

High blood pressure in school children and adolescents in Argentina over the past 25 years: A systematic review of observational studies

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ABSTRACT

Introduction. Over the past years, hypertension has been recognized as an important health problem in the pediatric population. A systematic review of observational studies published between 1988 and 2014 was conducted to estimate the prevalence of high blood pressure and cardiovascular risk factors among children and adolescents in Argentina.

Population and methods. A bibliographic search was done in MEDLINE, SciELO, and LILACS to look for studies on high blood pressure prevalence in school children and adolescents in Argentina. Studies and surveys that had included the measurement of blood pressure in children and adolescents (aged 5-20 years) according to the Fourth Report on the Diagnosis, Evaluation, and Treatment of High Blood Pressure in Children and Adolescents by the American Academy of Pediatrics were included in this study.

Results. Fourteen publications were identified. The pooled prevalence in 11 706 subjects (random effects model) was 6.61% (95% confidence interval [CI]: 4.30-9.37). The crude prevalence was 7.35% (95% CI: 6.88-7.83). High blood pressure was more prevalent among adolescents than children ≤ 10 years old (7.4% versus 4.3%, $P = 0.001$), and among boys than girls (11.2% versus 6.8%, $P = 0.001$). The most common risk factors included a sedentary lifestyle (50%), overweight (15.4%), abdominal obesity (13.7%), obesity (11.5%), and smoking (6.5%).

Conclusions. Our data show that the prevalence of high blood pressure and cardiovascular risk factors in school children and adolescents is high, and this accounts for a very important public health problem in Argentina.

Key words: hypertension, child, adolescent, epidemiology, systematic review.

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INTRODUCTION

High blood pressure (HBP) is a public health issue that has reached epidemic proportions.¹ Over the past years, HBP has been recognized as an important health problem in the pediatric population. Most population studies done in Europe and the United States of America have reported that HBP prevalence ranges from 1% to

5%, although it reaches 10% in some geographic regions.^{2,4-6}

Data from different epidemiological studies reinforce the concept of regular blood pressure (BP) monitoring since childhood and into adulthood; in addition, and most likely, the detection of high BP values during childhood may help to predict the development of sustained arterial hypertension (AHT) during adulthood.⁷ Although AHT is a known risk factor for morbidity and mortality in Argentina, few national, large studies have been done to assess BP values periodically and establish the prevalence of HBP in children and adolescents attending school in Argentina. In an attempt to fill in such knowledge gap, the primary objective of this study was to estimate the prevalence of HBP in school children and adolescents in Argentina by means of a systematic review of research studies published in the past 25 years. In addition, the secondary objective of this study was to establish the prevalence of obesity, overweight, smoking, and a sedentary lifestyle observed in the studies included in this systematic review.

POPULATION AND METHODS

This systematic review was designed and developed in accordance with the Preferred Reporting Items in Systematic Reviews and Meta-Analyses (PRISMA) Statement.⁸

Bibliographic search strategy

A bibliographic search was done in the following databases: MEDLINE (National Library of Medicine), SciELO (Scientific Electronic Library Online), and LILACS (Latin American and Caribbean Health Sciences

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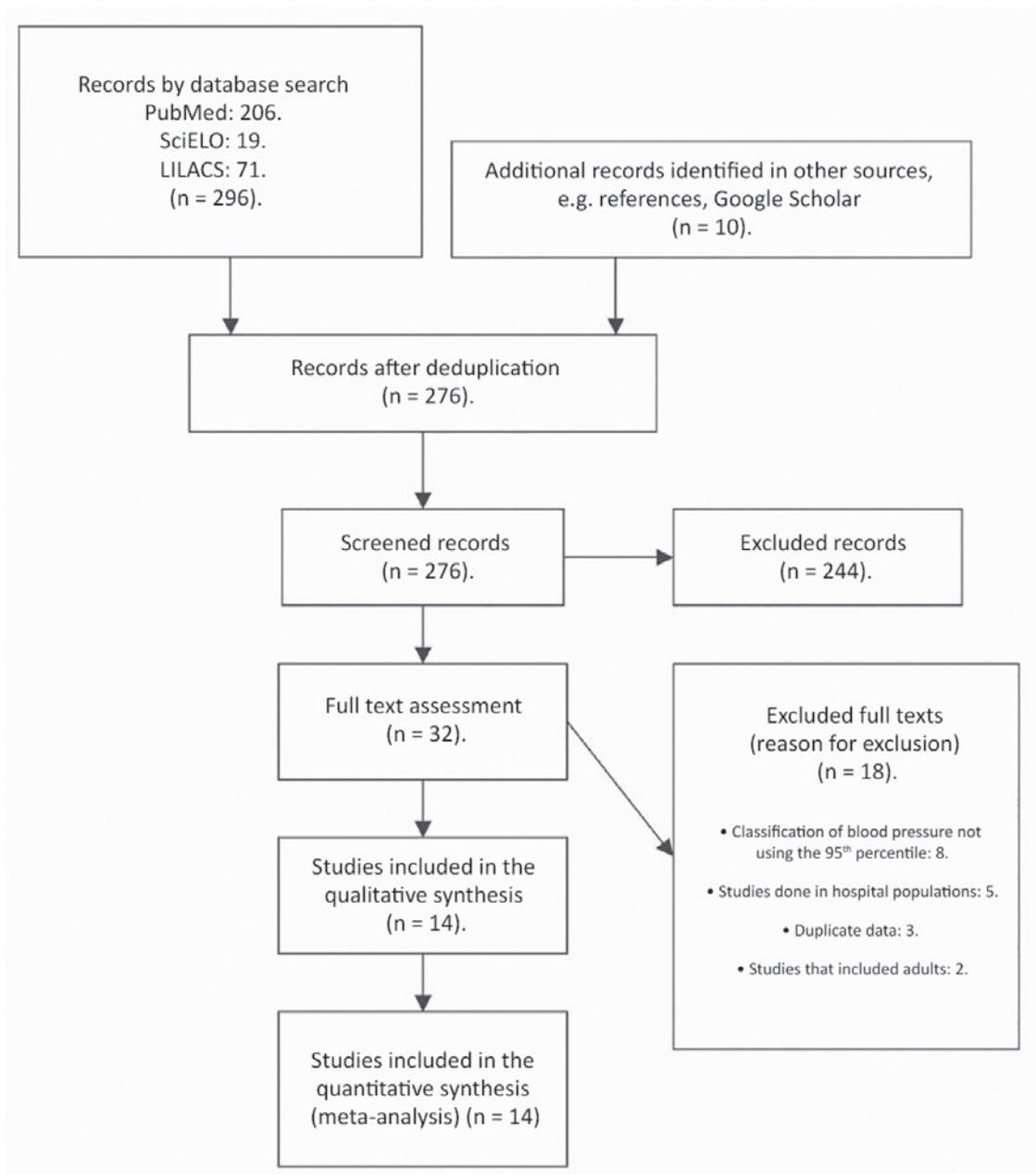
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Literature), to look for studies conducted in Argentina between January 1988 and December 2014. The following search terms were used (in English, Spanish, and Portuguese): school children, adolescents, pediatrics, hypertension, high blood pressure, prevalence, cross-sectional studies, epidemiology, and Argentina. Results were compensated with a manual search of relevant references quoted in the analyzed articles obtained from the bibliographic search.

Data from each study were extracted by a single reviewer following a standard protocol; a standard data collection form with a checklist was used.^{8,9}

The full-text versions of all potentially relevant articles were downloaded from the databases or requested to authors by e-mail. Two investigators selected the studies, extracted data independently, and cross-checked data; discrepancies were solved by consensus. *Figure 1* summarizes the

FIGURE 1. Flowchart of study selection for the systematic review



study selection process. Selected studies were assessed using an appraisal tool established for the surveillance of AHT prevalence studies in Latin America and the Caribbean.⁹

Inclusion criteria

Inclusion criteria were the following: 1) studies or surveys including BP measurements and HBP prevalence reports (or values that enabled BP estimations); 2) studies conducted in the school setting in children and adolescents (aged 5-20 years) in Argentina; 3) studies for which HBP diagnosis had been established based on the Fourth Report on the Diagnosis, Evaluation, and Treatment of High Blood Pressure in Children and Adolescents (BP \geq the 95th percentile or the use of antihypertensive drugs).¹⁰

Exclusion criteria

Studies were excluded in the following cases: 1) if participation was restricted to special populations (e.g., transplant patients, dialysis patients, series of patients with secondary HBP, or hospital database analysis); 2) if there were duplicate publications; and 3) if diagnostic criteria were different from the BP values or percentiles established in the Fourth Report on the Diagnosis, Evaluation, and Treatment of High Blood Pressure in Children and Adolescents.¹⁰

Collected outcome measures included year of study, city of study, participants' mean age, sample size, type of BP measuring device and measuring technique, definition used for HBP diagnosis.

The following was also assessed for each study: 1) the presence of diabetes and dyslipemia (both considered categorical, dichotomous outcome measures and defined as known diagnosis at the time of examination); 2) smoking (present smoking habit at the time of examination); 3) a sedentary lifestyle (defined as physical activity < 3 days per week for less than 30 minutes a day); 4) abdominal obesity (considered as a categorical outcome measure and defined as a waist circumference \geq the 90th percentile, or \geq 80 cm for women and \geq 94 cm for men); 5) overweight (considered as a categorical outcome measure and defined as a body weight between the 85th and the 96th percentiles, or a Z-score > 1 standard deviation [SD]); 6) obesity (considered as a categorical outcome measure and defined as a body weight \geq 97th percentile or a Z-score > 2 SD).

Data were entered in a Microsoft Office

Excel™ spreadsheet designed in accordance with the PRISMA guidelines.⁸

This study was based on previously published anonymized data, so no approval from the Bioethics Committee was required.

The crude prevalence of HBP was estimated by dividing the number of subjects with HBP in each study into the total number of subjects assessed in each study. Also, the prevalence of HBP was specifically analyzed for the 5-10-year-old child group and the > 11-year-old adolescent group. Results were described as percentage (and its corresponding 95% confidence interval [CI]). HBP prevalence was analyzed using two models: the fixed effects model (when lack of heterogeneity is assumed among studies) and the random effects model (when the studies included in the review are assumed to account for a random sample of all existing studies). Heterogeneity among studies was quantified using the i^2 statistics and tested using the Cochran's Q-test. The statistical analysis was done using the Medcalc software for Windows, version 14.8.1 (Medcalc Software, Ostend, Belgium).

RESULTS

The initial bibliographic search identified 276 studies. For the second step of the search, 244 titles and abstracts were excluded. For the third step, the full text of 32 studies was analyzed; 18 were excluded (see reason for exclusion in *Figure 1*). Finally, 14 studies were included in the analysis based on 11 706 subjects.¹¹⁻²⁴ The analysis showed heterogeneity among studies ($Q= 384$, $P= 96.6\%$, $P= 0.0001$) and no publication bias. *Table 1* shows the characteristics of each study, including number of participants, mean age, HBP prevalence (total and by gender), and other cardiovascular risk factors. The number of participants per study ranged between 93 and 2507 subjects.

Ten studies (71.4%) reported the number of visits and measurements used to establish BP values. Aneroid sphygmomanometers were used in 43% of studies. Mercury sphygmomanometers and automatic electronic devices were used in 36% and 21% of studies, respectively.

Two or more BP measurements were done in a single visit in 5 studies (35.7%). BP was measured in 2 or more visits in 5 studies (35.7%).

Prevalence of high blood pressure

The prevalence of HBP in school children and adolescents in Argentina was 7.35% (95% CI: 6.88-7.83) (fixed effects model), and ranged between

1.08% and 13.4% (Figure 2). The pooled prevalence (random effects model) was 6.61% (95% CI: 4.30-9.37). Only 9 studies (64%) reported the mean age of the study population, which was 11.6 ± 3.6 years. Half of studies (7) published the prevalence of HBP by gender and observed that it was higher among boys than girls (11.2% versus 6.8%, $P = 0.001$). The prevalence of HBP increased from 4.3% in the group of children aged 5-10 years old to 7.4% in the group of adolescents ≥ 11 years old.

None of the studies included in this analysis assessed the level of knowledge, treatment, and control of BP.

Other cardiovascular risk factors

Eleven studies reported the prevalence of obesity (average: 11.5%, range: 2.2%-22.2%), and only 5 studies assessed the prevalence of smoking (average: 6.5%, range: 1.6%-10.7%). Only 1 study reported the prevalence of dyslipemia (average: 20%). No study reported the prevalence of diabetes.

The presence of central (abdominal) obesity was assessed only in 6 studies (prevalence: 13.7%, range: 4.6%-21%). The prevalence of overweight was 15.4% (range: 10.9%-26.3%) and was reported in 9 studies.

The most prevalent risk factor was a sedentary lifestyle (50%, range: 36.3%-61%), and obesity was the most studied risk factor.

DISCUSSION

Data obtained in this systematic review indicate that, in Argentina, more than 1 in every 20 school children and adolescents have HBP. We also found a high prevalence of associated cardiovascular risk factors in children and adolescents. As per our knowledge, to date, this is the first systematic review of the literature done to estimate the prevalence of HBP and cardiovascular risk factors in children and adolescents in Argentina.

One of the greatest myths regarding AHT in children and adolescents is that it is an adult disease with no actual relevance in the pediatric population.²⁵ However, recent data show that the prevalence of HBP in pediatrics is not much lower than that of other childhood diseases, such as attention deficit hyperactivity disorder or asthma (9% prevalence), and is much higher than some other disorders that receive dramatically more attention, such as autism or epilepsy (1% prevalence).²⁵

Consistent with our data, a report of the United States National Survey on Nutrition and Health (1999-2010) on 9250 children and adolescents (8-17 years old) reported a 6.07% prevalence of AHT.²⁶ Also, recent data from a systematic review of 122 053 adolescents indicate that the prevalence of HBP is higher among children and adolescents from low- and middle-income countries.²⁷

TABLE 1. Characteristics of the 14 studies included in the systematic review of high blood pressure in 11 706 school children and adolescents in Argentina, 1988-2014

Main author and year of the study (reference)	Age range	n	Measuring device	No. of m.	HBP prevalence (%)				Sedentary lifestyle (%)	Smoking (%)	Obesity (%)	Overweight (%)	CO (%)
					V	Total	95% CI	Male					
Morales et al., 1989 ¹¹	7-12	1018	M	2-3	11.7	9.7-13.8	ND	ND	ND	ND	ND	ND	ND
Dei-Cas et al., 2000 ¹²	15	363	M	3-2	7.7	5.1-10.9	13	4.7	61	10.7	7.4	ND	ND
Martínez et al., 2001 ¹³	11-18	2115	AN	1-1	3.0	2.3-3.8	4.7	2.1	ND	ND	2.2	10.9	ND
Dumas et al., 2005 ¹⁴	6-12	1038	M	2-3	3.37	2.3-4.6	3.8	2.8	ND	ND	ND	ND	ND
Poletti et al., 2007 ¹⁵	10-15	2507	M	3-1	13.4	12.0-14.7	12.5	1.4	36.3	ND	4.5	17.1	ND
Szer et al., 2010 ¹⁶	6-10	816	AN	ND	9.40	7.4-11.6	9.7	9.1	ND	ND	16.7	17.9	20.3
Tringler et al., 2012 ¹⁷	5-18	334	M	3-2	4.30	2.3-7.0	ND	ND	50.2	4.4	9.2	14	ND
Chaila et al., 2012 ¹⁸	6-19	700	AN	2-1	7.0	5.2-9.1	ND	ND	ND	ND	14	2	15
Gotthelf et al., 2012 ¹⁹	16-20	395	A	2-1	11.4	8.4-14.9	19	5.7	ND	5.4	7.1	11	9.9
Abraham et al., 2013 ²⁰	10-17	1056	A	3-2	10.6	8.8-12.6	ND	ND	52.5	1.6	13.3	18.7	ND
Vergottini et al., 2013 ²¹	15-18	93	AN	ND	3.0	0.5-8.8	ND	ND	ND	10.7	15.5	ND	4.6
Zeberio et al., 2013 ²²	6-10	555	A	ND	10.8	0.3-2.3	ND	ND	ND	ND	15.1	26.3	14.5
Sapag et al., 2014 ²³	6-15	361	AN	ND	0.13	0.4-3.0	ND	ND	ND	ND	22.2	20.8	21
Hirschler et al., 2014 ²⁴	ND	355	AN	2-1	12.8	9.5-16.7	15.9	9.6	ND	7.9	2.8	ND	10.9

HBP: high blood pressure; No. of m.: number of measurements; V: visits; CO: central (abdominal) obesity; ND: no data; M: mercury; A: automatic; AN: aneroid.

An “ideal” way to determine the prevalence of pediatric AHT in Argentina would be to conduct a national survey, with samples representative of each region, and measure BP in different, multiple visits to confirm the diagnosis of established AHT. In the absence of such “ideal study,” systematic reviews help to collect and analyze scientific evidence, for which the analysis units are the original, primary studies. Systematic reviews and meta-analyses are essential tools to summarize available scientific information and identify areas for future research.

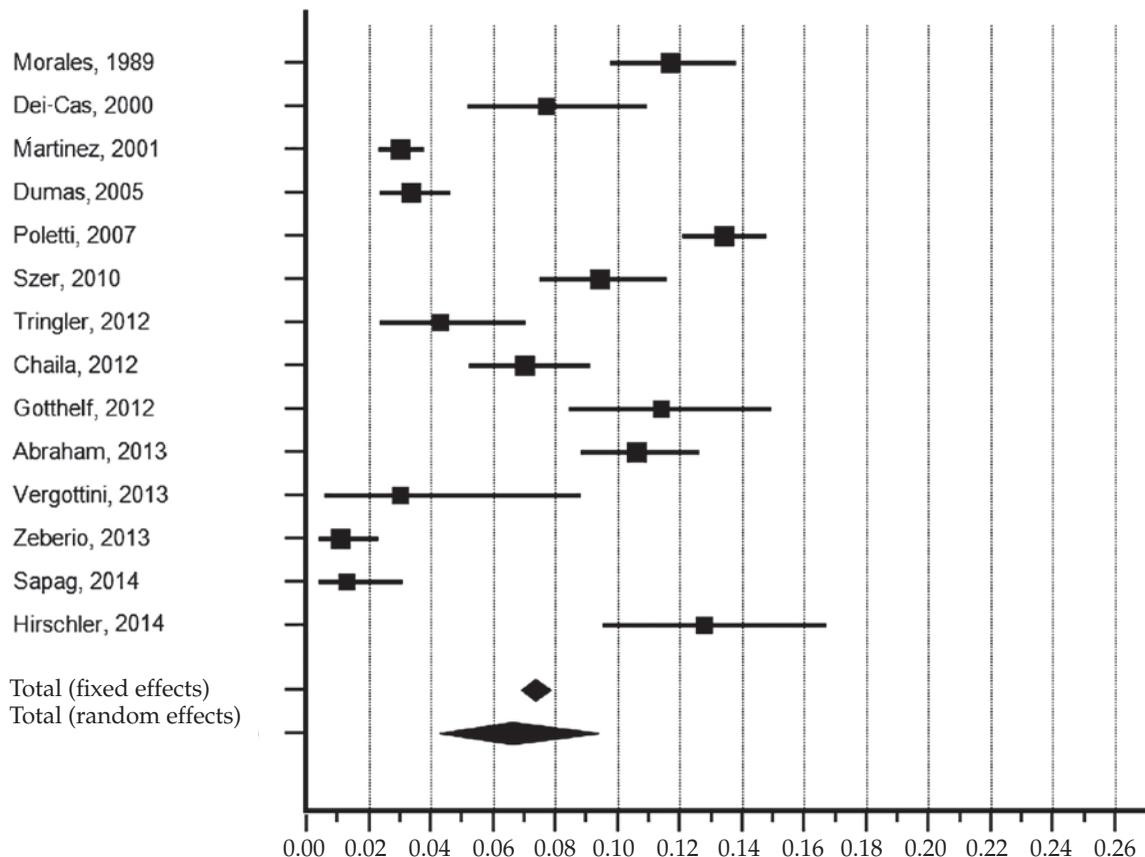
In spite of methodological differences among the studies included in this review, the overall prevalence of pediatric HBP in Argentina is similar to the regional prevalence reported in population studies.²⁷⁻²⁹ This systematic analysis of the prevalence of HBP in children and adolescents is an attempt to compensate the lack of national data on pediatric AHT in our country. However,

results may not adequately represent indigenous or rural populations given that analyzed data were obtained from studies conducted in urban areas of Argentina. Therefore, the results of this review may not replace a prevalence study conducted at a national level.

It is worth noting that the prevalence of HBP estimated in this review may overestimate the actual prevalence of established AHT. In this regard, in the population studies included in this review, BP was generally measured in a single visit, which provided an incidental estimation of prevalence, and should, therefore, be clearly differentiated from sustained AHT.

Also, it is known that, based on the regression toward the mean and repeated measurements, the initial HBP prevalence may decrease to less than 5%.^{2,4} A study conducted in adolescents with an initial HBP prevalence of 9.4% reported a reduction to 3.2% after the third control.²⁹ In

FIGURE 2. Forest plot for the estimated prevalence of high blood pressure (squares) and 95% confidence intervals (bars) of the 14 studies (n: 11 706) included in the systematic review of high blood pressure in school children and adolescents in Argentina, 1988-2014^a



^a The pooled ratio of estimated children and adolescents with high blood pressure is represented by the diamond.

addition, the Belo Horizonte Study reported that the initial prevalence of 6.5% declined to 3.5% after the second measurement.³⁰

Although the definition of overweight, obesity, and abdominal obesity was not homogeneous across studies, it is worth noting that our data show a higher prevalence of obesity than that reported in the National Survey on School Health.³¹

The pooled prevalence of childhood overweight and obesity has increased at a fast pace in most Latin American and Caribbean countries, and ranges between 18.9% and 36.9% in school children and between 16.6% and 35.8% in adolescents.³²

In pediatrics, HBP is determined by multiple factors; therefore, it is important to warn patients and their parents on lifestyle, eating habits, body weight and physical activity changes.³³ A sedentary lifestyle during childhood increases the risk for HBP in a two-year follow-up.³⁴

In our study, a low level of physical activity was the most common risk factor, and its prevalence was similar to that reported in the Argentinean National Survey on School Health.³¹ It was comparable to the rate of sedentary lifestyle reported in children and adolescents in Brazil³⁴ and other Latin American countries.³⁵

Prevention and treatment of cardiovascular risk factors are an ongoing challenge for pediatricians. In this regard, the Argentine Society of Pediatrics has established guidelines to implement effective prevention strategies, an early detection and treatment of cardiovascular risk factors in pediatrics.³⁶

Limitations

This systematic review poses certain limitations. First of all, there are variations among the different studies in terms of age structure and BP measurement techniques. This restricts the possibility of making reliable comparisons among studies and hinders the adjustment of prevalence rates by age group. Also, the prevalence of risk factors associated with the development of HBP (a sedentary lifestyle, diabetes, obesity, etc.) is not comparable given the differences in methodology and the varying diagnostic criteria used. Lastly, the heterogeneous prevalence of HBP within each study was high; this may be attributed to differences in genetic, regional, and environmental factors, as well as different lifestyles (smoking, physical activity, and salt intake).

CONCLUSIONS

In spite of the relatively limited evidence, we observed a high prevalence of HBP and cardiovascular risk factors in school children and adolescents in Argentina, and this accounts for an important public health problem in Argentina. ■

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