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High prevalence of asthma and atopy in the Canary Islands, Spain

G. Juliá-Serdá,* P. Cabrera-Navarro,* O. Acosta-Fernández,† P. Martín-Pérez,* P. Losada-Cabrera,‡ M. A. García-Bello,§ T. Carrillo-Díaz,¶ J. Antó-Boqué#

***Servicio de Neumología, Hospital Universitario Dr Negrín, Las Palmas de Gran Canaria; †Hospital Nuestra Señora de la Candelaria, Santa Cruz de Tenerife; ‡Servicio de Análisis Clínicos, §Unidad de Investigación and ¶Servicio de Alergia, Hospital Universitario Dr Negrín, Las Palmas de Gran Canaria, Canary Islands; #Centre for Research in Environmental Epidemiology (CREAL), Department of Experimental and Health Sciences, Universitat Pompeu Fabra (UPF), Municipal Institute of Medical Research (IMIM-Hospital del Mar), CIBER Epidemiología y Salud Pública (CIBERESP), Barcelona, Spain**

SUMMARY

OBJECTIVE: To evaluate the prevalence of and risk factors for asthma and related conditions in the Canaries, Spain.

METHODS: From a randomised sample of 9506 adults aged 20–44 years who answered a short questionnaire, a random sample corresponding to 20% of the original was taken. Subjects classified as symptomatic in the previous survey and who were not included in the random sample were also invited to participate. The subjects completed a respiratory questionnaire, and underwent spirometry, bronchial hyperresponsiveness (BHR) test, skin tests and immunoglobulin E (IgE) measurements.

RESULTS: The random sample included 593 subjects. The prevalence of skin sensitisation to mites was 30.3% (95%CI 26.7–34.2) and the prevalence of IgE to mites 30.5% (95%CI 26.2–35.2). A prevalence of 40.6% (95%CI 35.9–45.5) was found for atopy, 14.1% (95%CI 11.1–17.1) for BHR and 4.2% (95%CI, 2.5–5.9) for asthma. The risk factors most strongly associated with asthma were atopy (OR 4.89, 95%CI 3.07–7.78) and respiratory infection before the age of 5 years (OR 2.78, 95%CI 1.66–4.67).

CONCLUSION: This study shows a high prevalence of sensitisation to mites, atopy, BHR and asthma in the Canaries, similar to that observed in English-speaking countries. We suggest that these findings could partially result from climatic conditions.

KEY WORDS: asthma prevalence; atopy; dust mites; asthma risk factors

THE TWO epidemiological surveys that have contributed the most to the study of the prevalence of asthma in recent years are likely the European Community Respiratory Health Survey (ECRHS) in young adults and the International Study of Asthma and Allergy in Childhood (ISAAC).[1,2] These studies show that the highest prevalence of asthma is found in English-speaking countries and the lowest in East Europe, India and the Far East.[3,4] To explain these variations in prevalence, various hypotheses have been proposed suggesting genetic, environmental, cultural or economic factors, as well as different perceptions of asthma.[5] Risk factors for asthma also show remarkable geographic variability, and this could partially explain the variation in disease prevalence.[6–8]

In a recent study using the ECRHS methodology, a high prevalence of asthma-related symptoms was observed in the Canary Islands.[9] This finding was in contrast with the lower prevalence found elsewhere in Spain, but consistent with other studies reporting high rates of asthma in islands and in coastal populations.[3] The reasons for this geographic pattern are unclear. A possible explanation that has received previous attention has been the high prevalence of sensitisation to mites in humid climate areas.[10]

In the present study, we assess the prevalence of allergenic sensitisation, bronchial hyperresponsiveness (BHR), atopy, asthma and risk factors for asthma in young adults in the Canaries using the ECRHS methodology.

MATERIAL AND METHODS

The initial phase of the ERCHS survey involved a random sample of 10 000 subjects (5000 subjects from Gran Canaria Island and 5000 from Tenerife Island) aged 20–44 years, who were sent a short questionnaire by mail.[9] The final sample in the first phase of the study consisted of 9506 subjects. In the second phase, a random sample corresponding to 20% of

Correspondence to: Gabriel Juliá-Serdá, Servicio de Neumología, Hospital Dr Negrín, Barranco de la Ballena s/n, 35020 Las Palmas de Gran Canaria, Spain. Tel: (+34) 928 450 563. Fax: (+34) 928 450 085. e-mail: jjulser@gobiernodecanarias.org
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the initial sample ($n = 1901$) was taken from both islands. In addition to this random sample, all subjects not chosen in the random sampling and who were categorised as symptomatic by the screening questionnaire used in the first phase of the study were also invited to participate ($n = 1232$). A subject was considered symptomatic if a positive answer was given to at least one of the following questions: 1) Have you, at any time in the last 12 months, been woken up at night by shortness of breath? 2) Have you, at any time in the last 12 months, had an asthma attack? 3) Are you currently taking any medicines (including inhalers, aerosols or tablets) for asthma? The symptomatic subjects were included in the analysis of the risk factors related to asthma but not in the prevalence study, as this would have confounded the results.

Subjects who were selected and agreed to participate in the study attended the hospital to complete an extensive questionnaire and perform spirometry, BHR, test, skin hypersensitivity tests and measurement of total and specific immunoglobulin E (IgE) levels in blood samples. All tests were performed on the same day. The Hospital Ethics Committee had previously approved the protocol, and all subjects signed a consent form. The questionnaire used in the second phase of the ERCHS was a variation of the International Union Against Tuberculosis and Lung Disease (The Union) questionnaire on respiratory symptoms.[11] A total of 71 questions were included, dealing with respiratory symptoms, self-perception of asthma and allergic conditions, family history of asthma and atopy, environmental exposure and treatment for asthma.

Spirometry was performed using a spirometer with a membrane pneumotachograph (Erich Jaeger, Würzburg, Germany). Both the spirometer and the technique complied with the American Thoracic Society/European Respiratory Society criteria.[12] BHR was assessed through a methacholine test.[13] Subjects with a forced expiratory volume in one second (FEV_1) of $<70\%$ of the predicted value did not take the methacholine test. Instead, they performed a bronchodilatation test with salbutamol (200 μg), administered using an inhalation chamber. BHR was defined as a $\geqslant 20\%$ fall in FEV_1 compared to the best FEV_1 value following diluent inhalation.

Skin sensitivity was evaluated by skin prick test. The most common aeroallergens found in the Canaries were used: house dust mite (*Dermatophagoides pteronyssinus, Blomia tropicalis*), cat epithelium, cockroach, pollens (*Gramineae*, *Artemisia vulgaris*, *Parietaria judaica*) and fungus (*Alternaria alternata*; ALK Abelló, Madrid, Spain). Skin reactions of >3 mm diameter were considered positive. Total and specific IgE (against *D. pteronyssinus, B. tropicalis,* cat epithelium, cockroach, *A. vulgaris*, *A. alternata*) were performed by the capsulated hydrophilic carrier method (Kabi Pharmacia, Uppsala, Sweden). A total serum IgE level of >100 U/l was considered to be increased.[14] Atopy was defined as the presence of >0.35 U/l of specific IgE or a >3 mm skin reaction.[15]

Two definitions of asthma were used in the analysis of risk factors: the first was based on symptoms, and subjects were considered asthmatic if they responded affirmatively to one of the following questions on the extensive questionnaire: 1) Have you, at any time in the last 12 months, been woken up at night by shortness of breath? 2) Have you, at any time in the last 12 months, had an asthma attack? 3) Are you currently taking any medicines (including inhalers, aerosols or tablets) for asthma? A stricter definition required the presence of BHR and a positive answer to one of the questions above. To emphasise the hereditary factor of asthma, we defined the variable genetic predisposition, which includes parental history of asthma and/or atopy.

Statistical analysis was performed using SPSS version 15.0 (Statistical Package for Social Sciences, Chicago, IL, USA). The random sample was used to estimate the prevalence rates of symptoms, BHR and atopy, while the random and symptomatic samples were pooled to assess the associations between asthma and risk factors. Significant differences between prevalence values were determined by the χ^2 test. Logistic regression analysis as well as odds ratios and χ^2 were used to evaluate the relationship between asthma and risk factors. $P < 0.05$ was considered statistically significant.

RESULTS

In the second phase of the study, there were 1183 participants aged 20–44 years, of whom 753 (63%) came from Gran Canaria and 430 (37%) from Tenerife. This group included both the random sample ($n = 593$, 50.6% men, representing 31.1% of the initial random sample of 1901) and the additional sample of symptomatic subjects who agreed to participate ($n = 588$, representing 47.7% of the total of symptomatic subjects). The Figure presents a flow diagram of the study. The prevalence of relevant asthma-related symptoms is presented in Table 1. Overall, women had higher prevalence, but the differences were not significant. A higher prevalence of wheezing and cough was found in current smokers than in non-smokers. However, asthma-related symptoms that we used to define asthma were not related to smoking. The prevalence of asthma (as defined by symptoms and by symptoms + BHR), BHR, atopy, positive skin prick tests, and presence of total and specific IgE in men and women is presented in Table 2. In relation to the skin prick test for both mites (*D. pteronyssinus* and *B. tropicalis*), the prevalence was 30.3% (95% confidence interval [CI] 26.7–34.2), and that of the combined immunoglobulins was 30.5% (95%CI 26.2–35.2). As the prevalence of atopy considering reaction

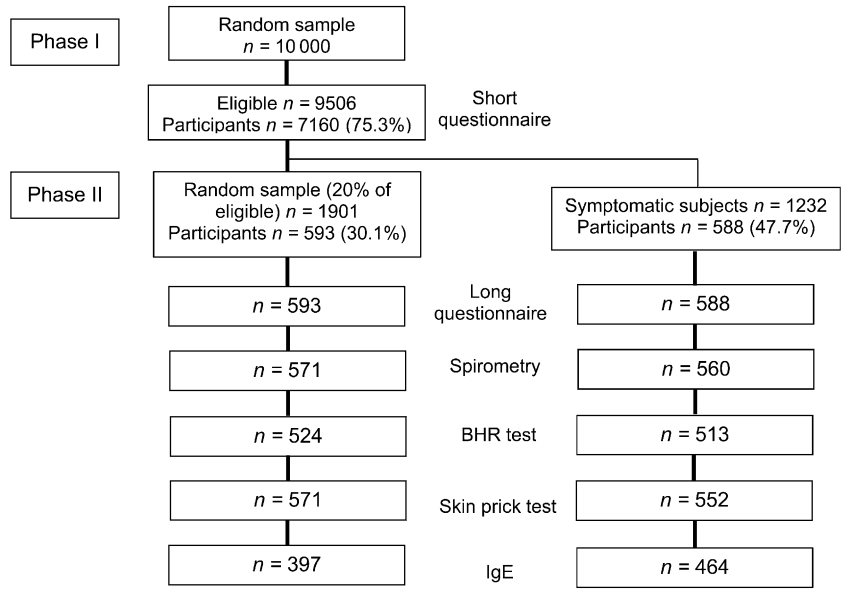

Figure Flow diagram of the first and second stages of the study on asthma in the Canary Islands, showing the number of subjects participating in the different tests. BHR = bronchial hyperresponsiveness; IgE = immunoglobulin E.

to mites alone was 37.1% (95%CI 32.4–41.9), the proportion of atopy attributable to mites alone was 91% (95%CI 85.9–94.7). Analysis of the relationship between atopy and BHR showed that 65% (95%CI 51.8–76.9) of the subjects with a positive methacholine challenge had atopy compared to 35% (95%CI 30.7–41.5) of those non-reactive to the challenge ($P < 0.01$). Finally, analyses of prevalence did not show significant differences between sexes, except for total IgE and specific IgE against *Dermatophagoides*, which were higher in men (Table 2). In the sample comprising symptomatic subjects, skin testing was positive in 50.3% (278/552), of whom 68.1% (316/464) had at least one specific IgE > 0.35 U/l. The methacholine test was positive in 33.1% (167/513). Atopy was present in 53.6% and asthma, as defined by symptoms plus a positive methacholine challenge, was present in 22.8%.

The risk factors for asthma, as defined by symptoms plus a positive methacholine test, were genetic disposition, atopy, respiratory infection before the age of 5 years, female sex, having a mother who smoked and the presence of moulds at home (Table 3). Table 3 also lists risk factors for asthma as defined by symptoms alone. Asthma as defined by symptoms plus positive methacholine challenge was shown by multivariate analysis to be significantly related to age, sex (female), atopy, genetic predisposition and respiratory

Table 1 Overall and sex-specific prevalence of asthma-related symptoms in the study population

Asthma symptom	Total (n = 593) % (95%CI)	Women (n = 294) % (95%CI)	Men (n = 299) % (95%CI)	P value
Have you, at any time in the last 12 months, had wheezing or whistling in your chest?	24.4 (18.5–25.3)	22 (17.2–26.8)	26.7 (21.6–31.8)	0.185
Have you, at any time in the last 12 months, had wheezing or whistling apart from cold?	18.9 (72.1–86.5)	17.5 (13.1–22)	20.3 (15.7–24.9)	0.396
Have you, at any time in the last 12 months, been woken up by a feeling of tightness in your chest?	13.7 (10.9–16.5)	16.4 (12.1–20.7)	11.0 (7.4–14.6)	0.060
Have you, at any time in the last 12 months, had an attack of shortness of breath that came on at rest during the day?	7.6 (5.4–9.8)	9.7 (6.3–13.1)	5.5 (2.9–8.1)	0.057
Have you, in the last 12 months, had an attack of shortness of breath that came on exercise?	27.4 (23.8–31.0)	30.9 (25.6–36.2)	24.0 (19.1–28.9)	0.061
Have you, at any time in the last 12 months, been woken up at night by an attack of shortness of breath?	10.9 (8.4–13.4)	12.9 (9.0–16.8)	8.9 (5.6–12.2)	0.123
Have you ever had asthma?	8.3 (6.0–10.5)	8.4 (5.2–11.6)	8.3 (5.1–11.5)	0.980
Have you, at any time in the last 12 months, had an asthma attack?	34.8 (21.0–48.6)	25.0 (7.7–42.3)	45.5 (24.7–66.3)	0.146
Are you currently taking any medicines for asthma?	45.8 (31.7–59.9)	36.0 (17.2–54.8)	56.5 (36.7–76.3)	0.154

CI = confidence interval.

Table 2 Overall and sex prevalence of asthma, BHR, atopy, skin prick test and total and specific IgE

	Total % (95%CI)	Women % (95%CI)	Men % (95%CI)	*P* value
Asthma (symptoms)	13.6 (11–16.6)	16.1 (12.3–20.8)	11.1 (7.9–15.2)	0.079
Asthma (symptoms + BHR)	4.2 (2.5–5.9)	4.8 (2.1–7.4)	3.7 (1.4–5.9)	0.541
BHR	14.1 (11.1–17.1)	14.8 (10.4–19.2)	13.4 (9.3–17.5)	0.643
Atopy	40.6 (35.9–45.5)	36.1 (29.6–42.9)	45.0 (38.2–29.6)	0.069
Positive skin prick tests*				
Dermatophagoides pteronyssinus	27.8 (24.7–31.6)	24.2 (19.7–29.5)	31.3 (26.3–36.8)	0.054
Blomia tropicalis	12.5 (10.1–15.4)	11.3 (8.1–15.4)	13.7 (10.2–18.1)	0.376
Cat	7.6 (5.7–10)	7.5 (5–11.2)	7.7 (5.1–11.1)	0.942
Pollens†	2.4 (1.4–4)	3.5 (1.9–6.4)	1.4 (0.5–3.4)	0.148
IgE‡				
Total	28.7 (24.3–33.3)	24.0 (18.0–30.0)	33.7 (27.1–40.3)	0.034
D. pteronyssinus	28.2 (24.0–32.8)	22.8 (17.5–29.1)	33.5 (27.3–40.3)	0.018
B. tropicalis	17.1 (13.7–21.5)	15.7 (11.3–43.3)	18.5 (13.7–24.5)	0.468
Cat	11.6 (8.8–15.1)	12.8 (8.3–17.5)	11.0 (7.3–16.1)	0.713
Pollens†	5.3 (3.5–7.9)	4.6 (2.4–8.4)	6 (3.4–10.1)	0.524

*Prick tests were positive when the skin lesion was >3 mm diameter.[14]
†Including *Gramineae*, *Artemisia vulgaris* and *Parietaria judaica*.
‡Total IgE was positive when it was >100 U/l and specific IgE >0.35 U/l.[15]
BHR = bronchial hyperresponsiveness; IgE = immunoglobulin E; CI = confidence interval.

infection before the age of 5 years. Asthma as defined by symptoms alone was significantly associated with all of the above variables except age (Table 4).

DISCUSSION

In this study, we have shown that prevalence of asthma, asthma-related symptoms, BHR and sensitisation to mites in young adults living in the Canaries are the highest so far reported in Spain, and rank among the highest in the world. These results strongly suggest that sensitisation to house dust mites is one of the main factors explaining the high prevalence of asthma in our population. In a previous publication,[16] a high rate of positive skin tests against *D. pteronyssinus* had been reported in the Canaries; however, no conclusions regarding prevalence could be drawn from that study, as it involved a non-randomised sample of students aged 15–22 years. The high prevalence of sensitisation to mites observed here (reflected by both positive skin tests and specific IgE) is one of the highest compared to other relevant epidemiological studies.[3,17] The ECRHS reported a mean prevalence of 21.7% skin sensitisation to mites, while that of specific IgE was 21%.[3] With respect to Spain, the prevalence of sensitisation to mites fluctuated between centres, with the skin test ranging between 4.8% and 17.5% and specific IgE between 7% and 28%.[8,18] We also found an increased prevalence of atopy, much higher than the mean prevalence from the ECRHS and the rest of Spain, where it varies according to region (men 24.6–39.6%, women 10.3–28.8%). Moreover, in our study atopy was almost exclusively due to sensitisation to house dust mites, in contrast with most centres in Europe, where different types of antigen contribute to this variable.[8] The increased sensitisation to mites corresponds to the high density of these arthropods, often exceeding 100 μg/g in bedrooms of sensitised patients in the city of Las Palmas de Gran Canaria.[19] We believe that these findings

Table 3 Risk factors (crude OR) for asthma as defined by symptoms plus BHR and by symptoms

Risk factors	Asthma (symptoms + BHR) OR (95%CI)	Asthma (symptoms) OR (95%CI)
Sex (female)*	0.67 (0.47–0.97)†	0.77 (0.60–0.97)†
Genetic predisposition‡	1.70 (1.19–2.44)§	1.97 (1.55–2.52)§
Infection before the age of 5 years	3.17 (1.99–5.03)§	3.40 (2.28–5.04)§
House moulds	1.44 (1.01–2.07)†	1.48 (1.12–1.81)†
Atopy¶	5.42 (3.54–8.29)§	2.72 (2.13–3.46)§
Smoking mother#	1.76 (1.04–2.99)†	1.32 (0.89–1.95)
Siblings with asthma	1.48 (0.99–2.08)	1.42 (1.12–1.82)§

*Reference category: female.
†$P < 0.05$.
‡Includes parental history of asthma and/or atopy.
§$P < 0.01$.
¶Defined as the presence of >0.35 U/l specific IgE or >3 mm skin reaction.
#Whether the mother smoked during the childhood of an asthmatic or before the child was born.
OR = odds ratio; CI = confidence interval; IgE = immunoglobulin E.

Table 4 Logistic regression: OR for asthma as defined by symptoms plus BHR and by symptoms alone

Risk factors	Asthma (symptoms + BHR) OR (95%CI)	Asthma (symptoms) OR (95%CI)
Age	0.95 (0.92–0.98)*	1.01 (0.98–1.02)
Sex (female)	0.62 (0.41–0.93)*	0.73 (0.57–0.94)*
Genetic predisposition	1.63 (1.09–2.35)*	1.83 (1.41–2.37)†
Atopy	4.89 (3.07–7.78)†	2.68 (2.04–3.45)†
Infection before the age of 5 years	2.78 (1.66–4.67)†	2.99 (3.25–7.95)†

*$P < 0.03$.
†$P < 0.001$.
BHR = bronchial hyperresponsiveness; OR = odds ratio; CI = confidence interval.

could be explained by the environmental conditions of the region.

The climate in the Canaries is notably different from that of the rest of Spain. It is a subtropical climate with mild temperatures that remain fairly stable throughout the year. The absolute humidity of the air is high, promoting the development of mites. This type of climate with high levels of humidity is present in other islands (New Zealand, the United Kingdom and Ireland) and on the south-eastern coast of Australia (Melbourne), although with different temperatures. The highest prevalence of sensitisation to mites has been reported from these areas, and estimates are similar to those from this study.[3,8] Furthermore, the significant difference in total and specific IgE against mites found between men and women should be noted. The higher prevalence of these immunoglobulins in men has been described by other authors,[20,21] although the explanation for this disparity remains unknown.

In the ECRHS, BHR prevalence varied greatly between centres (3.4–27.8%). Essentially, the highest values were found in New Zealand, Australia, the United Kingdom Great Britain and the United States.[22] The BHR rate in the Canaries is among the highest in Europe and fits with the high prevalence of asthma-related symptoms and increased sensitisation to mites.

Another relevant finding of this study is the high prevalence of asthma symptoms and asthma (BHR plus symptoms). These findings place the Canary Islands alongside New Zealand, Australia and the United Kingdom[3] as one of the areas with the highest levels of asthma. The fact that this geographic pattern is consistent with the distribution of atopia lends support to the hypothesis that asthma is likely due to environmental factors.

Risk factors for asthma prevalence include a wide set of environmental, genetic and socio-cultural variables, which likely reflect the complexity of this condition, particularly from the aetiological perspective.[5,23] It is therefore difficult to find a restricted set of common risk factors that allow a reliable estimate of the probability of asthma, regardless of the population studied. Nevertheless, there are some risk factors that are reported in most epidemiological investigations. For example, the relationship between atopy and asthma was demonstrated in the ECRHS study.[8] We have also observed a strong relationship between atopy and both asthma and asthma-related symptoms. As discussed above, the atopy risk factor in this study resulted almost entirely from sensitisation to mites. This finding suggests a causal relationship between asthma and exposure to mites, as advocated by some authors.[24] Family history of asthma has been associated with asthma, suggesting a heredity factor for this condition. In our study, this variable was associated with both asthma and asthma-related symptoms, supporting the significance of genetics in asthma.

As in the ECRHS,[25] we have found that an episode of respiratory infection during childhood is another risk factor strongly related to asthma. It has been demonstrated that infections with various viruses (respiratory syncytial virus, metapneumovirus) are related to childhood asthma.[7,26] However, the lack of specificity of the only question referring to childhood infection should be highlighted, as an attack of asthma (or other dispnoeic conditions) could be mistaken for respiratory infection. For this reason, and because childhood respiratory infections are quite frequent, we think this risk factor is weak for discriminating asthma.

As reported in other studies,[21,25] we identified sex as an independent variable related to asthma. In general, asthma predominates in boys before puberty, but this tendency reverses in adulthood in favour of women. This might be a result of overrepresentation of women in these studies or due to some as yet unknown hormonal factors.[21] The association between smoking and asthma is not clear. Our findings on the relation of asthma and smoking suggest that tobacco exposure is a trigger of asthma symptoms rather than a risk factor for this condition.

Our study findings should be interpreted in the light of some relevant limitations. We had a large proportion of non-responders; however, this percentage is comparable to other prevalence studies where a BHR test was used.[27,28] Our study followed a cross-sectional design, and our risk factors may be partially explained by association with asthma persistence rather than by incidence. An important part of our interpretation included comparisons with other Spanish areas and countries of the ECRHS study. We followed the same protocol and study methods, and although our research was performed in a different period, it is unlikely that a period effect affected our comparisons.

In summary, this study demonstrates a high prevalence of atopy from sensitisation to mites, BHR, asthma-related symptoms and asthma in the Canaries, similar to that observed in English-speaking countries. This phenomenon is likely to have a complex aetiology, with sensitisation to mites, genetic and climate factors such as the proximity to the ocean and high absolute humidity being possible determinants.

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RÉSUMÉ

OBJECTIF : Évaluer aux Canaries la prévalence de l'asthme et des affections en relation avec lui ainsi que leurs facteurs de risque.

MÉTHODES : On a prélevé un échantillon aléatoire correspondant à 20% d'un échantillon original randomisé de 9506 adultes, âgés de 20 à 44 ans, qui avaient répondu à un questionnaire court. De plus, on a invité à participer les sujets classés comme symptomatiques lors de l'enquête antérieure et qui n'étaient pas inclus dans l'échantillon aléatoire. Les sujets ont rempli un questionnaire respiratoire, exécuté une spirométrie, et subi un test d'hyperréactivité bronchique (BHR), des tests cutanés et des mesures d'immunoglobuline (IgE).

RÉSULTATS : L'échantillon aléatoire comportait 593 sujets. La prévalence de la sensibilité cutanée aux mites a été de 30,3% (IC95% 26,7–34,2) et la prévalence des IgE contre les mites de 30,5% (IC95% 26,2–35,2). La prévalence de l'atopie a été de 40,6% (IC95% 35,9–45,5), celle de la BHR de 14,1% (IC95% 11,1–17,1) et celle de l'asthme de 4,2% (IC95% 2,5–5,9). Les facteurs de risque en association la plus étroite avec l'asthme ont été l'atopie (OR 4,89 ; IC95% 3,07–7,78) ainsi qu'une infection respiratoire avant l'âge de 5 ans (OR 2,78 ; IC95% 1,66–4,67).

CONCLUSION : Cette étude montre aux Canaries une prévalence élevée de la sensibilisation aux mites, de l'atopie, du BHR et de l'asthme, observations similaires à celles faites dans les pays de langue anglaise. Nous suggérons que ces faits pourraient résulter en partie des conditions climatiques.

RESUMEN

OBJETIVO: Este estudio se diseñó con la finalidad de analizar la prevalencia y los factores de riesgo de asma, así como otras variables relacionadas con el asma, en las Canarias.

MÉTODOS: A partir de una muestra aleatoria de 9506 adultos con edades comprendidas entre 20 y 44 años, que anteriormente respondieron a un cuestionario corto, se obtuvo una muestra al azar correspondiente al 20% de la inicial. Además, las personas clasificadas como sintomáticas en la primera encuesta y no incluidos en esta muestra aleatoria fueron también invitadas a participar. Los sujetos cumplimentaron un cuestionario respiratorio, realizaron una espirometría, una prueba de hiperrespuesta bronquial (BHR), un test de alergia cutánea, y se les determinó la IgE sérica.

RESULTADOS: La muestra aleatoria incluyó a 593 sujetos. La prevalencia de sensibilización cutánea a ácaros fue 30,3% (95%CI 26,7–34,2) y la prevalencia de IgE a ácaros del 30,5% (95%CI 26,2–35,2). Se observó una prevalencia de atopia de 40,6% (95%CI 35,9–45,5), de BHR de 14,1% (95%CI 11,1–17,1) y de asma de 4,2% (95%CI 2,5–5,9). Los factores de riesgo que más se asociaron a asma fueron la atopia (OR 4,89; 95%CI 3,07–7,78) y el haber padecido una infección respiratoria antes de los 5 años (OR 2,78; 95%CI 1,66–4,67).

CONCLUSIÓN: Este estudio demuestra una elevada prevalencia de sensibilización a ácaros, de atopia, de BHR y de asma en las Canarias, parecida a la observada en otros países de habla inglesa. Sugerimos que estos hallazgos pueden ser parcialmente explicados por condiciones climáticas.