it is written to assist health care providers in prevention of WRR among apprentices and other young adults entering the workforce.

Incidence of sensitization, rhinitis and asthma because of occupational agents

About 15 years ago, several cohort studies in apprentices exposed to HMW or low molecular weight (LMW) agents were started in Europe and North America. These studies include information regarding health events (e.g., SS, work-related respiratory and nasal symptoms). The main characteristics and results of those studies are reported in Table 1.

Key messages box

Students starting career programs with exposure to HMW allergens have a substantial frequency of specific sensitization (SS) to work-related allergens that is related to atopy and bronchial hyperresponsiveness (BHR).

The incidence of work-related symptoms (WRS) is higher in the first 2–3 years after starting exposure and decrease afterward.

Work-related rhinitis and asthma (with or without SS to a work agent) are more common in those with pre-existing allergic rhinitis and/or BHR.

At least for several allergens, such as enzymes, coffee, and castor beans, flour, laboratory animals and green house allergens, sensitization to common inhalant allergens is associated with the development of sensitization to occupational allergens and the development of work-related respiratory symptoms. Atopy may interact with exposure–response relationships.

A baseline health assessment should be performed before starting a vocational school or work that includes exposure to respiratory sensitizers, to identify personal determinants for the development of sensitization and respiratory allergy, and/or to identify pre-existing respiratory diseases susceptible to worsening with workplace exposure.

Adolescents with asthma and allergy often do not consider these conditions in their career choices and may not be aware of the effects that work may have on asthma.

There is a need for improved education of adolescents and young adults with asthma as to the potential effects of work on asthma.

Environmental control is the cornerstone for prevention, and every effort should be made to keep the workplaces as healthy places. The physician in charge should have a detailed knowledge of the job and work environment; specialist in occupational health/occupational medicine should be consulted if available.

The physician in charge for the baseline health assessment should discuss the results with the young adult helping her/him in making the professional choice.

The young adult should be educated to adopt all preventive measures to limit occupational exposure to potential allergens and respiratory irritants and to recognize and report immediately all possible symptoms suggestive of onset of WRR or work-related exacerbations to her/his health care personnel and to her/his teachers/employees too.

Medical surveillance should be prioritized in the first 2–3 years of exposure and scheduled according to the clinical profile, exposure details, and reliability of available tests.

Incidence of work-related sensitization, asthma, and rhinitis

In workers exposed to laboratory animals (LA), the incidence of SS was between 4.1 and 10.7/100 person years (PY) when the duration of follow-up was 2–4 years (12–15); it was lower (1.8/100 PY) when the follow-up was longer (7.6 years) (4) (Table 1). Rat-SS (8.7/100 PY) tended to be higher than mouse-SS (5.8/100 PY) (15). The incidence of WRRS and positive skin prick tests (SPTs) to LA has ranged from 0.4 to 1.6/100 PY (12, 16). The incidence of work-related nose symptoms (WRNS) and SPTs to LA has ranged from 2.0 to 5.7/100 PY (12, 14, 16, 17). Probable occupational asthma (POA), defined as sensitization to LA and increase in bronchial responsiveness, was 2.7/100 PY (17). Work-related nose

Table 1 Incidence of sensitization, rhinitis, and asthma among apprentices

References	Study year	Subjects (n)	Participation rate (%)	Duration of follow up (years)	Agents	Occupation	Atopy (%)	SS/100 PY (95% CI)	WRNS/ 100 PY	WRNS + SPT/ 100 PY	WRCS/ 100 PY	WRCS + SPT/ 100 PY
High molecular weight agents												
Laboratory animal allergens												
(12)	1990–1993	342	96	2.7 (range 2.2–4.2)	Rat	Laboratory workers	36	4.1	7.3	2.3	3.5	1.6
(13)	1993–1999	394	94	3.7	LA	Animal health tech.	40	8.9 (7.3–11.0)				
(17)	1993–1999	373	89	3.7	LA	Animal health tech.	40			5.7		POA 2.7
(14)	1993–1999	387	93	3.7	LA	Animal health tech.	40		11.3	4.5		
(16)	1991–2003	495	76	12.0	LA	Laboratory workers	32			2.0		0.4
(4)	1994–2006	242	69	7.6 (range 4.0–11.7)	LA	Animal health tech.	43	1.8				
(15)		110		2.0	Rat and mouse	Laboratory animal workers	39	10.7, rat SS 8.7, mouse SS 5.8				
Flour												
(13)	1993–1996	230	81	0.7–1.3	Flour	Pastry-making	47	4.2 (1.8–8.2)				
(18)	1992–1995	125	87	2.5	Flour	Bakers	29	5.2			5.2	3.6
(19)	1990–1993	300	80	3.3 (range 0.1–7.6)	Flour	Animal health tech., pastry making and dental-hyg. tech.	34	3.7	11.8		4.1	
(20)	1993–1996	188	82	1.4	Flour	Pastry-making	47	4.2	13.1	1.3		
(8)		287	62	2.0	Flour	Bakers	19	3.1	2.9	OR 2.2	2.2	OA 1.5
(21)		114	61	1.7	Flour	Bakers	35	4.0	22.1		10.0	
(4)	1994–2006	88	50	7.6 (range 4.0–11.7)	Flour	Pastry-making	43	1.0				
Latex												
(22)	1993–1998	110	90	2.7	Latex	Dental-hygiene tech.	43	2.5		0.7		POA 1.8
(4)	1994–2006	54	54	7.6 (range 4.0–11.7)	Latex	Dental-hygiene tech.	43	0.7				
Laboratory animal allergens, flour and latex												
(4)	1994–2006	384	61	7.6 (range 4.0–11.7)	LA, flour and latex	Animal health tech., pastry making and dental-hyg. tech.	43	1.3	1.7		0.7	
Low molecular weight agents												
Welding fumes												
(23)		194	68	1.2	Welding fumes	Welding students					6.1	POA 2.5

SS, specific sensitization; PY, person years; CI, confidence interval; WRNS, work-related nose symptoms; WRNS + SPT, work-related nose symptoms and positive specific skin prick test; WRCS, work-related chest symptoms; WRCS + SPT, work-related rhinitis symptoms and positive specific skin prick test; POA, probable occupational asthma (SS and bronchial hyperresponsiveness); OA, occupational asthma; OR, occupational rhinitis; LA, laboratory animals.

symptoms owing to LA tended to be more frequent than work-related chest symptoms (WRCS).

In apprentice bakers/pastry makers, the incidence of SS ranged from 3.1 to 5.2/100 PY when the mean duration of follow-up was lower than 4 years (8, 13, 18–21), but it was 1.0 for a longer period of follow-up (4). Incidence of WRRS ranged from 2.2 to 10.0/100 PY. New WRNS were 1.3–2.9 times more frequent than WRRS. In apprentice bakers, the prevalence of occupational asthma (OA) and rhinitis (OR), defined as WRRS or WRNS, respectively, and a positive inhalation challenge test were 1.5 and 2.2/100 PY, respectively (8).

In apprentices exposed to latex, SS was 2.5/100 PY for a relatively short follow-up (<3 years) (22) and it declined to 0.7/100 PY in the same group of apprentices for a mean follow-up longer than 7 years (4). In one study, apprentices exposed to LMW agents (welding fumes) had an incidence of WRRS of 6.1/100 PY and POA, defined as new WRRS, and increase in bronchial hyperresponsiveness (BHR) during follow-up of 2.5/100 PY (23).

Remission of work-related sensitization, asthma, and rhinitis

Only one study analyzed remission of SS, WRRS, and WRNS in a long-term (8-year) prospective cohort of apprentices exposed to HMW agents (4). The remission of SS, WRRS, and WRNS acquired during apprenticeship was 18.5, 9.6, and 9.6 per 100 PY, respectively, in subjects no longer in

a job related to training, and 9.5, 8.7, and 10.6 per 100 PY among those who were still in the same field (although the exposures and personal protective measures could not be compared with those during apprenticeship). Specific sensitization is more likely to resolve in those who no longer continued to have the same work exposure. Negative SPTs for common allergens at the time of entry in the apprenticeship were associated with the remission of SS and WRNS. Baseline normal bronchial responsiveness was also associated with the remission of SS.

Risk factors for sensitization, rhinitis and asthma because of occupational agents

Sensitization to HMW agents precedes the development of rhinitis and asthma symptoms (2), whereas for LMW agents, the evidence that sensitization precedes respiratory symptoms is scarce. Exposure level is the most important determinant in OA (2, 24). Several genetically determined host markers and acquired factors have been examined in apprentices (Table 2).

High molecular weight agents

The Canadian cohort of apprentices

In a cohort of 769 apprentices in animal health or veterinary medicine, pastry making, and dental hygiene, sensitization to LA, flour, or latex developed in 111 subjects over 8–

Table 2 Determinants of sensitization, rhinitis, and asthma among apprentices

References	Determinants
Laboratory animal allergens	
(12)	Intensity of rat exposure associated with SS and any WRS
(13)	Atopy, nasal and respiratory Sx during the pollen season, and exposure to rodents associated with SS
(17)	Baseline positive SPT to pets and bronchial responsiveness associated with POA
(20)	Rhinitis Sx on contact with pets and positive SPT to pets associated with WRNS in atopic subjects
(14)	Sensitization to grass pollen, nasal and bronchial symptoms associated with WRNS
(15)	The combination of atopy and total IgE > 100 associated with SS
(27)	Exposure to laboratory animal allergens associated with SS and WRNS
Flour	
(18)	History of allergic disease and sensitization to wheat or α -amylase associated with WRCS
(19)	Intensity of exposure associated with SS, WRNS and WRCS
(20)	SS and persistent rhinitis associated with WRNS
(30)	SS associated with WRNS, WRCS and eye Sx
(8)	Atopy associated with SS, OA and OR, SS associated with OA
(21)	Atopy associated with WRCS
Latex	
(13)	Atopy and asthma associated with SS
(22)	Atopy associated with SS, atopy and previous asthma associated with WRCS
Laboratory animal allergens, flour, and latex	
(25)	Atopy, WRS, and BHR associated with SS
(4)	Possibly duration of exposure inversely associated with SS and WRS. Level of bronchial responsiveness at time of entry in apprenticeship associated with SS and WRCS

SS, specific sensitization; Sx, symptoms; SPT, skin prick test; POA, probable occupational asthma; WRNS, work-related nose symptoms; WRCS, work-related chest symptoms; OA, occupational asthma; OR, occupational rhinitis; WRS, work-related symptoms; BHR, bronchial hyperresponsiveness.

44 months and was associated with positive SPTs to common allergens, WRS, and BHR (13, 25). In the animal health group, atopy and exposure level were the predictors of sensitization, and in the dental-hygiene program, atopy and asthma were determinants. Bronchial hyperresponsiveness was associated with new onset of respiratory symptoms (26). At 8-year follow-up in 408 of these apprentices, 78% held a job related to their training (4). The incidence of sensitization, symptoms, and BHR was lower while at work than during the apprenticeship period and a high proportion of subjects in a job not related to training experienced remission of symptoms acquired during apprenticeship (4). Exposure to animal-derived HMW allergens was associated with an increased risk for SS and rhinoconjunctivitis (RC) symptoms at work (27).

Bakers

De Zotti et al. (28) underlined the important role of atopy as a predisposing factor in the development of occupational disease. In 188 pastry-makers apprentices, a high incidence of work-related RC symptoms (16.1%) was found, while only a minority of subjects (1.6%) developed SS to flour allergens. Skin prick tests reactivity to grass pollen and pets, persistent rhinitis, seasonal RC, RC on contact with pets and SS to wheat flour were associated with the incidence of work-related RC symptoms.

Skjold et al. (21) suggested that respiratory symptoms and allergy may develop through separate pathways. Among 114 Danish baker apprentices, at 20-month follow-up, the cumulative incidence was 40.2% and 20.5% for rhinitis and asthma-like symptoms, respectively, whereas the cumulative incidence of SS to bakery allergens was 6.1% (21). In apprentices with new onset of respiratory symptoms, an increase in BHR from baseline was observed. No relationship was observed between new sensitization and new symptoms. Conversely, Walusiak et al. (8) found that most cases of WRS among apprentice bakers were related to SS. Atopy was a risk factor for sensitization to occupational allergens, OR and OA, and SS to occupational allergens on entry to the training was a risk factor for asthma.

Laboratory animals

In a cohort of 417 apprentices exposed to LA, the positive predictive values (PPVs) of SS to work-related allergens for the development of work-related RC and WRRS were 30% and 9.0%, respectively, while the PPVs of work-related RC for the development of OA were 11.4% (29). Sensitization, symptoms, and diseases occurred maximally in the first 2–3 years after starting exposure to LA. In 105 LA workers during a follow-up of 2.1 years, SS to work allergens was the strongest predictor of new-onset WRRS or WRNS (30). Pre-existent bronchial inflammation was associated with the development of WRNS.

Baseline skin reactivity to pets and BHR were associated with an increased risk of probable OA (17). In the same cohort (31), baseline rhinitis symptoms on contact with pets and SS were determinants for occupational RC in atopic subjects, whereas in nonatopic subjects, occupational RC was associated with BHR.

Symptoms indicative of asthma and allergic symptoms at baseline predicted the occurrence of SS and WRRS (32, 33). The questionnaire is an easy tool that can give accurate prediction of the incidence of occupational sensitization and symptoms. Addition of SPTs and/or BHR testing to the questionnaire increased the specificity of the model for LA sensitization, but not for symptoms at work (33).

Latex

In 122 apprentices in dental hygiene exposed to latex, the cumulative incidences for skin sensitization, probable occupational RC, and OA owing to latex were 6.4%, 1.8%, and 4.5%, respectively (22). Sensitized subjects were more likely to be atopic and have a previous history of asthma and respiratory symptoms on exercise than nonsensitized subjects.

Low molecular weight agents

Hairdressers have an increased prevalence of respiratory diseases and are at high risk of OA (34), persulfate salts being the major causal agents. Specific sensitization to persulfate salts seems more related to an individual susceptibility than environmental factors.

Relationships between occupational and nonoccupational sensitization

IgE-mediated allergy to HMW-allergens at work is often associated with sensitization to common inhalant allergens. Two questions are important, i.e. is sensitization to nonoccupational allergens or atopy a risk factor for developing sensitization to occupational allergens, and WRS, and conversely, is sensitization to occupational inhalants a risk factor for developing sensitization to common allergens, respiratory symptoms and/or worsening of asthma. The first question is particularly important for (pre-)apprentices making their choice for a specific career.

The relation between sensitization to common inhalant allergens and occupational sensitization

A relationship between atopy and sensitization to occupational allergens has been demonstrated with several agents.

Enzymes

In 300 UK bakery and flour mill workers, atopics were more likely to develop a positive SPT to flour and α -amylase, but not to develop WRS (19). In the Dutch bakery industry, α -amylase exposure levels and atopy were the most important determinants of skin sensitization (35). An association between sensitization to industrial enzymes and atopy has been described in Finland (36). In a pharmaceutical industry, atopics were at greater risk of developing IgE antibodies and allergic symptoms to enzymes. However, even in a few nonatopics, IgE-mediated hypersensitivity occurred after long-lasting exposure to enzymes.

Coffee and castor beans

A strong association between skin positivity to common and occupational allergens has been reported (37).

Bakery allergens

Houba et al. (35) showed a strong association between wheat flour exposure and sensitization particularly in atopics. Prevalence ratios for high and medium wheat allergen exposure were 5.2 (95% CI, 1.6–16.2) and 2.7 (0.5–14.5) for atopic workers and 2.5 (0.8–7.5) and 1.4 (0.3–6.4) for nonatopics, compared with workers with low wheat exposure. In sensitized bakers, elevated allergen exposure more often led to WRS, with prevalence ratios for high and medium wheat allergen exposure of 3.5 (CI 1.6–7.5) and 2.6 (CI 0.9–7.8), respectively.

Laboratory animals

The odds ratio for developing an immediate skin test reaction to rats was increased by direct rat contact and atopy (12).

Acid anhydrides

Regarding the organic acid anhydrides hexahydrophthalic and methylhexahydrophthalic anhydrides and the development of specific IgE and IgG antibodies and WRS, there was a high prevalence of sensitization (IgE 22%, IgG 21%), which correlated with exposure. Atopy did not increase this risk significantly (38). In contrast, Venables demonstrated a weak association between IgE production to tetrachlorophthalic anhydride and atopy. Smoking and atopy interacted the prevalence of IgE antibodies being 16.1% in atopic smokers, 11.7% in nonatopic smokers, 8.3% in atopic nonsmokers, and nil in nonatopic nonsmokers ($P < 0.025$) (39).

Greenhouse allergens

In greenhouses producing bell peppers, sensitization to the bell pepper plant and inhalant atopy were the most important risk factors for the occurrence of WRS of the upper airways [prevalence rate ratio (PRR) 2.6, CI 2.1–3.2 and PRR 2.2, CI 1.8–2.8] and lower airways (PRR 4.1, CI 2.4–7.0 and PRR 3.2, CI 1.9–5.3) (40). Sensitization to inhalant allergens was also related with sensitization to predator mites, a biologic agent used against thrips (41).

The relation between occupational sensitization and incident sensitization to common allergens and/or nonwork-related asthma

These relations have been examined in a cohort of 769 apprentices in animal health technology, pastry making, and dental hygiene (42). Subjects with new occupational sensitization were at greater risk of developing new sensitization to common aeroallergens than nonsensitized subjects.

Legislation across Europe regarding pre-apprentices and apprentices

High-quality vocational education and training oriented toward practical and economical requirements is of great

importance in modern society. Generally, educational programs contain principles of occupational health and safety. However, occupational health laws and organizations are directed to employees and not to schools or apprentices (43). Occupational health services in Europe vary widely (44), but generally the European workplace legislation regarding the protection of young workers is based on two Directives: 89/391/EEC (45), 94/33/EC (46) and subsequent amendments (47).

Directive 89/391/EEC (45) specifies that every workplace should have a good health and safety management system that protects everyone. Special attention should be paid to the vulnerability of young workers and new employees. Employers' duties to their workers, regardless of age, include identifying hazards and carrying out a risk assessment and based on the latter putting in place arrangements for ensuring safety and health at work.

The European Council Directive 94/33/EC (46) [amended by Directive 2007/30/EC (47)] defines 'young person' as someone who has not reached the age of 18, 'child' a person under the age of 15 or who is still subject to compulsory full-time schooling under national law, and 'adolescent' any young person of at least 15 years of age but <18 years of age who is no longer subject to compulsory full-time schooling under national law. These definitions may differ slightly among the EU Member States, depending on national law (school systems). The same Directive (46) article 7, paragraph 2, states that '....Member States shall to this end prohibit the employment of young people for:..... work involving harmful exposure to agents which are toxic, carcinogenic, cause heritable genetic damage, or harm to the unborn child or which in any other way chronically affect human health'. Substances that 'may cause sensitization by inhalation (R42) or by skin contact (R43)' are listed in the Annex 'Nonexhaustive list of agents, processes, and work', paragraph 3, 'Chemical agents', (b) 'Substances and preparations classified according to Directives 67/548/EEC and 88/379/EEC as harmful.....'. (46) Nevertheless, the article 7, at paragraph 3, reports that 'Member States may, by legislative or regulatory provision, authorize derogations from paragraph 2 in the case of adolescents where such derogations are indispensable for their vocational training, provided that protection of their safety and health is ensured by the fact that the work is performed under the supervision of a competent person within the meaning of Article 7 of Directive 89/391/EEC and provided that the protection afforded by that Directive is guaranteed'. Therefore, national work regulations may vary widely among the EU Member States. In some countries, the Directives (45–47) have led to a higher level of protection for young workers.

Regulations of many countries following the International Labour Organization (ILO) directions regarding child labor focus on such areas as a minimum age for admission to employment; pre-employment medical examination, limiting or gradually prohibiting night work and defining a list of jobs prohibited for young people (48). The main ILO standard is Conventions No 77 and 78 (1946) on Medical Examination of Young Persons, which makes thorough medical

examination of children and young persons under 18 years of age, admitted to employment or work in nonindustrial occupations obligatory (49, 50).

Perception of work-related respiratory allergies and occupational risks in young adults

Adolescents and young adults, even those with asthma, often have a poor understanding or appreciation for the effect that the workplace may have in causing or exacerbating asthma. Career choices are generally made at this age. A Swedish study (51) demonstrated that working-aged men who had asthma as adolescents (1.8% of all men) had greater mortality and hazard ratio (HR) 1.5 (95% CI 1.0–2.2) compared to healthy individuals or those with allergic rhinitis. They showed only a nonsignificant trend to avoid jobs with a higher probability of exposures known to cause airway irritation compared with nonasthmatic controls. In contrast, those with allergic rhinitis but no asthma in adolescence were significantly more likely to avoid jobs with expected irritant exposures (odds ratio 0.6, 95% CI 0.5–0.7). This might relate to the earlier onset of WRR compared with asthma; an increased risk of developing rhinitis has been identified in adolescents within 10 months of starting work with LMW agents (7). It has been shown that respiratory work disability is associated with potentially avoidable exposures to biologic dust, mineral dust, gases or fumes, especially in those with asthma (incidence 5.7 per 1000 PY in the European Respiratory Community Health Survey) (52).

Radon et al. (6) assessed adolescents with asthma and allergy among those in school-based vocational training programs and found that these conditions did not significantly influence career choice. In a study of Canadian young adults aged 16–22 with asthma, 91% cared for by primary care physicians, 55% indicated that asthma had an impact on their lives but similar to the previous study, only 35% said that asthma was an important factor in their career considerations, 44% were not aware of occupations that could worsen their asthma and only 14% had discussed their asthma and career with their physician (9).

These data stress the importance that adolescents and young adults be made aware that career choice should take into account also the possible health consequences and indicate the need for better communication to adolescents and young adults as to the possibility of occupational sensitization and allergic respiratory disorders (53).

Consensus suggestions for the prevention of work-related respiratory allergies among pre-apprentices or apprentices and other young workers

Prevention strategies of WRR among pre-apprentices or apprentices and other young workers should include.

- 1 Information campaigns and educational tools.
- 2 Environmental control.
- 3 Pre-apprentice health assessment and advice, medical surveillance during apprenticeship and early working years.

Information campaigns and educational tools

Potential means of providing information would include programs in schools, colleges/universities, and vocational training centers, as well as via workplaces and health care providers. The campaigns should be addressed not only to the young population potentially at risk but also to parents, teachers, and schools. It is also imperative that the knowledge of the respiratory risk is disseminated to employers who bear the responsibility for a safe work environment (54) and for adequately informing workers about work-related risks.

As work-exacerbated asthma (WEA) is common (occurring in up to 25% of workers with asthma) (55) and adolescents with asthma or allergy are most likely to interact with health care providers, the latter would be a particularly appropriate group to target to deliver such information at a stage when these patients may be considering future careers. An appropriate aim would be to develop the understanding of possible risks and preventive measures rather than instilling fear or preventing a young adult with asthma from entering the career of their choice. Specifically, the aim would not be to exclude asthmatic subjects from any workplace.

Examples of the information that could be provided in an information campaign are listed in Table 3.

The optimum means of communicating this information require further research. Possible methods include brochures elaborated and addressed to medical doctors (56, 57) and pamphlets to young adults and their parents (53), web-based programs, and individual advice by health care providers or others.

Environmental control

Work-related respiratory allergies result from interactions between host factors and the environment, but at least in OA, there is evidence that exposure levels represent one of the major determinants for the development of the disease (2, 24). The possibility that chronic rhinitis or asthma may be aggravated by the exposures involved in a particular job should also be considered. Health care providers should be aware that environmental control (minimizing the risk through reducing the levels of airborne sensitizers and respiratory irritants) is the cornerstone of any prevention strategy and that workplaces should be kept as healthy places. Hence,

Table 3 Examples of information that could be provided in an information campaign

Understanding
The risk for sensitization and development of allergic disorders;
The differences between occupational asthma (OA) and work-exacerbated asthma (WEA), common causative agents and jobs for OA and types of exposure causing WEA;
Rhinitis as an early marker;
Asthma control markers and action plans;
The importance of exposure control measures in workplaces;
Indicators of work-related asthma and the steps to take if asthma worsen in relation to work exposures.

for an effective prevention action, health care providers should have a detailed knowledge both of the individual characteristics and of the specific workplace environment.

Pre-apprentice health assessment and advice, medical surveillance during apprenticeship and early working years

When work will involve exposure to respiratory sensitizers, before starting vocational school or work, a baseline health assessment should be performed to evaluate the presence of personal determinants for the development of sensitization and respiratory allergy and/or to identify pre-existing respiratory diseases susceptible to worsening with workplace exposures. Besides providing the necessary clinical information and laboratory data on the young adult's health status at the time of entering the apprenticeship or starting work, the pre-exposure medical examination is important to the young adult's subsequent occupational history because it represents an indispensable baseline for the evaluation of any changes in health status that may occur later on.

The individual factors involved in the development of WRRAs have been studied in few categories of apprentices and regard only some HMW agents, but because of the common immunologic mechanisms, the present suggestions may be extended to all HMW agents. Contrarily, owing to the scarcity of data in apprentices exposed to LMW agents that act with various and mostly unknown mechanisms, (23, 34) no specific suggestions but only general considerations may be provided for these agents.

In respect of exposure to allergens, basic means for the baseline assessment are listed in Table 4. In case of a suggestive clinical history, presence of individual risk factors, and/or spirometry abnormalities, additional testing may be needed (Table 4), and in this case, the consultation of an allergologist is strongly suggested, including advice on the appropriate immunologic tests to perform, and their interpretation.

On the basis of the results of the clinical evaluation, the physician will identify an individual clinical risk profile. Considering individual risk factors, special attention should be paid to atopy, owing to the high frequency of this condition in the general population. There is evidence that at least for

several occupational allergens, sensitization to common inhalant allergens or atopy is associated with the development of SS and the development of WRR and asthma symptoms. However, it is also known that the majority of atopic subjects will develop neither sensitization nor symptoms. In line with this, an evidence-based guideline states that the PPVs of screening criteria are too poorly discriminating for screening out potentially susceptible individuals, particularly in the case of atopy where the trait is highly prevalent (58). Therefore, atopy should not represent a contraindication to starting vocational school involving exposure to allergic risks. It is mandatory, however, that close environmental control aimed to risk reduction at the workplace is made, because, although the risk for an atopic new employee is in relative terms higher than that for one who is not atopic, the absolute risk is dependent on the conditions of work. The same pertains to other individual risk factors (pre-existing RC and asthma, BHR, sensitization to cross-reactive allergens, Table 4) for which the predictive value for developing WRR is not known.

The panel shared the opinion that subjects with clinical history or objective evidence of *severe/uncontrolled asthma* should be informed in-depth about the risk of a career choice with expected exposure to airborne allergens and/or irritants (59, 60).

The physician should discuss the results of the baseline health assessment with the young adult and maybe with parents helping in making the professional choice. Moreover, the young adult should be educated to adopt all preventive measures to limit occupational exposure to potential allergens and irritants and to recognize and report immediately to a physician all possible symptoms suggestive of onset of WRR.

It should be made clear, however, that pre-employment screening is not intended, and should never be used, to exclude workers from any particular job.

After starting exposure, during apprenticeship or work, medical surveillance should occur through periodic health assessments aimed at detecting as early as possible the onset of sensitization and/or of occupational allergy or of work-exacerbated rhinitis or asthma. An individual program should be planned to investigate all early markers of sensitization and allergy (RC and asthma symptoms, skin tests, or *in-vitro* specific IgE when available) and pulmonary function (for those with known or detected asthma, there may be additional tests such as measures of BHR and/or serial peak flow readings) at regular intervals. An additional assessment should take place if WRS occur. The surveillance schedule should be adapted to each individual according to the clinical profile, exposure details, and reliability of available tests. Published data show that the incidence of SS, WRCS and WRNS, OA and OR start and reach the maximum within the first 2–3 years of exposure (4, 7, 8, 12–15, 18, 21, 22) and tend to decline afterward (4). Consequently, surveillance of workers exposed to occupational sensitizers should be carried out, within the boundaries of national work regulations, at least annually, and prioritized (be more frequent) in the first 2–3 years after starting exposure.

Table 4 Baseline clinical assessment

Basal assessment
Clinical history
History of atopy
Pre-existing rhinitis and asthma
General physical examination
Skin prick test (SPT)/serum-specific IgE for common allergens for those with allergic or asthma symptoms
Spirometry
Additional testing
SPTs/serum-specific IgE for the specific occupational agents
SPTs/serum-specific IgE for cross-reactive agents with the specific occupational agents
Bronchodilator test
Methacholine challenge test

Authors' contribution

This Position Paper is the result of the collaboration of a panel of experts who contributed to the document according to their different experiences and competences, coordinated by Dr Gianna Moscato.

Conflicts of interest

All Authors have no conflict of interest to declare.

References

- Kogevinas M, Zock JP, Jarvis D, Kromhout H, Lillienberg L, Plana E et al. Exposure to substances in the workplace and new-onset asthma: an international prospective population-based study (ECRHS-II). *Lancet* 2007;**370**:336–341.
- Becklake MR, Malo JL, Chan-Yeung M. Epidemiological approaches in occupational asthma. In: Bernstein IL, Chan-Yeung M, Malo JL, Bernstein DI, editors. *Asthma in the workplace*, 3rd edn. NY, USA: Taylor & Francis Group, 2006:37–85.
- Moscato G, Vandenplas O, Gerth Van Wijk R, Malo JL, Quirce S, Walusiak J et al. EA-ACI Task Force on Occupational Rhinitis: occupational Rhinitis. Position Paper. *Allergy* 2008;**63**:969–980.
- Gautrin D, Ghezzo H, Infante-Rivard C, Magnan M, L'Archevêque J, Suartha E et al. Long-term outcomes in a prospective cohort of apprentices exposed to high-molecular-weight agents. *Am J Respir Crit Care Med* 2008;**177**:871–879.
- Tarlo SM, Malo JL. An ATS/ERS report: 100 key questions and needs in occupational asthma. *Eur Respir J* 2006;**27**:607–614.
- Radon K, Huemmer S, Dressel H, Windstetter D, Weinmayr G, Weiland S et al. Do respiratory symptoms predict job choices in teenagers? *Eur Respir J* 2006;**27**:774–778.
- Riu E, Dressel H, Windstetter D, Weinmayr G, Weiland S, Vogelberg C et al. First months of employment and new onset of rhinitis in adolescents. *Eur Respir J* 2007;**30**:549–555.
- Walusiak J, Hanke W, Gorski P, Palczynski C. Respiratory allergy in apprentice bakers: do occupational allergies follow the allergic march? *Allergy* 2004;**59**:442–450.
- Bhinder S, Cicutto L, Abdel-Qadir HM, Tarlo SM. Perception of asthma as a factor in career choice among young adults with asthma. *Can Respir J* 2009;**16**:e69–e75.
- Poonai NP, van Diepen SF, Bharatha A, Manduch M, Deklaj T, Tarlo SM. Barriers to diagnosis of occupational asthma. *Can J Public Health* 2005;**96**:230–233.
- Santos M, Jung H, Peyrovi J, Lou W, Liss G, Tarlo SM. Occupational asthma and work-exacerbated asthma: factors associated with time to diagnostic steps. *Chest* 2007;**131**:1768–1775.
- Cullinan P, Cook A, Gordon S, Nieuwenhuijsen MJ, Tee RD, Venables KM et al. Allergen exposure, atopy and smoking as determinants of allergy to rats in a cohort of laboratory employees. *Eur Respir J* 1999;**13**:1139–1143.
- Gautrin D, Ghezzo H, Infante-Rivard C, Malo J-L. Incidence and determinants of IgE-mediated sensitization in apprentices. A prospective study. *Am J Respir Crit Care Med* 2000;**162**:1222–1228.
- Rodier F, Gautrin D, Ghezzo H, Malo J-L. Incidence of occupational rhinoconjunctivitis and risk factors in animal-health apprentices. *J Allergy Clin Immunol* 2003;**112**:1105–1111.
- Krop EJ, Heederik DJ, Lutter R, de Meer G, Aalberse RC, Jansen HM et al. Association between pre-employment immunologic and airway mucosal factors and the development of occupational allergy. *J Allergy Clin Immunol* 2009;**123**:694–700.
- Elliott L, Heederik D, Marshall S, Peden D, Loomis D. Incidence of allergy and allergy symptoms among workers exposed to laboratory animals. *Occup Environ Med* 2005;**62**:766–771.
- Gautrin D, Infante-Rivard C, Ghezzo H, Malo J-L. Incidence and host determinants of probable occupational asthma in apprentices exposed to laboratory animals. *Am J Respir Crit Care Med* 2001;**163**:899–904.
- De Zotti R, Bovenzi M. Prospective study of work related respiratory symptoms in trainee bakers. *Occup Environ Med* 2000;**57**:58–61.
- Cullinan P, Cook A, Nieuwenhuijsen MJ, Sandiford C, Tee RD, Venables KM et al. Allergen and dust exposure as determinants of work-related symptoms and sensitization in a cohort of flour-exposed workers; a case-control analysis. *Ann Occup Hyg* 2001;**45**:97–103.
- Gautrin D, Ghezzo H, Infante-Rivard C, Malo J-L. Incidence and host determinants of work-related rhinoconjunctivitis in apprentice pastry-makers. *Allergy* 2002;**57**:913–918.
- Skjold T, Dahl R, Juhl B, Sigsgaard T. The incidence of respiratory symptoms and sensitization in baker apprentices. *Eur Respir J* 2008;**32**:452–459.
- Archambault S, Malo J-L, Infante-Rivard C, Ghezzo H, Gautrin D. Incidence and sensitization, symptoms, and probable occupational rhinoconjunctivitis and asthma in apprentices starting exposure to latex. *J Allergy Clin Immunol* 2001;**107**:921–923.
- El-Zein M, Malo J-L, Infante-Rivard C, Gautrin D. Incidence and probable occupational asthma and changes in airway calibre and responsiveness in apprentice welders. *Eur Respir J* 2003;**22**:513–518.
- Baur X, Chen Z, Liebers V. Exposure-response relationships of occupational inhalative allergens. *Clin Exp Allergy* 1998;**28**:537–544.
- Gautrin D, Infante-Rivard C, Dao TV, Magnan-Larose M, Desjardins D, Malo JL. Specific IgE-dependent sensitization, atopy, and bronchial hyperresponsiveness in apprentices starting exposure to protein-derived agents. *Am J Respir Crit Care Med* 1997;**155**:1841–1847.
- Gautrin D, Ghezzo H, Malo JL. Rhinoconjunctivitis, bronchial responsiveness, and atopy as determinants for incident non-work-related asthma symptoms in apprentices exposed to high-molecular-weight allergens. *Allergy* 2003;**58**:608–615.
- Suartha E, Heederik D, Ghezzo H, Malo JL, Kennedy SM, Gautrin D. Risks for the development of outcomes related to occupational allergies: an application of the asthma-specific job exposure matrix compared with self-reports and investigator scores on job-training-related exposure. *Occup Environ Med* 2009;**66**:256–263.
- De Zotti R, Bovenzi M, Molinari S, Larese F, Peresson M. Respiratory symptoms and occupational sensitization in a group of trainee bakers: results of a 6-month follow up. *Med Lav* 1997;**88**:155–165.
- Gautrin D, Ghezzo H, Infante-Rivard C, Malo JL. Natural history of sensitization, symptoms and occupational diseases in apprentices exposed to laboratory animals. *Eur Respir J* 2001;**17**:904–908.
- de Meer G, Postma DS, Heederik D. Bronchial responsiveness to adenosine-5'-monophosphate and methacholine as predictors for nasal symptoms due to newly introduced allergens. A follow-up study among laboratory animal workers and bakery apprentices. *Clin Exp Allergy* 2003;**33**:789–794.
- Gautrin D, Ghezzo H, Infante-Rivard C, Malo JL. Host determinants for the development of allergies in apprentices exposed to laboratory animals. *Eur Respir J* 2002;**19**:96–103.

32. Suarathana E, Meijer E, Heederik D, Ghezzi H, Malo JL, Gautrin D. The Dutch diagnostic model for laboratory animal allergen sensitization was generalizable in Canadian apprentices. *J Clin Epidemiol* 2009;**62**:542–549.
33. Suarathana E, Malo JL, Heederik D, Ghezzi H, L'Archevêque J, Gautrin D. Which tools best predict the incidence of work-related sensitisation and symptoms. *Occup Environ Med* 2009;**66**:111–117.
34. Moscato G, Galdi E. Asthma and hairdressers. *Curr Opin Allergy Clin Immunol* 2006;**6**:91–95.
35. Houba R, Heederik DJ, Doekes G, van Run PE. Exposure-sensitization relationship for alpha-amylase allergens in the baking industry. *Am J Respir Crit Care Med* 1996;**154**:130–136.
36. Vanhanen M, Tuomi T, Nordman H, Tupasela O, Holmberg PC, Miettinen M et al. Sensitization to industrial enzymes in enzyme research and production. *Scand J Work Environ Health* 1997;**23**:385–391.
37. Romano C, Sulotto F, Piolatto G, Ciacco C, Capellaro E, Falagiani P et al. Factors related to the development of sensitization to green coffee and castor bean allergens among coffee workers. *Clin Exp Allergy* 1995;**25**:643–650.
38. Nielsen J, Welinder H, Jonsson B, Axmon A, Rylander L, Skerfving S. Exposure to hexahydrophthalic and methylhexahydrophthalic anhydrides – dose-response for sensitization and airway effects. *Scand J Work Environ Health* 2001;**27**:327–334.
39. Venables KM, Topping MD, Howe W, Luczynska CM, Hawkins R, Taylor AJ. Interaction of smoking and atopy in producing specific IgE antibody against a hapten protein conjugate. *Br Med J (Clin Res Ed)* 1985;**290**:201–204.
40. Groenewoud GC, de Jong NW, van Oorschot-van Nes AJ, Vermeulen AM, van Toorenenbergen AW, Mulder PG et al. Prevalence of occupational allergy to bell pepper pollen in greenhouses in the Netherlands. *Clin Exp Allergy* 2002;**32**:434–440.
41. Groenewoud GC, de Graaf in 't Veld C, vVan Oorschot-van Nes AJ, de Jong NW, Vermeulen AM, van Toorenenbergen AW et al. Prevalence of sensitization to the predatory mite *Amblyseius cucumeris* as a new occupational allergen in horticulture. *Allergy* 2002;**57**:614–619.
42. Nguyen B, Ghezzi H, Malo JL, Gautrin D. Time course of onset of sensitization to common and occupational inhalants in apprentices. *J Allergy Clin Immunol* 2003;**111**:807–812.
43. Rantanen J, Kauppinen T, Toikkanen J, Kurppa K, Lehtinen S, Leino T. Work and health country profiles. Country profiles and national surveillance indicators in occupational health and safety. People and Work. Research Reports 44. Helsinki: Finnish Institute of Occupational Health, 2001.
44. World Health Organization. Occupational medicine in Europe: scope and competencies. Regional Office for Europe, Copenhagen: World Health Organization, 2000.
45. Council Directive 89/391/EEC of 12 June 1989 on the introduction of measures to encourage improvements in the safety and health of workers at work. Available at: http://europa.eu.int/smartapi/cgi/sga_doc?smartapi!celexapi!prod!CELEXnumdoc&lg=EN&numdoc=31989L0391&model=guichett
46. Council Directive 94/33/EC of 22 June 1994 on the protection of young people at work. Available at: <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CONSLEG:1994L0033:20070628:EN:PDF>
47. Directive 2007/30/EC of the European Parliament and of the Council of 20 June 2007 amending Council Directive 89/391/EEC, its individual Directives and Council Directives 83/477/EEC, 91/383/EEC, 92/29/EEC and 94/33/EC with a view to simplifying and rationalising the reports on practical implementation Text with EEA relevance. Available at: <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2007:165:0021:01:EN:HTML>.
48. Alli BO. Fundamental principles of occupational health and safety. Geneva: International Labour Organization, 2001.
49. Medical Examination of Young Persons (Industry) Convention, 1946, No.77. Available at: <http://www.ilo.org/ilolex/cgi-lex/con- vde.pl?C077>.
50. Medical Examination of Young Persons (Non-Industrial Occupations) Convention, 1946, No.78. Available at: <http://www.ilo.org/ilolex/cgi-lex/con- vde.pl?C078>.
51. Wiebert P, Svartengren M, Lindberg M, Hemmingsson T, Lundberg I, Nise G. Mortality, morbidity and occupational exposure to airway-irritating agents among men with a respiratory diagnosis in adolescence. *Occup Environ Med* 2008;**65**:120–125.
52. Toren K, Zock JP, Kogevinas M, Plana E, Sunyer J, Radon K et al. An international prospective general population-based study of respiratory work disability. *Thorax* 2009;**64**:339–344.
53. Olgiati-Des Gouttes D, Boillat MA. Allergie et apprentissage: un apprenti informé en vaut deux. Lausanne: Suva, 2009, 4 p.
54. Sigsgaard T, Nowak D, Annesi-Maesano I, Nemery B, Torén K, Viegi G et al. ERS position paper: work-related respiratory diseases in the EU. *Eur Respir J* 2010;**35**:234–238.
55. Henneberger PK. Work-exacerbated asthma. *Curr Opin Allergy Clin Immunol* 2007;**7**:146–151.
56. Olgiati-Des Gouttes D, Boillat MA. Quels conseils donner aux apprentis allergiques? *Forum Med Suisse* 2006;**6**:769–772.
57. Olgiati-Des Gouttes D, Boillat MA. Quels conseils donner aux apprentis allergiques? Delémont: Groux arts graphiques SA, 2009, 83. Available at: <http://www.sgai.ch>.
58. Nicholson PJ, Cullinan P, Taylor AJ, Burge PS, Boyle C. Evidence based guidelines for the prevention, identification, and management of occupational asthma. *Occup Environ Med* 2005;**62**:290–299.
59. Holgate ST, Polosa R. The mechanisms, diagnosis, and management of severe asthma in adults. *Lancet* 2006;**368**:780–793.
60. Global Strategy for Asthma Management and Prevention, Global Initiative for Asthma (GINA) 2007. Available at: <http://www.ginasthma.org>.