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ORIGINAL ARTICLE

Trend of self-reported asthma prevalence in Brazil from 2003 to 2013 in adults and factors associated with prevalence

Felipe Moraes dos Santos[1,a], Karynna Pimentel Viana[1,b], Luciana Tarbes Saturnino[1,c], Evelyn Lazaridis[1,d], Mariana Rodrigues Gazzotti[1,e], Rafael Stelmach[2,f], Claudia Soares[1,g]

1. GlaxoSmithKline, Rio de Janeiro (RJ) Brasil.
2. Hospital das Clínicas, Faculdade de Medicina, Universidade de São Paulo, São Paulo (SP) Brasil.

a. http://orcid.org/0000-0002-3512-4543
b. http://orcid.org/0000-0001-8288-1398
c. http://orcid.org/0000-0002-5415-1491
d. http://orcid.org/0000-0001-9984-3486
e. http://orcid.org/0000-0002-6061-785X
f. http://orcid.org/0000-0002-5132-1934
g. http://orcid.org/0000-0002-8425-2066

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ABSTRACT

Objectives: To determine the trend of self-reported asthma diagnosed prevalence and to describe the factors associated with asthma in Brazilian adults. **Method:** Epidemiological cross-sectional study based on databases analysis from three national household **surveys:** Pesquisa Nacional por Amostra de Domicílios (PNAD) 2003, PNAD 2008 and Pesquisa Nacional de Saúde (PNS) 2013. Participants between 18–45 years old were included. Trend analysis of asthma diagnosed prevalence was conducted using a logistic general linear model. A hierarchical logistic regression model was used to select factors significantly associated with asthma prevalence. **Results:** Asthma diagnosed prevalence was 3.6% (2003), 3.7% (2008) and 4.5% (2013), showing a statistically significant increased trend. Asthma diagnosed prevalence also increased when analysed by gender (annual change for men: 2.47%, $p < 0.003$; women: 2.16%, $p < 0.001$), urban area (annual change for urban: 2.15%, $p < 0.001$; rural: 2.69%, $p = 0.072$), healthcare insurance status (annual change without healthcare insurance: 2.18%, $p < 0.001$; with healthcare insurance: 1.84%, $p = 0.014$), and geographic regions (annual change North: 4.68%, $p < 0.001$; Northeast: 4.14%, $p < 0.001$; and Southeast: 1.84%, $p = 0.025$). Female gender, obesity, living in urban areas and depression were associated with asthma diagnosed prevalence. **Discussion:** PNAD and PNS surveys allow for a very large, representative community-based sample of the Brazilian adults to investigate the asthma prevalence. From 2003 to 2013, the prevalence of self-reported physician diagnosis of asthma increased, especially in the North and Northeast regions. Gender, region of residence, household location (urban/rural), obesity, and depression diagnosis seem to play significant roles in the epidemiology of asthma in Brazil.

Keywords: Adults; Asthma; Logistic models; Prevalence; Risk factors.

INTRODUCTION

Asthma is a chronic heterogeneous disease characterized by recurrent attacks of breathlessness and wheezing, which vary in severity and frequency from person to person.[1,2] Common risk factors for asthma include allergies, air pollution, obesity, respiratory viral infections, and occupational exposures.[3] Asthma is a serious global health problem, and it is estimated that 235 million people have asthma worldwide and over 80% of asthma deaths occur in low and lower-middle income countries. The prevalence of asthma varies according to geographic location, climate, lifestyle, and economic development of a specific region in the world.[1,2] In Brazil, it is estimated that five patients dies per day[4] due to asthma and the average of 100,000 hospitalizations per year occurs in the public healthcare system, highlighting the impact of this disease.[4]

Despite knowledge that asthma affects every age group,[2] the focus of local Brazilian research to date has primarily been on children and adolescent populations. For example, in Brazil, the Pesquisa Nacional de Saúde do Escolar (PeNSE) indicated high prevalence of asthma symptoms (23.2%) and previous medical diagnosis of asthma (12.4%) in children and adolescents.[5] Three of five state capitals from PeNSE survey presented increased asthma symptoms prevalence when compared with the International Study of Asthma and Allergies in Childhood (ISAAC).[5] There are just two publications providing prevalence data for adults, one conducted in 2002–2003 for 18 and 45 years old, and the other using the National Health Survey in 2013 for individuals aged 18 or older.[6,7] No studies to date have evaluated trends in asthma prevalence in the adult population.

Local studies, mainly derived from the ISAAC survey, reported that asthma prevalence in adolescents was associated with female gender, having pets, parents smoking behaviour, having rhinitis, and others factor.[8] However, studies describing asthma prevalence associated factors for adults are limited to two publications, restricted to the urban area of Pelotas city, South region of Brazil, conducted in 2000 and 2010.[7,9]

Correspondence to:
Felipe Moraes dos Santos. Estrada dos Bandeirantes, 8464, Jacarepaguá, CEP 22783-110, Rio de Janeiro, RJ, Brazil. Tel.: 55 21 2141-6411. E-mail: felipe.s.moraes@gsk.com
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In order to add to the understanding of the magnitude of asthma in Brazilian adults, and trends in asthma prevalence, this study aimed to:

- determine the trend of self-reported asthma diagnosed prevalence in Brazil from 2003 to 2013 in adults by gender, healthcare insurance, household location (urban and rural), and geographic region;
- describe the factors associated with prevalence of self-reported asthma diagnosed in Brazilian adults.

METHOD

This was an epidemiological cross-sectional study based on analysis of three different national household surveys: Pesquisa Nacional por Amostra de Domicílios (PNAD) 2003,[10] PNAD 2008[11] and Pesquisa Nacional de Saúde (PNS) 2013.[12] PNAD and PNS microdata are available in the public domain via Instituto Brasileiro de Geografia e Estatística (IBGE), at http://www.ibge.gov.br.

PNAD is a household survey conducted since 1967 in Brazil with annual application since 1971. Starting in 1998, it also included a health supplement collecting data of health characteristics of residents at five year intervals. The health supplement of PNAD became an independent survey in 2013, named as PNS. Both PNAD and PNS have a complex sample design. For PNAD, information about all residents in the sampled households was collected,[13] whereas for PNS only one resident aged 18 or older was selected by simple random sampling.[14] More information on the sampling methods for PNAD and PNS can be retrieved in the literature.[13,14]

In summary, PNAD 2003 and PNAD 2008 have a probabilistic sampling of households. In the first stage, the counties were selected; some were classified as autorepresentative, with 100% of selection probability, and the others as non-autorepresentative, with selection probability proportional to the resident population. In the second stage, the census tracts were selected with selection probability proportional to the number of existing households in the census tracts. In the third stage, the households were sampled with equal probability in each census tract. Information about all residents in the sampled households was collected.

The PNS 2013 sample, however, is a subsample of the integrated household surveys master sample from the IBGE. The primary sampling units (PSUs) were formed by area units which were selected to meet different surveys of the IBGE's integrated household surveys. The PSU was stratified using four different criteria:

- administrative: capital, rest of the metropolitan area or integrated economic development region, and rest of the federal unity;
- geographic: subdivision of capitals and other large counties in more strata;
- situation: urban or rural;
- statistic: homogeneous strata using information regarding total income of households and total permanent households, in order to improve the accuracy of estimates.

Finally, the PNS sample was then selected in three stages. The first stage of selection was a PSU subsample selection, with probability proportional to size (given by the number of permanent households in each unit using the 2010 demographic census as reference) in each stratum of the master sample. In the second stage, there was a selection of households by simple random sampling in each PSU selected in the first stage. At the last stage, one household adult (≥ 18-year-old) was selected by simple random sampling to answer the complete version of the interview. Basic information of all residents in the sampled households was also collected.

The individuals participating in the surveys answered questions through a face-to-face interview conducted by trained interviewers. For 2008 and 2013, the interviewers had a Personal Digital Assistance (PDA) to assist with the interview.

The three surveys are representative of the Brazilian population, its regions, federal unities, and for nine metropolitan regions, except PNAD 2003, whose samples did not include households located in the rural area of the North region, providing a unique data source to generate national and regional estimates of asthma prevalence.

In accordance to the study objectives, a trend analysis was conducted using the three aforementioned Brazilian cross-sectional surveys; factors associated with asthma diagnosed prevalence were investigated using the 2013 survey only. All participants aged between 18 and 45 years old that participated in these surveys were included in the study. We excluded from the analysis those aged > 45 years due to the increased prevalence of chronic obstructive pulmonary disease (COPD) in older adults and the misdiagnosis between asthma and COPD that could bias the asthma diagnosed prevalence results. The PNAD and PNS samples were composed as follow:

- 384,834 individuals from 133,255 households were surveyed in PNAD 2003;
- 391,868 individuals from 150,591 households were surveyed in PNAD 2008;
- 60,202 individuals from 64,348 households were surveyed in PNS 2013.

Asthma cases were identified using the following questions:

- "Has a physician or healthcare professional ever told you that you have bronchitis or asthma?" (PNAD 2003[10] and 2008);[11]
- "Has any physician ever given you asthma diagnosis (or asthmatic bronchitis)?" (PNS 2013).[12]

The question used in PNS 2013 was more specific to evaluate asthma diagnosed prevalence compared with the other two surveys, since it did not include bronchitis and the diagnosis was limited to diagnosis only made by a physician and not by any healthcare professional, as in 2003 and 2008.

The self-reported asthma diagnosed prevalence rates were calculated as the proportion of adults that reported "Yes" to either of these questions by the total of the adult population sample for each year (2003, 2008 and 2013). The mean annual change in prevalence rates was calculated as the geometric mean between 2003 and 2013 rates.

Initially, generalized estimating equations with an identity matrix were considered to analyse trends in asthma diagnosed prevalence. However, as very low correlations between time and all study variables ($\rho < 0.06$) were observed, a logistic general linear model was used. The trend analysis of asthma diagnosed prevalence was conducted overall and stratified by gender, insurance status, household location, and geographic regions. Wald tests (t) were applied to test the significance of observed trends in asthma prevalence.

Hierarchical logistic regression model was used to evaluate statistically significant factors associated with asthma diagnosed prevalence. The group of variables selected considered an adapted version of the conceptual model developed by Bernat et al.[15] for respiratory symptoms and the availability of variables in PNAD/PNS databases. Sex (male/female), age (18–25/26–35/36–45 years), race/ethnicity (white/black/other), household location (urban/rural) and region (North/Northeast/South/Southeast/MidWest) were selected as demographic variables (first block of variables). Education level (no instruction/primary level education or equivalent/high school degree or equivalent/college degree or equivalent) and healthcare insurance (yes/no) were selected as socio-economic factors (second block of variables). Behaviour aspects, health status, and household characteristics composed the third block of variables: house material (brickwork/others), type of stove fuel (cooking gas or piped gas or electricity/others), smoking status (current smoker/ex-smoker/never smoker), access to healthcare in the last two weeks (yes/no), body mass index (BMI) (underweight (< 18.5 kg/m^2), eutrophic (18.5–24.9 kg/m^2), overweight (25–29.9 kg/m^2), and obese (≥ 30 kg/m^2), depression (yes/no) and mental disease (yes/no).

A backward model selection method was executed, which included all variables in the first block, retaining all covariates with $p < 0.05$. Next, all variables in the second block were added and retained if $p < 0.05$; variables in the first block were not taken out from the model even if statistical significance were lost. This process was repeated for variables in the third block. *Odds ratio* (OR) with their respective 95% confidence interval (95%CI) were derived from the final adjusted regression model.

Data was analysed considering the sample weights and also the structural information of the PNAD/PNS sampling plan — that is, the sample weights were used to correct the variance measures according to the sample plan for each survey, which allows comparability between PNAD and PNS.

Statistical Package for the Social Sciences (SPSS) version 19 was used for the analysis.

This study presents analyses of databases of three national household surveys, whose data are not identified. In addition, no interaction with humans was done to collect additional data, using exclusively the data presented in the databases available by IBGE. Thus, it was not necessary to have approval of an ethics committee to conduct the research and elaboration of this manuscript.

RESULTS

The asthma diagnosed prevalence in Brazil was 3.6% in 2003, 3.7% in 2008, and 4.5% in 2013, representing a 2.3% average annual increase between 2003 and 2013 ($p < 0.001$). Higher asthma diagnosed prevalence was observed for women in all years than for men, although the annual change was higher in men (2.5%) compared to women (2.2%) (Figure 1).

Asthma diagnosed prevalence also increased in urban areas (2.2%) and in rural areas (2.7%), although the increase was not statistically significant for rural areas (Figure 2). Both those with (1.8%) and without (2.2%) healthcare insurance showed increase in the prevalence of asthma diagnosed (Figure 3).

Significant increases in asthma diagnosed prevalence were observed for the North, Northeast and Southeast geographic regions, but not for the South and Midwest (Figure 4).

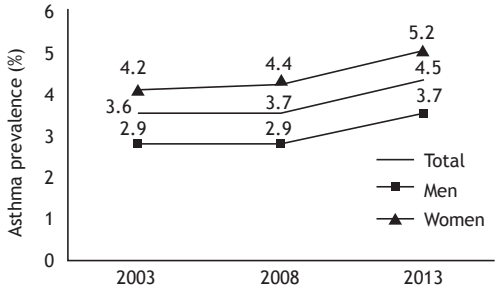
In relation to factors associated with asthma diagnosed prevalence, depression was the most strongly associated factor (Table 1). Subsequently, living in urban areas, being from the South, Southeast, and North regions, female gender, and obesity were also associated with asthma diagnosed prevalence. Older age was inversely associated, though. Other variables including race/ethnicity, education level, type of fuel stove, house material, smoking status, and access to healthcare in the last two weeks were not included in the final model.

DISCUSSION

The results of our study showed increase of asthma diagnosed prevalence in Brazilian adults — overall and stratified by gender, healthcare insurance, household location (urban and rural), and geographic regions. The multivariable regression analysis showed positive association between asthma diagnosed prevalence and depression, living in urban areas, being from the Northeast, Southeast, and North regions, female gender and obesity.

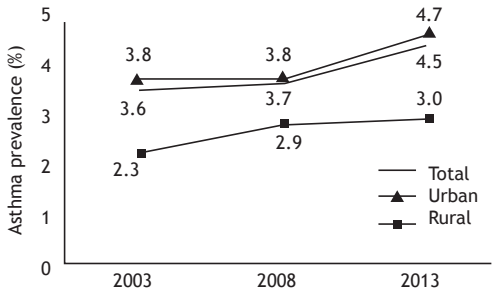
A rising prevalence of asthma diagnosed had been described in adults from other countries.[16-19] However, in Brazil, before the present study, similar results were only described for children[20] and adolescents.[5]

A possible explanation for the increase in asthma diagnosed prevalence in Brazil is the general improvement in diagnosis in primary healthcare services



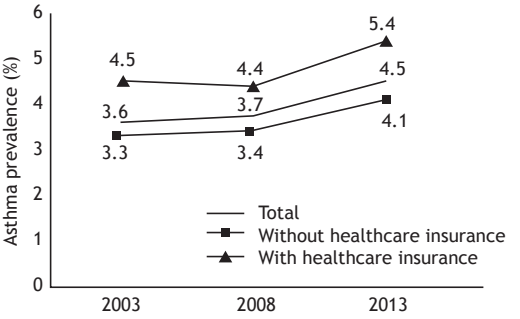
Geometric mean annual change
Men: 2.5% (p = 0.003)
Women: 2.2% (p < 0.001)

Figure 1. Trends in asthma prevalence according to gender in Brazilian adults, 2003–2013.



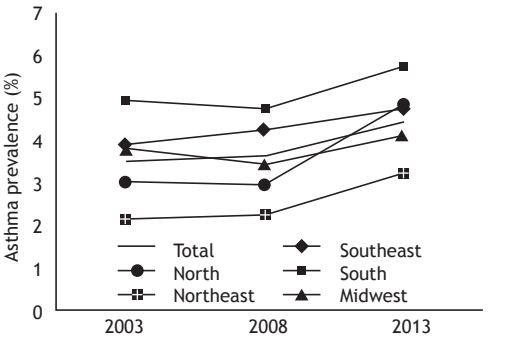
Geometric mean annual change
Urban: 2.2% (p < 0.001)
Rural: 2.7% (p= 0.072)

Figure 2. Trends in asthma prevalence according to household location in Brazilian adults, 2003–2013.



Geometric mean annual change
Without healthcare insurance: 2.2% (p < 0.001)
With healthcare insurance: 1.8% (p = 0.014)

Figure 3. Trends in asthma prevalence according to healthcare insurance in Brazilian adults, 2003-2013.



Geometric mean annual change
North: 4.7% (p < 0.001)
Northeast: 4.1% (p < 0.001)
Southeast: 1.8% (p = 0.025)
South: 1.5% (p = 0.121)
Midwest: 0.74% (p = 0.588)

Figure 4. Asthma prevalence in adults by Brazilian regions, 2003–2013.

and family health teams over time.[21] The increase observed in access to health in recent years could explain the increase of asthma diagnosed prevalence, as more asthmatics would be receiving the disease diagnosis. Another hypothesis is the expansion in urbanization,[18,22] since evidence suggested that asthma and asthma-related symptoms occurred more frequently in urban than in rural areas. That association was also found in our study. Previous studies have suggested that this observation may be related to differences in environmental risk exposure, socioeconomic class, and healthcare access.[18]

Remarkably, the prevalence of asthma diagnosed in adults varied considerably between regions. Higher prevalence rates were observed in the South and Southeast regions, but the increase in prevalence was more marked in North and Northeast regions. However, there was no evidence that the improvement in healthcare access in North and Northeast was higher than in the other regions in recent years. In fact, Nunes et al.[23] evaluated the time trend on the demand and lack of access to public healthcare services in Brazil from 1998 to 2013, and the higher improvement on healthcare access was shown in Southeast and South regions. Additionally, the increase in urbanization rate from 2000 until 2010[24] in North, Northeast and South had been found similar according to national statistics reports, opposed to our study, in which the increase in asthma diagnosed prevalence was higher in North and Northeast region. Our findings reinforce the importance of other studies specifically investigating the geographic changes in asthma diagnosed prevalence in Brazil, preferably considering the disparities in each region. This is especially important, since the prevalence is influenced by mortality rates, which are different between the regions.[25]

The positive association between asthma among women was also described in other studies.[5,7,26] Possible explanation of this finding could be attributed to hormone, behavioral changes about the time of puberty and genetic polymorphisms, which evidence suggested to lead women to be more susceptible to asthma in adulthood.[5,26] However, as our study evaluated the diagnosed prevalence of asthma, the increased prevalence in women could be related to a higher use of healthcare system by women.[27]

Regarding the association between asthma and depression, we found an approximately 2.1 times higher chance of reporting to have asthma diagnosed

Table 1. Analysis of the factors associated with self-reported asthma in Brazilian adults aged 18–45 years old in Pesquisa Nacional de Saúde (PNS) 2013.

Characteristic	aOR	95%CI	
Gender			
Man	Ref.		
Woman	1.368	1.083	1.727
Age			
18-25y	Ref.		
26-35y	0.736	0.570	0.951
36-45y	0.678	0.517	0.889
Household location			
Urban	1.576	1.004	2.474
Rural	Ref.		
Region			
Northeast	Ref.		
Southeast	1.439	1.094	1.893
South	1.723	1.313	2.262
Midwest	1.093	0.832	1.436
North	1.596	1.235	2.062
Healthcare insurance			
No	Ref.		
Yes	1.231	0.979	1.547
BMI			
Underweight	1.547	0.711	3.367
Eutrophic	Ref.		
Overweight	1.294	1.000	1.675
Obese	1.493	1.137	1.959
Depression			
No	Ref.		
Yes	2.094	1.525	2.876

aOR: adjusted *odds ratio*; 95%CI: 95% confidence interval; Ref.: reference; BMI: body mass index.

in patients who have depression. However, it was not possible to evaluate the temporality between depression and asthma, which is an inherent limitation of the cross-sectional design. Nevertheless, a meta-analysis of prospective studies[28] pointed depression as a marker for incident adult-onset asthma. This finding highlights the importance of physician and healthcare providers to be aware of the potential for new onset asthma in their patients with depression.

Our results also found that obesity was associated with asthma. The relationship between obesity and asthma has been observed in other studies and is complex.[29-32] A recent cross-sectional study[33] showed that mean BMI was significantly increased in groups of asthmatic aged 18–60 years compared to a control group of healthy patients, and the result was statistically significant ($p < 0.001$). In some cases, asthma patients, due to their increasingly sedentary lifestyle and the use of corticosteroids, develop obesity later, causing disease worsening.[31,34] Other studies also found that obesity may affect asthma expression,[35] asthma exacerbations, decreasing asthma control, and steroid responsiveness. For example, a study conducted in Brazil in a moderate to severe asthma cohort of obese patients showed a gain in asthma control after dietary, pharmacologic and rehabilitation interventions.[36,37] In addition to that, studies suggested that programs to increase opportunities for physical activities and healthy food choice may decrease the prevalence of obesity and may directly affect the prevalence and severity of asthma.[34]

PNAD 2003, PNAD 2008, and PNS 2013 are nationally representative surveys designed to assess the health status of the Brazilian population, and their representativeness is a strength of our study. However, some limitations should be noted. The increase in asthma diagnosed prevalence observed in our study is probably underestimated due to two changes in the question adopted in PNS 2013 compared with the question in PNAD 2003 and PNAD 2008. The question used in PNS 2013 provided a more specific definition for asthma diagnosed prevalence assessment, since it did not include the term *bronchitis* and restricted to asthma physician diagnosis instead of including any healthcare professional as in the PNAD 2003 and 2008 surveys. Even with a more specific question in the last survey, we observed an increase in asthma prevalence throughout the years. Also, to mitigate the inclusion of other respiratory diseases, *e.g.*, COPD, we limited the analysis to patients aged 18–45 years since in this age group COPD prevalence is expected to be lower than in older patients.

Another limitation of our analysis was that the exclusion of the rural area in PNAD 2003 could overestimate the prevalence in North in 2003 since only urban areas were included. Despite this, the asthma prevalence observed in the North region for 2003 was lower than 2008 and 2013.

Potential reverse causality is another limitation of this study, since temporality could not be ascertained in cross-sectional designs. Changes in time to the exposures could also bias the associations observed. For example, individuals with asthma living in rural/urban areas or Brazilian regions could live in different areas in their childhood and only move out to another area in their adulthood. This is especially important because the majority (81.1%) of asthma patients identified in PNS 2013 were diagnosed in childhood (data not shown). In addition, it is important to reinforce that the increase in asthma diagnosed prevalence could not mean that more subjects have been affected by asthma, but could be a result of more individuals getting access to healthcare facilities and diagnosis. Other studies evaluating not only the self-reported diagnosis of asthma in adults are need to understand if the prevalence of self-reported asthma increase due to changes in access or other causes over the year.

Our study suggested that asthma diagnosed prevalence has been increasing in Brazil, which may result in a significant societal and healthcare burden due to asthma and its related complications. We also identified that trends in asthma diagnosed prevalence vary by geographic regions and were associated with factors including depression, obesity, female gender, and living in urban areas. These results may help to

gain insight into developing effective interventions for the early diagnosis of asthma and preventive strategies for the control of the disease in these groups. Due to the country size and differentiated geography, the creation of a disease management program, better healthcare professional capabilities in primary care, and an increase of asthma-awareness in society are possible initiatives.[25]

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