Applied Mathematical Sciences, Vol. 16, 2022, no. 6, 279 - 285
HIKARI Ltd, www.m-hikari.com
https://doi.org/10.12988/ams.2022.916756

Exposure to Solid Biodegradable Waste Dumps and Risk of Acute Respiratory Infections, Case of Buterere Population in Bujumbura (2018-2020): Case-Control Study

Jean-Marie Hashazimari [1], Christophe Niyungeko [2], Marius Nonvignon Kedote [3], Vestine Ntakarutimana [3] and Luc Djgbenou [3]

[1] University of Burundi, Doctoral School, Ph.D. student in Environmental Sciences and Health; Laboratory of Natural Sciences and Environment

[2] University of Burundi, Laboratory of Natural and Environmental Sciences

[3] University of Abomey-Calavi, Benin, Regional Institute of Public Health, Research Center for Tropical Diseases

Abstract

The polluted environment has deleterious effects on ecosystem health. Weather conditions (wind, heat), sometimes as a consequence of climate change, play a major role in the spread of viruses and bacteria in the air from polluted soil, which is responsible for Acute Respiratory Infections (ARI).
The present study focuses on the assessment of the risk of contracting ARI in the area exposed to the unprotected landfill of Buterere (Bujumbura) by a case-control epidemiological study. The association parameters analyzed are Odds Ratio (OR), Risk Difference (RD) followed by an MH statistical test. The study included 344,935 people, 117,812 in the exposed area and 227,123 in the unexposed area.
Overall, there was an excess risk of contracting ARI in Buterere (OR > 1; OR=3.19; DR=19,6%: the further away from the landfill area, the less likely one was to contract the disease. Those under 5 years of age are more affected compared to those over 5 years of age. Further research on the types of pollutants and their contribution remains a necessity.

Keywords: Association; Case-control study, air pollution, acute respiratory infections, solid waste landfills, Health risk

1. Introduction

Due not only to its impact on climate change but also on public and individual health, the “air pollution is the cause of increased morbidity and mortality in living beings, particularly in humans"(Jean-Michel Balet, 2014) [1]. The respiratory system is the most affected by the harmful effects of air pollutants (Bliefert/Perraud, 2014) [2].

Anthropogenic air pollution is one of the greatest public health risks in the world, accounting for approximately 9 million deaths per year (WHO Air Pollution. http://www.who.int/airpollution/en/).

Studies by APHEIS on 26 European cities have shown an increased prevalence of respiratory diseases as a result of air pollution [3]. The main diseases of concern are lung disease, rhinitis, asthma, respiratory tract infections, and chronic obstructive pulmonary disease (D’Amato, G., Cecchi, L., 2014) [4].

Among the sources of air pollution are poorly managed landfills of solid biodegradable waste, for which "adaptation and mitigation measures are necessary" to limit their hazardousness (Bliefert/Perraud, 2014) [2]. The dispersion of pollutants in the air is determined by many parameters, including atmospheric stability and wind (Kelishadi R, Poursafa P., 2010) [5]. While creating nuisance to human health and the surrounding environment through pollution, solid waste landfills should be designed to reduce emissions to the unavoidable minimum (Directive 1999/31/EC). Indeed, bad weather (wind and heat for example), carries in the air toxic pollutants proliferates molds, particles, bacteria, and viruses from the polluted soil (Bliefert/Perraud, 2014) [2] causing acute respiratory infections in addition to other nuisances.

In Burundi, reports from the Ministry of Public Health indicate an increase in the number of cases of acute respiratory infections (ARI) in the Buterere area located near the landfill compared to other localities in Bujumbura, but unfortunately, the risk factors remain undocumented to allow better management of the population (MSPLS, DHS2).

The hypothesis is that there is an increased risk of contracting acute respiratory infections (ARI) in the neighborhoods surrounding the Buterere landfill (Bujumbura). The general objective of the study is to evaluate, through an epidemiological study of case-control type, the impact of this landfill on the health of the neighboring population, in particular the risk of acute respiratory infections (ARI). Is living near the uncontrolled Buterere solid waste landfill a risk for ARI? This is the research question.

2. Materials and methods

Characteristic of the study areas: The exposure area (Buterere) is located north of the capital Bujumbura. The temperature varies between 17°C and 31°C, rarely below 16°C or above 33°C" [6]. This area contains a former uncontrolled landfill that has been active since 1983 and was theoretically closed in 2009 but is still in use. The control areas (Musaga and Kanyosha) are located south of the capital Bujumbura. The inhabitants of these areas have socio-cultural characteristics similar to those of the exposed group.

Case definition: ARI in this study was considered to be bronchitis, pneumonia or bronchiolitis. The quality of diagnosis of ARI by caregivers is not verified, we limit ourselves to reported cases.

Sampling: A purposive sampling approach using quotas and standard units is used (Francois DABIS et al., 1992) [7]. The population is subdivided into two subsets, where a sample of standard units that can summarize each subset is drawn: these are the public health centers (CDS) and the private CDS. The samples were drawn from the public health centers, which are heavily frequented by the population.

Inclusion criteria: All patients (all ages and genders) living mostly in the above-mentioned areas, who consulted in the public CDS located in the target areas from 2018 to 2020 (3 years). These health care are Buterere I; Buterere II and Mutakura CDS (Exposure Zone); Musaga and Kanyosha CDS (Non-exposure Zone).

Target population: The study covers a population of 135,044 inhabitants in the Buterere zone and 131,735 inhabitants in the control zone at the end of 2020 (source: MSPLS).

Source population: These are the patients who presented themselves in the above-mentioned public CDS for 3 years. They numbered 344,935, with 117,812 in the exposed area and 227,123 in the unexposed area. To make the drawn samples more comparable, the cases and controls compared were analyzed on the population covered reduced to 100 persons (proportion);

Data collection and analyses: The data analyzed were collected from the MSPLS DHS2 database. They were compared with those of the standard consultation registers in the indicated CDS.

The parameters analyzed were: (i) Odds Ratio (OR), (ii) Risk Difference (RD), (iii) Mantel-Haenszel Chi-square statistical tests, and (iv) Calculation of the 95% Confidence Interval (François DABIS, Jacques BRUCKER, 1992) [7]. The formulas are given below.

Table 1. Data matching table

	Sick.	not sick	Total
Exposed to risk factors	a	b	L1
Not exposed to factors	c	d	L2
Total	C1	C2	T

Parameters analyzed: RR (relative risk), OR (odds ratio), DR (difference in risk), Mantel-Haenszel chi-square, calculation of a confidence interval by the semi-exact method

OR = (a/c)/(b/d) = (a*d) /(b*c); DR = D1-R0 =(a/L1) -(c/L2) (6)

The Mantel-Haenszel chi-square formula ($\chi^2 MH$) est *(6):*

$$\chi^2 MH = \frac{[(a*d)-(b*c)]^2\ (T-1)}{L1*L0*C1*C0} = \frac{T-1}{T}\chi^2\ (ddl=1)$$

Calculation of a confidence interval by the semi-exact method *(6)*

IC à 95%=OR$*$ exp[$\pm 1{,}96 \sqrt{[\left(\frac{1}{a}\right)+\left(\frac{1}{b}\right)+\left(\frac{1}{c}\right)+\left(\frac{1}{d}\right)]}$

Interpretation of RR OR: The interpretation of relative risk is as follows:
RR or OR = 1: no relationship between the risk factor and the disease;
RR or OR > 1: increased risk of disease (excess risk);
RR or OR < 1: reduced risk of disease (protective factor).

Interpretation of Chi-square: if the value of p ≤ α, we reject the null hypothesis and conclude that there is a statistically significant association between the variables studied and if Value of p > α: impossible to conclude that the variables are associated (do not reject H0).

3. Results

The following tables and graphs show the results obtained:

Table 2.1. Overall results over the years 2018, 2019, and 2020:

	sick	non-sick	total	
Exposure area	38 777	79 035	117 812	OR=3,19 ; DR=19,6%
Control area	30 297	196 826	227 123	*χ2 MH=18 560,001*
Total	69 074	275 861	344 935	IC à 95% [3.25 ; 3.14]

Table 2.2. Overall results, Cases and Controls in the 5+ age group

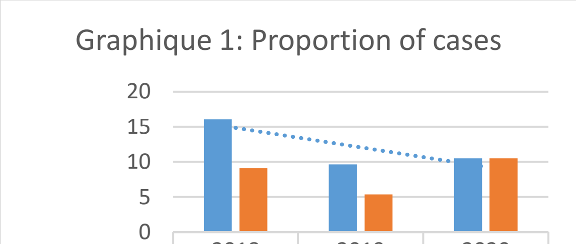
	sick	non-sick	total	
Exposure area	9 602	36 941	46 543	OR=60,3 ; DR=16,5%
Control area	5 899	136 771	142 670	*χ2 MH=12 696*
Total	15 501	173 712	18 9213	IC à 95% [58.26 ; 66.540]

Table 2.3. Overall results, Cases and Controls under 5 years of age

	sick	non-sick	total	
Exposure area	29 175	42 094	71 269	OR=1,706 DR=0,12
Control area	24 398	60 055	84 453	*χ2 MH=2 485,674*
Total	53 573	102 149	155 722	IC à 95% [1.63 ; 1.78]

Table 2.4. Proportion of cases (ill) to the population covered

	2018	2019	2020	
Exposure area	16,07	9,63	10,51	16,07=11 872/73 855
Control area	9,10	5,37	10,49	9,63=12 708/131879
Total	25,17	15,00	21,03	10,53=14 197/135 044



	2018	2019	2020
Buterere	16,07	9,63	10,51
Musaga& Kanyosha	9,1	5,37	10,49

4. Discussion

The results of the different statistical parameters measured show the overall excess risk of contracting ARI in the exposed group (OR > 1);
($\chi 2$ MH=18,560.001; p<0.001 with ddl=1; 95% CI= 3.245; 3.1358).
The risk is 32.9% of contracting the disease in exposed (38 777/117 812) while it is 13.3% in unexposed (30297/227 123).
Children under 5 years of age are globally the most affected compared to those over 5 years of age. They occupy a proportion of 75.27% among the exposed (29,175/38,777) and 80.53% among the non-exposed (24,398/30,297).
During the years 2019 and 2020, the number of ARI cases decreased in the exposure zone compared to 2018 while remaining, nevertheless, higher than the cases recorded in the control zone. This situation is probably due to the long period of rainfall that Bujumbura experienced during this period, which constrained the action of pollutant dispersion factors, namely temperature and wind.
The trend in the frequency of ARI in the exposure area and the frequency in under 5 years old compared to other age groups has been noted by other authors.
In particular, they say that disadvantaged groups including children are most affected by respiratory infections associated with changing weather parameters (Prel JB, Puppe W, Gröndahl B, et al., 2009) [8]
Other studies have shown a strong association of respiratory diseases with air pollution. This is a study in southeast China conducted in 2018 (Mo, Z., Fu, Q., Zhang, L., Lyu, D., Mao, G., Wu,2018) [9].
The association of ARI with environmental pollution was also confirmed by a study conducted in Atlanta, Georgia, from 1993-2010 by Darrow et al. (Darrow, L. A., Klein, M., Flanders, W. D., Mulholland, 2014) [10]. The 2019 Afghanistan study of ARI in children under 5 years of age also confirmed their association with indoor pollution (Rana, J., Uddin, J., Peltier, R., & Oulhote, Y. 2019) [11].
A study conducted in Ouagadougou in 2018 found an association between ARI in children under 5 years of age and indoor pollution on several variables (B., Savadogo, P. W., Millogo, T., Sana, A., Kouanda, S., & Sondo, B. (2018). [12]

Conclusions

The present topic addresses the association between acute respiratory infections (ARI), surface pollution, and weather conditions (wind, temperature).
A case-control study was conducted to confirm the hypothesis that there is an increased risk of contracting ARIs in Buterere. To estimate the risk of contracting these infections in the area exposed to surface pollution (unprotected landfill of Buterere) and unexposed, a sample of health care facilities where the individuals to be studied will be taken was chosen.
The results showed an increased risk of developing ARI in the exposed area (32.9%) while it is 13.34% in the unexposed area, i.e. a Risk Difference of 19.6%.
The only way to tackle this problem is for the Ministry in charge of Public Health to sensitize the public authorities and the local population on the danger of the situation and to seek a multidisciplinary approach of scientific experts, national and international organizations to address the emergence of this threat and propose sustainable solutions.

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Received: February 27, 2022; Published: July 16, 2022