

Exposure to indoor air pollution/outdoor air pollution: the silent killers – A pilot study

Exposição à poluição do ar interno/poluição do ar externo: os assassinos silenciosos – Estudo piloto

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ABSTRACT

Objective: To identify possible risks factors of exposure to indoor air pollution (IAP)/outdoor air pollution (OAP) and their relationship with noncommunicable diseases in men and women treated by primary care physicians. **Method:** In total, 551 patients (382 women) attended three basic health units in Uruguaiiana, Brazil, for various complaints, and completed a questionnaire about risk factors for exposure to IAP/OAP. **Results:** Women were significantly more exposed to wood-burning pollutants (79.6% vs. 52.7%, $p < 0.0001$) for having more housework-related activities; men had more outdoor activities and spent extended periods in traffic (47.3% vs. 18.8%, $p < 0.0001$). Arterial hypertension (AH)/chronic respiratory disease (CRD) were more frequent among women. Patients with AH/CRD were more exposed to OAP because of their work (18.1% vs. 11%, $p = 0.02$) or for living near a source of air pollution (45.6% vs. 29.6%, $p = 0.0002$) or on a street with heavy traffic (41.7% vs. 33%, $p = 0.04$). Passive smoking, active smoking, using wood, charcoal, or firewood for cooking, heating, or drying, or burning charcoal indoors were not associated with a higher prevalence of AH/CRD. **Conclusion:** Exposure to OAP was associated with AH/CRD. Women were more exposed to IAP from burning firewood, and men were more exposed to fossil fuel burning. Knowledge of these behaviors should be directed to primary care physicians and all health professionals so that preventive and educational measures can be implemented.

Keywords: Pollution, noncommunicable diseases, primary care physicians, health professionals.

RESUMO

Objetivo: Identificar possíveis fatores de risco da exposição à poluição intradomiciliar (PID) e extradomiciliar (PED) e sua relação com doenças não transmissíveis (DNT) em homens e mulheres tratados por médicos de atenção primária. **Método:** Quinhentos e cinquenta e um pacientes (382 mulheres) atendidos em três unidades básicas de saúde em Uruguaiiana, Brasil, por queixas diversas, responderam a um questionário sobre os fatores de risco para exposição à PID/PED. **Resultados:** As mulheres foram significativamente mais expostas aos poluentes da queima de lenha (79,6% vs. 52,7%, $p < 0,0001$) por terem mais atividades domésticas; os homens praticaram mais atividades ao ar livre e passaram longos períodos no trânsito (47,3% vs. 18,8%, $p < 0,0001$). Hipertensão arterial (HA) / Doença respiratória crônica (DRC) foram mais frequentes entre as mulheres. Pacientes com HA/DRC foram mais expostos à PED devido ao trabalho (18,1% vs. 11%, $p = 0,02$), ou por viver perto de uma fonte de poluição do ar (45,6% vs. 29,6%, $p = 0,0002$), ou em uma rua com trânsito intenso (41,7% vs. 33%, $p = 0,04$). O fumo passivo, o fumo ativo, o uso de lenha ou carvão para cozinhar, aquecer ou secar ou queimar carvão em ambientes fechados não foram associados a maior prevalência de HA/DRC. **Conclusão:** A exposição à PED foi associada a HA/CRD. As mulheres foram mais expostas à PID pela queima de lenha, e os homens foram mais expostos à queima de combustíveis fósseis. O conhecimento destes comportamentos deve ser direcionado aos médicos da atenção básica e a todos os profissionais da saúde, para que medidas preventivas e educacionais possam ser implementadas.

Descritores: Poluição, doenças não transmissíveis, médicos de atenção primária, profissionais de saúde.

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Introduction

Air pollution is the most significant environmental cause of disease and premature death in the world today.¹ Air pollution-related diseases accounted for approximately 9 million premature deaths in 2015 (16% of all deaths worldwide), three times more than AIDS, tuberculosis, and malaria combined and 15 times more than all wars and other forms of violence.^{2,3}

Importantly, air pollution disproportionately kills the poor and vulnerable. Almost 92% of air pollution-related deaths occur in low- and middle-income countries, and diseases caused by air pollution are more prevalent among minorities and marginalized people.⁴

Air pollution has a high social cost because related diseases cause productivity losses that compromise gross domestic product (GDP) in low- to middle-income countries by up to 2% per year.⁵ Air pollution-related illnesses result in health costs accounting for 1.7% of annual spending in high-income countries and up to 7% of health spending in heavily contaminated and rapidly developing middle-income countries.^{6,7} Well-being-related losses from air pollution are estimated at US\$4.6 trillion per year – 6.2% of world economic output, and such cost tends to increase as additional associations between air pollution and disease are identified.^{6,7}

Approximately 70% of the nine million deaths caused annually by air pollution are related to noncommunicable diseases (NCDs), such as heart disease, heart attack, chronic obstructive pulmonary disease (COPD), lung cancer, and others.^{8,9} Intervention against air pollution, which has been called the “new tobacco”,¹⁰ is not mentioned in the Global Action Plan for the Prevention and Control of Noncommunicable Diseases,¹¹ despite its close relationship with NCDs.

Global environmental challenges pose monumental risks to people's health and well-being. They also give us the opportunity to act. Based on the new concept of planetary health¹² and the recommendations of the American College of Physicians¹³ and the World Organization of National Colleges, Academies and Academic Associations of General Practitioners/Family Physicians (WONCA),^{14,15} we must highlight the role of primary care physicians (PCPs) representing the front line in health protection. Therefore, we conducted this pilot study with PCPs in the city of Uruguaiãna, Brazil, to investigate possible risk factors of exposure

to indoor air pollution (IAP)/outdoor air pollution (OAP) and their relationships with NCDs.

Methods

A cross-sectional study with a quantitative approach was conducted in the city of Uruguaiãna, Brazil, to identify possible risk factors of exposure to IAP/OAP and their relationships with NCDs in patients treated by PCPs. In total, 551 patients (382 women) who attended three primary health care facilities for various complaints completed a questionnaire on risk factors for IAP/OAP exposure, adapted from the Clinical Screening Tool for Air Pollution Risk¹⁶ (Figure 1). Some questions were included in an attempt to adapt it to the local reality. A convenience sample was recruited, and patients seen at basic health units during the months of January to June 2019 were admitted.

Ethical approval from the institution and patient consent were obtained.

The data were transferred to an Excel spreadsheet and the variables were presented as simple frequency. Depending on the nature of the variables, a parametric test (Student *t* test) or a nonparametric test (chi-square, Fisher exact test) was used, with a rejection level for the null hypothesis set at 5%.

Results

Table 1 shows socioeconomic and environmental characteristics of the evaluated population according to sex, including data on AH/CRD. The respondents were predominantly female (69%). Women were significantly more exposed to wood-burning pollutants (79.6% vs. 52.7%, $p < 0.0001$) as they were more involved in household chores. Men who had outdoor activities were exposed to intense traffic (47.3% vs. 18.8%, $p < 0.0001$).

The presence of relatives with AH (33.0%), asthma (36.3%), and/or chronic bronchitis (14.8%) was similar in both sexes. Active smoking was significantly higher among men (18.9% vs. 9.9%, $p < 0.003$), as well as having a job (61.5% vs. 43.5%, $p = 0.0001$). Among the 382 women (69%), there were patients with AH/CRD (asthma and/or bronchitis) who worked near a source of air pollution (18.1% vs. 11%, $p = 0.02$), lived near a source of air pollution (45.6% vs. 29.6%, $p = 0.0002$), and lived near a street with heavy traffic (41.7% vs. 33%, $p = 0.04$). There was no association between

CLINICAL SCREENING TOOL FOR AIR POLLUTION RISK

No. _____

SEX: male () female () AGE: _____ PROFESSION: _____

How many people live in your house? Adults: _____ Children: _____

HOUSEHOLD AIR POLLUTION:

1. Do you use firewood or charcoal for cooking meals, heating the home, or drying clothes? yes () no ()
2. What kind of stove do you use? gas () firewood () gas and firewood () electric () solar ()
3. How much time do you spend around the fire? morning () afternoon () night () all day () not applicable ()
4. Do you burn any material indoors to keep warm? yes () no ()
- 4.1 Which one(s)? firewood () charcoal () cardboard () plastic () other _____ not applicable ()
5. How do you ventilate the smoke from your home?
window () door () door and window () chimney () other _____
none () not applicable ()

OUTDOOR AIR POLLUTION:

6. Do you work near any source of pollution? yes () no ()
- 6.1 Dump () rice silo () unpaved road () open sewer () heavy traffic () smoke () dust () not applicable ()
7. Do you live near any source of pollution? yes () no ()
- 7.1 Dump () rice silo () unpaved road () open sewer () heavy traffic () smoke () dust () not applicable ()
8. Do you perform outdoor activities? yes () no ()
9. Are you exposed to high traffic for extended periods? yes () no ()
10. Where do you spend most of the time during the day? in traffic () at home ()
11. When driving, do you leave the windows open? yes () no () sometimes ()
12. Is your home near high traffic streets? yes () no ()
13. Is the street in front of your house paved? yes () no ()
14. Do you have, or have you had, any heart or breathing problems or cancer? yes () no ()
- 14.1 Which one(s): _____
15. Does anyone in your house have asthma or bronchitis? yes () no ()
- 15.1 Who? _____
16. Do you smoke? yes () no ()
- 16.1 For how many years? _____
17. Does anyone in your house smoke? yes () no ()
- 17.1 Who? _____
18. Do you work? yes () no ()
- 18.1 What is your monthly family income in Brazilian reais? Use Brazil's monthly minimum wage rate as a reference.

19. Do you receive *Bolsa Família* payments? yes () no ()
20. Is anyone in your family on *Bolsa Família* program? yes () no ()

Figure 1

Questionnaire on risk factors for IAP/OAP exposure (adapted from the Clinical Screening Tool for Air Pollution Risk¹⁶)

Table 1

Distribution of socioeconomic and environmental characteristics of participants according to sex

	Male n = 169	Female n = 382	p
Age (years)	50.6±17.1	46.5±15.8	< 0.001
Adults at home (mean)	3.9	2.8	0.01
Children at home (mean)	0.9	1	0.36
Using wood, charcoal, or firewood for cooking, heating, or drying (%)	44 (26)	76 (19.9)	0.1
Stove type			
Gas/electric (%)	129 (76.3)	321 (84)	
Firewood (%)	40 (23.7)	67 (17.5)	0.03
Do you burn material indoors? (%)	40 (23.7)	67 (17.5)	< 0.001
Which material?			
Firewood/coal (%)	39 (23.1)	379 (99.2)	< 0.001
How do you ventilate the smoke?			
Window/door/chimney (%)	24 (14.2)	54 (14.1)	0.77
Do you work near a pollution source? (%)	23 (13.6)	51 (13.3)	0.93
Which one(s)?			
Open dump/sewer (%)	2 (0.6)	5 (0.5)	
Unpaved street/vehicle traffic/dust (%)	7 (0.6)	31 (1.3)	0.91
Not applicable	146 (86.4)	328 (85.9)	
Do you live near a pollution source? (%)	49 (29)	145 (37.9)	0.04
Which one(s)?			
Open dump/sewer (%)	19 (11.2)	35 (9.2)	0.79
Unpaved street (%)	15 (8.9)	56 (14.6)	
Do you do outdoor activities? (%)	75 (44.4)	154 (40.3)	0.37
Are you exposed for a long time to heavy traffic? (%)	78 (46.2)	118 (30.9)	0.05
During the day, you spend most of the time:			
In traffic (%)	80 (47.3)	72 (18.8)	0.02
At home (%)	89 (52.7)	304 (79.6)	
When driving, do you leave the car windows open? (%)	44 (26)	100 (26.2)	0.97
Is your home located near high traffic streets? (%)	65 (38.5)	150 (39.3)	0.85
Is the street in front of your house paved? (%)	114 (67.5)	246 (64.4)	0.10
Do you have, or have you had, any heart or breathing problems or cancer? (%)	43 (25.4)	127 (33.2)	0.07
SAH/stroke (%)	19 (11.2)	47 (12.3)	
Asthma/bronchitis/rhinitis (%)	11 (6.5)	43 (11.2)	0.29
Does anyone have asthma or bronchitis in your house? (%)	34 (20.1)	111 (29)	0.02
Do you smoke? (%)	24 (14.2)	46 (12)	0.48
Does anyone smoke at home? (%)	34 (20.1)	92 (24.1)	0.30
Do you work? (%)	86 (51)	167 (43.7)	0.11
What is your family's income?			
Up to 2 minimum wages (%)	161 (95.3)	266 (69.6)	< 0.001
3 or more minimum wages (%)	8 (4.7)	96 (25.1)	
Do you receive <i>Bolsa Família</i> payments? (%)	41 (24.2)	35 (9.2)	< 0.001

SAH = severe arterial hypertension.

exposure to IAP due to burning of wood, charcoal, or firewood for cooking, heating, or drying (24.2% vs. 20.7%, $p > 0.05$) or burning charcoal/wood indoors (23.1% vs. 17.7%, $p > 0.05$) and AH/CRD (Figure 2). One-third of all participants earned a minimum wage (approximately US\$250 per month), and 18.8% received *Bolsa Família* payments (approximately US\$95 per month).

Discussion

Although air pollution affects people from all regions, ages, and socioeconomic groups, it is more likely to cause health problems and death in certain individuals. Air pollution disproportionately kills the poor and vulnerable in a context in which extrinsic and intrinsic factors determine the level of vulnerability to adverse health effects from exposure to air pollution.⁵

One-third of all patients evaluated earned a minimum wage, and 18.8% received *Bolsa Família* payments. The *Bolsa Família* Program has been responsible for considerable improvements in socioeconomic conditions in Brazil since 2006, providing financial aid to families defined as poor. Families living in poverty have not only low incomes but also fewer opportunities to improve living conditions because their access to education is limited, which affects employment opportunities and limits access to public services.¹⁷

Low- and middle-income populations disproportionately suffer the effects of transport-related air pollution, in part because of the use of old and inefficient diesel vehicles and the lack of adequate public transport networks,¹⁸ or because they live or work in densely populated and high traffic areas and near pollution sources.¹⁹ Transport-related air pollution affects several health parameters and is a potential risk factor for respiratory and cardiac diseases and disorders.²⁰⁻²² This was detected in the participants with AH/CRD. They reported being more exposed to air pollution sources, as they usually work (18.1%) or live near an air pollution source (43.6%) or near a street with heavy traffic (41.7%) (Figure 2).

The female participants were more exposed to pollutants derived from burning of wood because they were more involved in household chores. Using these fuels indoors deteriorates air quality, and IAP is estimated to cause 25% of all deaths from stroke and 15% of all deaths from ischemic heart disease and obstructive pulmonary disease among low- and middle-income individuals.^{23,24}

The Global Burden of Disease Study has attributed 2.6 million deaths per year to household air pollution, making it the second-largest environmental risk factor in the world and 10th in the total global disease burden.²⁵ Of all the human health risk factors analyzed in the study, household air pollution was the second-largest risk factor for women, girls, and men worldwide,

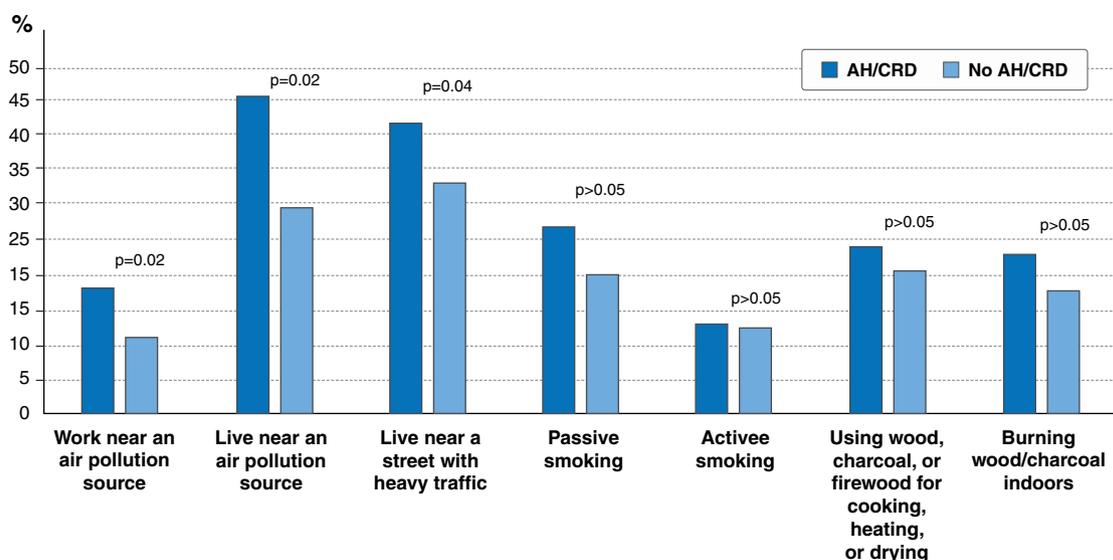


Figure 2

Frequency of arterial hypertension/chronic respiratory disease (AH/CRD) and air pollution exposure

and the fifth-largest risk factor after passive and active smoking, alcohol use, and hypertension.²⁶

More than three billion people still have pollutant and inefficient power systems to meet their daily cooking, heating, and lighting needs.²⁷ Low-income households do not replace one fuel with another as income increases; instead, they add fuels in a “fuel-stacking” process.²⁸ An essential consideration for using multiple fuels is the sense of energy security experienced by low-income households, as complete reliance on a single fuel leaves households vulnerable to price fluctuations and unreliable services, especially in isolated communities.²⁹

The concept of cumulative risk combines extrinsic and intrinsic factors to assess an individual's or a population's vulnerability to the harmful effects of air pollution. When the factors are combined, the effects can be additive or multiplicative. For example, pre-existing cardiopulmonary diseases increase the susceptibility to the effects of particulate matter present in polluted air.⁸

Assessments of potential health risks determined by a specific pollutant do not inherently reflect the multiple environmental and social stressors faced by vulnerable communities that can interact to damage health.⁸ Strategies for achieving health equality in these communities require major changes.

Engagement of PCPs in this fight is of great relevance.³⁰ They are the first to detect disease and can make recommendations to their patients for behavioral changes that have environmental co-benefits. Therefore, educating the public about the potential health effects and consequences of climate change, introducing planetary health concepts into education, research, and teaching and training curricula, and developing professional educational materials with primary care information are highly recommended.^{13,31-33}

A limitation of our study is that a written questionnaire is a simple and economical way to detect risk factors for environmental pollution to which patients are exposed. These risk factors are generally poorly investigated on anamnesis because the PCP lacks knowledge of how much they influence the recovery of their patients. Asthma and bronchitis were identified as CRDs, but pulmonary function was not assessed to identify COPD, and we hope to do it in a future study.

In conclusion, PCPs treat most patients with NCDs, especially in the early stages. The 2030 Agenda for

Sustainable Development calls for a new approach to health, environment, and equity to address preventive and sustainable health determinants.²⁰ As opinion leaders connected to their communities, the PCPs play an essential role in preventing and educating about the impacts of environmental pollution on the health of all their patients, working as strong promoters of actions that encourage environmental change in the community. The complex effects of these changes on health require the unique ability of PCPs to combine their legitimacy as knowledge specialists with close professional relationships with the people they treat, using evidence to protect planetary health and the quality of life of patients and families in the communities where their work.³¹

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