Allergol Immunopathol (Madr). 2018;46(1):31–38

Allergologia et immunopathologia

Sociedad Española de Inmunología Clínica, Alergología y Asma Pediátrica

www.elsevier.es/ai

ORIGINAL ARTICLE

# A rural environment does not protect against asthma or other allergic diseases amongst Mexican children

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Received 19 December 2016; accepted 24 January 2017
Available online 4 May 2017

**KEYWORDS**
Asthma;
Children;
Allergic diseases;
Rural;
Urban

**Abstract**
*Introduction:* The commonly held notion that a rural environment decreases the frequency of allergic diseases has proven to be inconsistent amongst children.
*Objective:* Our objective was to contrast the prevalence of bronchial asthma (BA), allergic rhinitis (AR), and atopic dermatitis (AD) between children that live in a rural environment and those that live in urban areas.
*Methods:* We carried out a cross-sectional study amongst children aged six to seven; they were selected through probabilistic, stratified and conglomerated sampling. The prevalence of BA, AR, and AD was identified with the use of the questionnaire provided by *The International Study of Asthma and Allergies in Childhood*, additionally, we inquired about each child's family history of atopy, their exposure to farm animals, the intake of unpasteurised cow's milk, and the number of siblings related to every child. We used logistic regression and multivariate analysis to determine the correlation between asthma, allergic diseases, and rural environment.
*Results:* We included 189/1003 (18.8%) children from a rural environment, and 814/1003 (81.2%) from an urban area. BA and AR were associated to a family history of atopy (OR = 2.15, $p = 0.001$; OR = 2.58, $p = 0.002$, respectively). BA was more prevalent in males (OR = 1.92, $p = 0.007$). Notably, a higher number of siblings seems to protect against AR (OR = 0.45, $p = 0.008$). A paternal history of allergies was associated to AD.

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https://doi.org/10.1016/j.aller.2017.01.010

*Conclusions:* In our study, we were unable to find protective factors in a rural environment that might decrease the prevalence of asthma or allergic diseases.


## Introduction

Urbanisation, along with heritage,[1,2] has been associated to an increasing prevalence of asthma, allergic rhinitis, and dermatitis around various parts of the world.[3,4] Some have argued that increased standards in hygiene and smaller nuclear families have contributed to this pattern.[5] Interestingly, this prevalence has not been observed in rural areas; the following rural conditions have been linked to potential protective agents that act against these diseases: a greater number of siblings,[1,6] sex,[2] breastfeeding,[7,8] type of delivery,[9–13] interaction with farm animals,[14,15] and the intake of unpasteurised cow's milk, amongst other.[16–18]

The effect that a rural environment might have on the frequency of asthma, allergic rhinitis, and atopic dermatitis has seldom been researched in Mexico,[19,20] thus we decided to study the matter, in order to do so, we contrasted the prevalence of these diseases amongst school-aged children that live in an urban setting to those that live in rural regions. Additionally, we attempted to determine which, if any, rural factors act as protective agents against these diseases.

## Methods

### Ethics

This study was approved by the Ethics Committee at The Hospital Civil de Guadalajara ''Dr. Juan I. Menchaca'' and ratified by *La Jurisdicción Sanitaria No. III Altos Sur de la Secretaría de Salud de Jalisco*, as well as by the board of directors in The *Delegación Regional de Servicios Educativos*. In order for children to participate in our study, a legal guardian had to sign a written consent form.

### Setting

*Tepatitlán de Morelos* is located in western Mexico, at an altitude of 1806 metres above sea level; it encompasses an area of 1532.78 $km^2$ in which approximately 141,322 inhabitants reside.[21] We selected this region because within its limits, it is possible to study both a rural and an urban population simultaneously.

### Design

Our cross-sectional study was population based, the candidate selection process took place from April 2012 to April 2013, our subjects were primary school (both public and private sectors) students, aged six to seven. The universe of study was of 3946 children.

### Sample size

We estimated a sample size of 848 school-aged children, plus a 20% increase due to potential non-response, we also considered a confidence interval at 95%, a statistical power of 80% and a higher proportion of children with asthma in an urban setting (12%) over those in a rural environment (7%).

### Pilot study

We carried out a pilot study to identify potential errors in our questionnaire, inexperienced interviewers, and any inadequacies in the selection of our test subjects. The test subjects selected for the pilot were not included in the final analysis.

### Techniques and sampling

Our sample selection was probabilistic, stratified and clustered, as seen previously in similar studies.[22]

We selected regions that had both rural and urban schools that were certified by Jalisco's Department of Education. The calculated sample was assigned proportionally into a rural or urban group, 17% and 83%, respectively. Each school zone was considered a stratum that contributed with a certain number of schools; they were selected through random numbers generated by a computer. The total number of schools per stratum was decided upon after we multiplied the percentage of students that each school zone contributed by the number of schools in each region, respectively; the obtained result was rounded to the nearest superior whole number. After selecting the schools, each grade was assigned to its own stratum that contributed proportionally to the calculated sample; when the number of selected schools did not reach the calculated sub-sample, we continued to randomly select schools until there were enough.

### Procedure

Once we identified potential test subjects, we explained the general objective and implications of our study to each individual; additionally, we received verbal consent from the primary school teachers and a signed consent form from a legal guardian.

### Measurements

The prevalence of asthma and allergic diseases was determined with the use of a questionnaire that has been

**Table 1** Characteristics of the studied population.

| | Total $n = 1003$ | | Rural $n = 189$ | | Urban $n = 814$ | | $p$ |
|---|---|---|---|---|---|---|---|
| | $n$ | % | $n$ | % | $n$ | % | |
| Sex, male | 474 | 47.6 | 87 | 46 | 387 | 47.7 | 0.676 |
| *Family atopy* | | | | | | | |
| Mother with asthma | 53 | 5.3 | 13 | 6.9 | 40 | 4.9 | 0.227 |
| Father with asthma | 41 | 4.1 | 9 | 4.8 | 32 | 3.9 | 0.603 |
| Mother with allergies | 151 | 15.1 | 33 | 17.5 | 118 | 14.5 | 0.305 |
| Father with allergies | 80 | 8.0 | 14 | 7.4 | 66 | 8.1 | 0.749 |
| Other family member | 342 | 34.2 | 70 | 37.0 | 272 | 33.5 | 0.355 |
| *Smokers* | | | | | | | |
| Mother | 145 | 14.5 | 25 | 13.2 | 120 | 14.7 | 0.594 |
| Father | 346 | 34.5 | 70 | 37.0 | 276 | 33.9 | 0.421 |
| Other family member | 321 | 32.0 | 63 | 33.3 | 258 | 31.7 | 0.664 |
| Breastfed | 675 | 67.3 | 123 | 65.1 | 552 | 67.8 | 0.470 |
| *Intake of cow's milk* | | | | | | | |
| Never | 422 | 42.1 | 61 | 32.3 | 361 | 44.3 | |
| 1/week | 156 | 15.6 | 30 | 15.6 | 126 | 15.5 | 0.006 |
| Daily | 425 | 42.4 | 98 | 51.9 | 327 | 40.2 | |
| *Number of siblings* | | | | | | | |
| None | 101 | 10.1 | 16 | 8.5 | 85 | 10.4 | |
| 1 | 313 | 31.2 | 47 | 24.9 | 266 | 32.7 | 0.047 |
| >1 | 589 | 58.7 | 126 | 66.7 | 463 | 56.9 | |
| *Contact with animals* | | | | | | | |
| Dog | 504 | 50.2 | 110 | 58.2 | 394 | 48.4 | 0.015 |
| Cat | 170 | 16.9 | 47 | 24.9 | 123 | 15.1 | 0.001 |
| Horse | 79 | 7.9 | 24 | 12.7 | 55 | 6.8 | 0.006 |
| Farm | 182 | 18.1 | 68 | 36.0 | 114 | 14.0 | <0.0001 |
| *Household pets* | | | | | | | |
| Dog | 235 | 23.4 | 58 | 30.7 | 177 | 21.7 | 0.009 |
| Cat | 71 | 7.1 | 19 | 10.1 | 52 | 6.4 | 0.077 |

Proportions were compared using the Chi Squared Test.

standardised and validated by the International Study of Asthma and Allergies in Childhood (ISAAC); notably, their questionnaire has been employed by similar studies in our country,[23] as it is a tool that helps identify the presence or absence of asthma, allergic rhinitis, and atopic dermatitis during the previous year of a subject's life, it also detects when a patient has been diagnosed by a physician, in regard to the aforementioned diseases. We looked into several other factors regarding each participant's past, such as: a family history of allergic diseases, exposure to second-hand smoke, whether or not the child was breastfed, interaction with household pets and farm animals (pigs, cows, goats and chickens). The definition of rural zone was a region with population that did not exceed 2500 residents.[24]

## Statistical analysis

Our results were analysed with The IBM SPSS software, version 20.0 for Windows (Armonk, NY, USA), the Chi Squared Test was used to compare proportions, and the association between allergic diseases and their symptoms within specific environments was evaluated with the Odds Ratio (OR); furthermore, we calculated their respective confidence intervals at 95% (95%CI). Risks were adjusted by using multivariate logistical regression. When $p \leq 0.05$, we registered it as statistically significant.

## Results

We included a total of 1003 children in this study, 189/1003 (18.8%) lived in a rural area, while 814/1003 (81.2%) lived within an urban sector; we had participation rates of 100% and 96.4%, respectively.

The proportion of participating children was very similar, Table 1. There was no significant difference between a rural environment and an urban one when it came to a family history of either asthma or allergic diseases; similarly, we were unable to link these diseases to parental smoking. Children from a rural environment consumed unpasteurised milk more frequently than children in urban areas ($p = 0.006$). We registered a median of two siblings (with a minimum and a maximum between 0 and 14) per household; children in

**Table 2** Prevalence of the symptoms regarding allergic diseases among school-aged children according to the region in which they live.

| | Total $n = 1003$ | | Rural $n = 189$ | | Urban $n = 814$ | | OR* | 95%CI | $p$ |
|---|---|---|---|---|---|---|---|---|---|
| | $n$ | % | $n$ | % | $n$ | % | | | |
| Wheezing at some point | 238 | 23.7 | 47 | 24.9 | 191 | 23.5 | 1.08 | 0.75–1.56 | 0.683 |
| Wheezing during the previous year | 96 | 9.6 | 19 | 10.1 | 77 | 9.5 | 1.07 | 0.63–1.81 | 0.803 |
| Wheezing during exercise | 65 | 6.5 | 19 | 10.1 | 46 | 5.7 | 1.87 | 1.07–3.26 | 0.029 |
| Nocturnal coughing during the previous year | 321 | 32.0 | 65 | 34.4 | 256 | 31.4 | 1.14 | 0.82–1.59 | 0.435 |
| Prevalence of asthma | 80 | 8.0 | 11 | 5.8 | 69 | 8.5 | 0.67 | 0.34–1.29 | 0.227 |
| Rhinitis at some point | 342 | 34.1 | 76 | 40.2 | 266 | 32.7 | 1.38 | 1.00–1.92 | 0.049 |
| Rhinitis during the previous year | 276 | 27.5 | 58 | 30.7 | 218 | 26.8 | 1.21 | 0.85–1.71 | 0.279 |
| Rhinitis and conjunctivitis in previous year | 99 | 9.9 | 23 | 12.2 | 76 | 9.3 | 1.58 | 0.99–2.53 | 0.057 |
| Prevalence of allergic rhinitis | 48 | 4.8 | 11 | 5.8 | 37 | 4.5 | 1.29 | 0.65–2.59 | 0.461 |
| Dermatitis at some point | 91 | 9.1 | 29 | 15.3 | 62 | 7.6 | 2.19 | 1.37–3.53 | 0.001 |
| Dermatitis during the previous year | 65 | 6.5 | 19 | 10.1 | 46 | 5.6 | 1.86 | 1.07–3.26 | 0.029 |
| Dermatitis in joints | 53 | 5.3 | 14 | 7.4 | 39 | 4.8 | 1.59 | 0.84–2.99 | 0.151 |
| Prevalence of atopic dermatitis | 24 | 2.4 | 7 | 3.7 | 17 | 2.1 | 1.80 | 0.74–4.41 | 0.197 |

* The reference group came from an urban setting.

rural areas had more siblings ($p = 0.047$). Exposure to household pets and farm animals was significantly higher amongst children in rural areas ($p < 0.001$); children in an urban environment had less contact with household dogs ($p = 0.009$).

Approximately one quarter of the children had experienced at least one episode of acute wheezing, but fewer than 10% had had an episode in the last year, Table 2. Interestingly, children in urban areas had fewer wheezing episodes than those in rural zones, a contrast that reached a significant statistical bearing ($p = 0.029$). We did not find any difference between the groups with regards to the prevalence of asthma and its symptoms. Allergic rhinitis was more common amongst rural children; however, there was a statistical difference when regarding one-time episodes of allergic rhinitis ($p = 0.049$). Lastly, dermatitis also proved to be considerably more frequent in rural areas, whether it was a one-time episode or a diagnosis from the previous year ($p < 0.001$ and 0.028, respectively).

In Table 3, we display the factors associated to the prevalence of asthma, allergic rhinitis, and atopic dermatitis, these factors have been adjusted with multivariate analysis. Asthma was associated to males (OR = 1.92, $p = .007$) and a family history of allergic diseases (OR = 2.15, $p = 0.001$). Similarly, allergic rhinitis was linked to a family history of allergies (OR = 2.58, $p = 0.002$), while a higher number of siblings was found to be a protective factor (OR = 0.45, $p = 0.008$) against these two diseases. With regard to atopic dermatitis, we observed that a paternal history of the disease was significantly associated to its prevalence (OR = 4.12, $p = 0.004$). Allergic diseases were not associated to: farm animal interaction, the intake of unpasteurised cow's milk, an urban school environment, or the number of siblings. In Table 4, we display the factors that were associated to symptoms of asthma, allergic rhinitis, and atopic dermatitis, one year prior to when our study took place. The only association that had significant statistical relevance was observed between the presence of allergic rhinitis during the previous year and a family history of allergic diseases (OR = 2.06, $p = 0.011$).

## Discussion

With the exception of inheritance, we were unable to associate a lower frequency of allergic diseases in children that live in rural areas, however, these children tend to have several siblings, and this does seem to decrease the prevalence of allergic rhinitis.

In Mexico, few publications have presented findings similar to ours, in fact, there have been reports of a decreased frequency of asthma amongst children in rural areas[19] and a 50% reduction in the prevalence of nasal symptoms.[20] These results are similar to those reached by other global studies on the matter. In Latin America, a study from Brazil reported a lower prevalence of asthma and allergic rhinitis amongst children in rural areas.[25] Bolivian children in urban sectors had a higher prevalence of wheezing episodes, symptoms of sever rhino-conjunctivitis, and severe dermatitis[26]; in the east, a Chinese study found that adolescents living in rural areas had a lower frequency of asthma and wheezing episodes during the previous year.[14] Nonetheless, not all of the compiled studies have reached this conclusion, for example, in Turkey there were no differences between an urban setting and a rural area regarding the prevalence of asthma, allergic rhinitis, and atopic dermatitis[27]; in The Republic of Macedonia, a population-based study showed no significant statistical differences between these two settings once they were adjusted by the confounder factors[28]; on the same note, a study in Portugal also reported that there was no disparity between these environments and the prevalence of asthma or its symptoms.[29] Our findings are consistent with the latter studies, this may be a result of

**Table 3** Multivariate model of factors associated to the prevalence of allergic diseases.

| Type of disease | OR | 95%CI | *p* |
|---|---|---|---|
| *DV: asthma* | | | |
| Male sex | 1.92 | 1.19–3.08 | 0.007 |
| Allergic mother | – | – | 0.960 |
| Allergic father | – | – | 0.788 |
| An allergic family member | 2.15 | 1.35–3.40 | 0.001 |
| Caesarean birth | – | – | 0.820 |
| Breastfeeding, four months or more | – | – | 0.146 |
| Siblings, more than one | – | – | 0.416 |
| Rural school environment | – | – | 0.199 |
| Interaction with farm animals | – | – | 0.732 |
| Intake of cow's milk | – | – | 0.674 |
| *DV: allergic rhinitis* | | | |
| Male sex | – | – | 0.446 |
| Allergic mother | – | – | 0.629 |
| Allergic father | – | – | 0.563 |
| An allergic family member | 2.58 | 1.42–4.67 | 0.002 |
| Caesarean birth | – | – | 0.594 |
| Breastfeeding, four months or more | – | – | 0.848 |
| Siblings, more than one | 0.45 | 0.24–0.81 | 0.008 |
| Rural school environment | – | – | 0.322 |
| Interaction with farm animals | – | – | 0.815 |
| Intake of cow's milk | – | – | 0.188 |
| *DV: atopic dermatitis* | | | |
| Male sex | – | – | 0.340 |
| Allergic mother | – | – | 0.607 |
| Allergic father | 4.12 | 1.59–10.71 | 0.004 |
| An allergic family member | – | – | 0.570 |
| Caesarean birth | – | – | 0.291 |
| Breastfeeding, four months or more | – | – | 0.890 |
| Siblings, more than one | – | – | 0.376 |
| Rural school environment | – | – | 0.180 |
| Interaction with farm animals | – | – | 0.410 |
| Intake of cow's milk | – | – | 0.297 |

DV: dependent variable.
OR: Odds ratio obtained by logistical regression using the *Forward Conditional* method.

the fact that rural children spend much of their time in urban settings nowadays, another contributing factor might be that rural families have gradually been moving to cities or begun to modify their lifestyles to more urban tendencies. Due to these contrasting results, we inquired about each child's interaction with farm animals or household pets, as well as their intake of unpasteurised cow's milk, factors which proved to be far more prevalent in the lives of children in rural settings. In the light of the inconsistent data regarding this matter, it is necessary to continue studying the effect that a rural environment might have on the origin of allergic diseases.

Breastfeeding has been researched in various studies that concern its effects on the development of allergic diseases, and the compiled data is still very contradictory. Our multivariate models did not find any connection between breastfeeding and allergic diseases, which is consistent to what other studies in western Mexico have reported.[7,30] Contrastingly, a recent meta-analysis reported that breast milk acts as a protective agent against allergic diseases.[8]

Like breastfeeding, studies that regard caesarean births and their potential association to allergic diseases have produced inconsistent results. In a Korean study, they reached findings similar to ours; that is to say, they found no difference between the prevalence of allergic diseases or the sensitisation of allergic diseases and birth methods.[12] Recently in Korea, Yu et al.[13] reported a correlation between atopic dermatitis and caesarean births, particularly when the operation was performed under emergency circumstances[9]; a meta-analysis showed a 20% increased risk of asthma in children that were delivered via caesarean section,[10] additionally, another study reported that children born in this manner are at a greater risk of developing immune system diseases, such as: asthma, ulcerative colitis, celiac disease, and juvenile idiopathic arthritis.[11]

Moreover, our study has found that a higher number of siblings reduces the prevalence of allergic rhinitis, which was also reported in Germany.[1] Contrastingly, the third phase of ISAAC has established that having more siblings

**Table 4** Multivariate model of factors associated to symptoms of asthma, allergic rhinitis, and atopic dermatitis during the previous year.

| Type of disease | OR | 95%CI | *p* |
|---|---|---|---|
| *DV: wheezing during the previous year* | | | |
| Male sex | – | – | 0.315 |
| Allergic mother | – | – | 0.145 |
| Allergic father | – | – | 0.497 |
| An allergic family member | – | – | 0.156 |
| Caesarean birth | – | – | 0.712 |
| Breastfeeding, four months or more | – | – | 0.901 |
| Siblings, more than one | – | – | 0.227 |
| Rural school environment | – | – | 0.782 |
| Interaction with farm animals | – | – | 0.554 |
| Intake of cow's milk | – | – | 0.138 |
| DV: rhinitis during the previous year | – | – | |
| Male sex | – | – | 0.38 |
| Allergic mother | – | – | 0.329 |
| Allergic father | – | – | 0.826 |
| An allergic family member | 2.06 | 1.18–3.60 | 0.011 |
| Caesarean birth | – | – | 0.778 |
| Breastfeeding, four months or more | – | – | 0.061 |
| Siblings, more than one | – | – | 0.516 |
| Rural school environment | – | – | 0.381 |
| Interaction with farm animals | – | – | 0.987 |
| Intake of cow's milk | – | – | 0.907 |
| *DV: dermatitis during the previous year* | | | |
| Male sex | – | – | 0.947 |
| Allergic mother | – | – | 0.279 |
| Allergic father | – | – | 0.153 |
| An allergic family member | – | – | 0.315 |
| Caesarean birth | – | – | 0.642 |
| Breastfeeding, four months or more | – | – | 0.187 |
| Siblings, more than one | – | – | 0.894 |
| School in a rural environment | – | – | 0.231 |
| Interaction with farm animals | – | – | 0.877 |
| Intake of cow's milk | – | – | 0.389 |

DV: dependent variable.
OR: Odds ratio obtained by logistic regression using the *Forward Conditional* method.

is also associated to a higher prevalence in allergic rhinoconjunctivitis, asthma, and atopic dermatitis.[6]

A very important factor that has grasped the attention of several studies concerns the intake of unpasteurised cow's milk and its association to a higher prevalence of allergic diseases. In our study, we did not find evidence to support this notion, despite the fact that children in rural settings drink unpasteurised cow's milk more regularly than children in urban areas. These findings contrast starkly with other studies in which it has been reported that the early ingestion of this type of milk reduces the risk of asthma, atopy and allergic dermatitis,[16,17] regardless of a child's living environment. Studies undertaken in Europe have reported a decreased prevalence in allergic diseases and a reduced risk to allergen sensitisation amongst children that drink unpasteurised cow's milk.[15,18] It is argued that by drinking cow's milk, children ingest a considerable amount of bacteria that affect how the immune system is regulated, thus, incorporating unpasteurised cow's milk into a child's diet might be considered a preventative measure.

The following limitations should be taken into consideration when interpreting our results. First, we only had a short amount of time to analyse the extent of the exposure that children had to the conditions that have been associated as protective agents within a rural environment against the development of allergic diseases; second, these diagnostics were not clinically corroborated; third, it is possible that parents have criteria that differ from our own when interpreting wheezing episodes; four, we did not differentiate between the type of medical treatments that each child had access to; five, the only nutritional aspects that we analysed regarded breastfeeding and the intake of unpasteurised cow's milk; lastly, we did not factor in whether caesarean sections had been planned or preformed under emergency circumstances.

## Conclusions

In this study, we were unable to uphold the hypothesis that a rural environment offers protective advantages against the prevalence of allergic diseases. However, we did observe that children with a higher number of siblings might have a decreased prevalence of allergic rhinitis. With regard to atopy, a family history of the disease has a significant bearing on its frequency; notwithstanding, further research is required to elucidate on these matters.

## Conflicts of interest

The authors have no funding or conflicts of interest to disclose.

## Funding

None.

## Ethical disclosures

**Confidentiality of data.** The authors declare that they have followed the protocols of their work centre on the publication of patient data and that all the patients included in the study have received sufficient information and have given their informed consent in writing to participate in that study.

**Right to privacy and informed consent.** The authors have obtained the informed consent of the patients and/or subjects mentioned in the article. The author for correspondence is in possession of this document.

**Protection of human subjects and animals in research.** The authors declare that the procedures followed were in accordance with the regulations of the responsible Clinical Research Ethics Committee and in accordance with those of the World Medical Association and the Helsinki Declaration.

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