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Study of the Factors Associated with the Treatment of Drinking Water in Semi-Urban Areas of Dakar in Senegal

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Abstract

Introduction: Home water treatment is considered an effective intervention in reducing the burden of waterborne diseases in developing countries.

This study aims to study the factors associated with the appropriate treatment of water in the semi-urban area of Dakar in Senegal.

Method: This is a cross-sectional and analytical study, carried out in June 2018 at the household level in the health districts of Mbao, Keur Massar and Guediawaye. Two-stage stratified random sampling was performed and data entered on tablets using CS Pro software. An ordinal logistic regression was carried out using the R software.

Result: A total of 533 households were surveyed. Heads of household had an average age of 52.6 years + -13.8, were male in 59.8%, married in 78.8% and predominantly had at least secondary education in 31.5% of case.

Water from an improved source was used in 97% of households. More than a third (35.6%) of respondents believed that the drinking water was not drinkable, of which 42.1% said it was colored.

Water was treated in 25% of households where bleach was used the most (65.7%), followed by filtration (32.8%) and the use of drinking tablets (16.5%).

Households headed by women treated water more (ORaj = 1.59 [1.01-2.51]), as did those who said they consumed non-potable water (ORaj = 1.57 [1.02-2.40]). In addition, the use of water from traditional pumps or wells was a favorable factor (ORaj = 2.46 [1.49-4.06]).

Conclusion: The use of household water treatment in reducing morbidity from waterborne diseases indicates the need for a better understanding of the determinants for long-term behavior change.

Keywords: Water; Hygiene; Sanitation; Water Treatment; Semi-Urban Area

Introduction

Access to drinking water has become a global issue, especially for developing countries with the birth of megalopolises [1]. Beyond quantity, water quality is a determinant of human health of particular concern in arid zones [2]. When accessible, it is often associated with chemical and / or bacteriological contamination [3,4]. Senegal has experienced a rapid increase in its population, which rose from 4,958,085 inhabitants in 1976 to 13,508,715 in 2013 [5.6]. This rapid increase in the population, which is more pronounced at the level of its capital Dakar with its 3,137,196 inhabitants, or nearly a quarter of the total population (23.2%) spread over 0.28% of the area [7,8], has led to an equally rapid growth in demand for drinking water, especially in its suburbs with areas having both urban and rural characteristics, located in the communes of Pikine, Mbao and Guediawaye. In fact, the accelerated and uncontrolled development of these areas and the proliferation of neighborhoods devoid of any urbanization plan are leading to a proliferation of individual non-standard sanitation systems, pushing the population to pour wastewater directly into nature without any prior treatment. These waters are likely to pollute the soil and the subsoil, due to their often high contents of organic matter and microorganisms of fecal origin with studies which have shown a nitrate level, which currently greatly exceeds 50 mg / l set by the WHO [9-11] on a precarious situation of permanent availability of drinking water, responsible for the use of groundwater via traditional pumps and wells which may be the source of an accentuated health risk by the vulnerability of this area to flooding [9,12]. In addition, these localities are located in the Niayes zone characterized by market gardening operations, some of which have been implicated in the reuse of wastewater and excreta, which is not without consequences on the health of the populations. Indeed, the spreading of raw wastewater on soils and the use of organic manure are often implicated in the microbiological contamination of groundwater [10,13] as well as the presence of the greatest and main open garbage dump in the Dakar region (Mbeubeuss), located in the district of Keur Massar [14] which can cause diseases of varying severity, from mild gastroenteritis to dysentery, to hepatitis or typhoid fever, or even severe and sometimes fatal diarrhea [12]. Water-borne diseases are thought to cause 3.4 million deaths each year, including 2.2 million from diarrheal diseases [15]. This poses a real public health problem.

To achieve the Millennium Development Goals MDGs in the areas of water and sanitation, the Senegalese government set up the Drinking Water Program since 2005 and Millennium Sanitation (PEPAM) which aims at universal and equitable access to drinking water for all. After using the data from the national inventory of access points to drinking water, it appears that the access rate in 2015 was 86.6% [16]. This objective was revised in the Sustainable Development Goals 2030. At the global level, the report on the progress made in water and sanitation, published jointly by WHO and UNICEF in 2017, had shown that 2.1 billion people, or 30% of the world's population, still do not have access to drinking water [17]. This report also indicates that in Senegal 19% of the population get their supplies from an unimproved water source (29% rural, including 1% from surface water and 7% urban) [17].

It is in this perspective of wanting to take stock of good practices in water management in a context of a demographic boom and the creation of new towns in the Dakar suburbs, that this study was conducted on factors associated with the treatment of drinking water in the semi-urban area of the Senegalese capital.

Method

Study framework

The Dakar region is located in the Cap Vert peninsula, limited to the east by the Thies region and by the Atlantic Ocean in its north, west and south parts, and covers an area of 550 km² for a population of 3,137,196 inhabitants, ie a density of 5704 inhabitants / km [8]. The study was carried out in the three districts of the semi-urban area of the Dakar region that are Keur Massar, Guediawaye and Mbao which are characterized by a high population density with respectively 18,187 inhabitants / km² for a population of 545,603 inhabitants, 12,688 inhabitants / km² for a population of 355,525 inhabitants and 11,717 inhabitants / km² for a population of 374,944 inhabitants against a national average density of 65 inhabitants per km². The lack of industrial activity and service zones means that this zone is essentially home to low-income economic activities, mainly informal sector activities such as market gardening, arbo-

riculture, trade, crafts, fishing and animal husbandry, which accounts for nearly 85% of the working population [8,18]. In terms of health, there are gaps in the structure of a health center, referring to the National Health and Social Development Plan PNDSS 2019-2028, knowing that each district has only one and that the standard is one center for 100,000 inhabitants [19].

Type of study

This was a cross-sectional, descriptive and analytical study at the household level, conducted from June 18 to 28, 2018 in the semi-urban area of the Dakar region.

Study

Population Study population was made up of all residents for at least six months, the household sampling unit having a child under five years old. Statistical units by the head of household (Male or Female) or other respondent aged at least 18 years.

Sampling sample

Thesize was calculated by Schwartz's formula ($N = Z\alpha^2 P [1-P] / i^2$) for a prevalence **(P)** of 50%, with a reduced deviation **(Zα)** of 1, 96 for α = 5% and a precision **(i)** of 0.05. Thus the calculated size N was 384, taking into account the refusal rate and for more power, the size was increased to a minimum of 400 individuals.

A two-stage stratified random sample had been carried out. First, there was the identification of the piezometers (sampling points for physico-chemical and microbiological analyzes of the water table) located in the districts drawn proportionally on a database of 79 piezometers located in the districts of the area. Study provided by the hydrogeology team of the science faculty of Cheikh Anta Diop University in Dakar. Secondly, according to the number of neighborhoods (water point) per health district, stratification was carried out and made it possible to obtain the number of households required per health district and per selected neighborhood. Then the selection of households was made step by step with a survey step of five right-left concessions and so on.

Data gathering

Before data collection, the investigators trained were12 in number, 3 of whom are officers from the hygiene services. The questionnaire was adapted from the *Sanitation, Focus-Opportunity-Ability-Motivation* (SaniFOAM) framework [20]. This questionnaire was then loaded into Android tablets using Cs Pro software, which enabled data to be entered instantly.

Data analysis

At the end of the survey, the data were extracted, before being analyzed using software R 3.4.4. The quantitative variables were described by the mean with its standard deviation and the qualitative variables by the frequency. For the analytical study, the Chi-square test and that of Fisher were used with an alpha risk of 5%. To take into account confounding factors, a multivariate analysis was performed. The latter used a simple logistic regression model, taking into account in the initial model all the variables whose p is less than 0.25 in the bivariate analysis. The comparison of the models was performed by the likelihood ratio test with a top-down procedure [21]. The relevance of the model was studied by the test of Hosmer and Lemeshow. The measure of association was the adjusted odds ratio and its confidence interval was 95% [22].

Ethics

An investigation authorization was issued by the health authorities. The free and informed consent of each person to be surveyed was obtained before the interview. These people could stop the interview at any time and even withdraw from the study without prejudice. Anonymity was respected and the results were kept confidential.

Results

Descriptive study

Socio-demographic characteristics: The study involved a total of 533 people spread over three health districts of Guediawaye (26.6%), Keur Massar (58.7%) and Mbao (14.5%). The average age of heads of household was 52.6 years (13.8 years) and a median of 52 years. They were men in 59.8% with one, predominantly married with 78.8% and have at least a secondary school level (31.5%). A quarter (25.3%) of household heads were unemployed and the poorest socio-economic well-being quintile was the most represented with 29.3% of households (Table 1).

		Absolute frequency (n)	Relative frequency (%)
Health district	Guediawaye	143	*26.6*
	Keur Massar	313	*58.7*
	Mbao	77	*14, 5*
Sex	Male	319	*59.8*
	Female	214	*40.2*
Marital status	Married	420	*78.8*
	Widowed	73	*13.7*
	Single	23	*4.3*
	Divorced / Separated	16	*3.0*
	Cohabitation	1	*0.2*
Level of education	No education	81	*15.2*
	Koranic education	152	*28.5*
	Primary	124	*23.3*
	Secondary and above	168	*31.5*
	Don't know	8	*1.5*
Household size	<10 people	245	*46.0*
	10 people and more	288	*54, 0*
Main activity of the head of household	Informal sector (Agriculture, livestock, fishing, construction)	260	*48.8*
	Administrative / employee worker	46	*8.6*
	Technician	17	*3.2*
	Manager	14	*2.6*
	Domestic	2	*0.4*
	Other	59	*11.1*
	None	135	*25.3*
Quintile of socio-economic well-being	The poorest	156	*29.3*
	The second poorest	60	*11.3*
	The average	106	*19.9*
	The second richest	137	*25.7*
	The richest	139	*13.9*

Table 1: Distribution according to personal characteristics

Water, Hygiene and Sanitation: The use of improved water source for consumption in households represented 97.0% or 517 households, of which predominantly service water at home with its 92.5% and for improved source of water for domestic use, it was 81.1%.

Referring to the source of water from the groundwater by traditional pumps and wells, it was 3.4% and 16.4% respectively for drinking and domestic use.

The majority (64.4) had a negative apprehension of water quality. Only one in four (25.1%) of household heads treated water and the bleach method was the most used with 16.5%

The presence of a hand washing device was observed in 52.5% Household. The proportion of individuals practicing systematic hand washing with soap after defecation was 86.7% of the population, or 462 in households. The availability of latrines / toilets was observed in 99.4% of households and improved toilets in 76.5% of households (Table 2).

Variables			Absolute frequency (n)	Relative frequency (%)
Potability assessment of drinking water		Yes	343	*64.4*
		No	190	*35.6*
Time taken to go and return to fetch water		Water on site (in the home)	429	*80.5*
		Less than 30 minutes	98	*18.4*
		30 minutes or more	59	*1.1*
Main source of drinking water	**Improved source**	Running water in the house (tap)	493	*92.5*
		Standpipe	19	*3.5*
		Bottled water	3	*0.6*
		Protected well	2	*0.4*
		Total	**517**	***97.0***
	Unimproved source (unprotected well, others)		**16**	***3.0***
Type of water source intended for consumption mation		**Service water** (tap, fountain, bottle)	515	*96.6*
		Groundwater (traditional pump, well)	18	*3.4*
Main source of water for domestic use	**Improved source**	Running water in the house (tap)	435	*81,5*
		Traditional pump	54	*10,1*
		Protected wells	27	*5,1*
		Fountain	11	*2,1*
		Total	**527**	***98,8***
	Unimproved source (Unprotected wells, others)		**6**	***1.2***
Type water source for domestic use		Service water (tap, fountain)	**446**	***83.6***
		Groundwater (traditional pump, well)	**87**	***16.4***
Drinking water treatment		Yes	134	*25.1*
		No	399	*74.9*
Drinking water treatment mode		Bleach (Chlorine)	88	*16.5*
		Filtration	44	*8.3*
		Drinking tablets	22	*4.1*
Existence of hand washing facilities near the toilets		Yes	280	*52.5*
		No	253	*47.5*
Systematic hand washing with soap after defecating		Yes	462	*86.7*
		No	71	*13.3*
Availability of latrines / toilets		Yes	3	*0.6*
		No	530	*99.4*
Type Latrines / Toilets		Improved toilets	408	*76.5*
		Shared unimproved toilets	125	*23.5*

* **Improved toilets:** Hand-flush toilets (TCM) watertight pit toilet, Septic tank toilets, Ventilated double latrines, VIP double pit, single pit latrines, Eco-friendly toilets

* **Shared unimproved toilets:** All types Shared improved toilets and Traditional latrines

Table 2: Distribution of households according to availability of and access to water, hygiene and sanitation

Analytical study

Multivariate logistic regression models were constructed and tested to identify factors associated with drinking water treatment. Were statistically significant in the final model retained: the female sex of the head of household, the non-drinkability of water and water for domestic use from groundwater through the use of wells. Other variables were found in the model and did not show a statistically significant relationship. These were the marital status and the size of households. These results are shown in Table 3.

Variables	Water treatment (Yes)					
	Yes		Total	**ORb** [IC 95%]	**P value**	**ORaj** [IC 95%]
	n	%	N			
Gender of household head						
Male	72	*22,6*	319	Ref	**0,047**	Ref
Feminine	62	*29,0*	214	1,4 [0,94-2,08]		**1.59 [1.01-2.51]** *
Marital status						
Single	7	*29,2*	81	Ref	Ref	Ref
Divorcee)	8	*50,0*	152	2,43 [0,65-9,07]	0,272	2.14 [0.55-8.37]
Married)	109	*26,0*	124	0,85 [0,34-2,11]	0,886	0.93 [0.37-2.37]
Widowed	10	*13,7*	168	0,39 [0,13-1,16]	0,054	0.32 [0.10-1.02]
Household size						
10 people and more	63	*21,9*	288	Ref	0,06	Ref
Less than 10 people	71	*29,0*	245	1,46 [0,98-2,16]		1.48 [0.98-2.22]
Potability						
Yes	59	*31,0*	343	Ref	**0,038**	Ref
No	75	*21,9*	190	1,61 [1,08-2,4]		**1.57 [1.02-2.40]** *
Type household water source						
Tap water (home, fountain)	99	*22,2*	446	Ref	**< 0,001**	Ref
Other types (Well, Pump, traditional)	25	*40,2*	87	2,36 [1,46-3,82]		**2.46 [1.49-4.06]** *

CI: Confidence Interval

OR: Odds Ratio

* **:** Significance

Table 3: Logistic regression of the determinants of water treatment

Discussion

The study covered a total of 533 households spread over three health districts, Guediawaye with a proportion of 26.8%, Keur Massar with 58.7% and Mbao 14.5%. The average age of the heads of household was 52.6 ± 13.8 years, indicating that the households belonged to the group of economically active persons [23]. Male heads of households accounted for 59.8%. This was found in a study in Benin in which respondents were predominantly male (63%) [24,25]. This reinforces the belief that men are generally considered to be heads of families. The average size per household was 11.3 ± 6 people, much higher than the averages found in Cameroon of 6 people [26] and in Côte d'Ivoire of 4.7 people [27]. On the other hand, these figures are comparable with the study by Faye A et al, carried out in the rural community of Ngohe in Senegal [28]. Heads of married households represented 78.8% and had at least a secondary education level which predominated in 31.5% and 15.2% had no education. This secondary school level is lower than the results of Jiokeng's study, which found 54.86%. The high illiteracy rate in the study area could promote bad behavior in water management and hygiene practices. It should be remembered that this zone has been characterized by a wide coverage of Muslim denominational boarding schools since the 1980s. The study had shown that 25.3% of heads of households had no income-generating activity. Almost half of the heads of household (48.8%) worked in the informal sectors of construction, agriculture, animal husbandry and fishing. This high proportion can be explained by the fact that this study area is partly located in the Niayes area characterized by the practice of market gardening, poultry farming and the proximity of the north coast of Dakar [29].

The availability of running water within households throughout the year was found in 85.6% of households and for each of the three districts, the availability of water within households was greater than 80%. The state of Senegal had recognized the need to strengthen investments to improve access and availability in this densely populated area over the past two decades by reopening the Thiaroye boreholes which were closed due to original pollution. anthropogenic of the water table and by on the lake of Guiers [9].

The improved source drinking water supply in our study was 97% with 92.5% coming from the tap inside the concession. At the national level for Senegal, the JMP in 2015 found the use of a water source improved by 63% in rural areas and 91% in urban areas [17]. Also, at the national level in 2017, the Senegalese demographic and health survey found eight out of ten households (81%) that had an improved water source, with however a gap between the urban environment (93%) and in rural areas (68%) and in nearly three quarters of households (74%), water came from a tap [30]. This difference could be explained by the fact that the study area is located in the capital and that Senegal had set up a program of universal access to drinking water (PEPAM) [16] for the achievement of the MDGs. 2015 and this policy is still in progress for this time the achievement of the SDGs by 2017. However, the results of access to water from an improved source of the regional assessment in the context of the economic situation and social aspects of the Dakar region in 2015 were in agreement with those found in the entire study population [8]. An internal disparity between the different health districts had been observed for example in Guediawaye the use of an improved water source was 100% unlike Keur Massar and Mbao which were 96.2% and 94.8% respectively. Despite high access to improved source water, 35.6% of households felt that the drinking water was unsafe or unsanitary and required treatment to ensure primary prevention of diarrhea whose effectiveness in reducing morbidity and mortality associated with this disease has been demonstrated [31,32]. This is similar to the results of the study carried out in 2019 in Douala where a third (33%) of households said they did not have access to good quality water [26].

The study revealed that a quarter (25.1%) of households practiced water treatment, ie 134 households. Bleaching with chlorine was the most used treatment method with 16.5%, followed by filtration (8.3%) and the use of drinking tablets (4.1%). A study carried out in Chad on the determinants of water treatment found 30% of households that carried out the treatment with mainly the use of chlorinated products [33]. In Congo another study found a 50.5% treatment with essentially boiling (28%), filtration (26%), decontamination with chlorine (21%). This improvement noted in the Congo followed the various interventions of NGOs such as the Red Cross [34]. This low rate of treatment could be linked to the fact that 92.5% of the drinking water came from the Water Company (SDE) which is the national service responsible for the distribution of drinking water. This explains why the treatment is mainly provided for water from the local groundwater through traditional water pumps and wells.

To ensure the large-scale and effective use of water treatment methods household, it was essential to identify the factors that influence treatment.

Female-headed households were more likely (ORaj = 1.59 [1.01-2.51]) to receive water treatment before use. As do those who thought they were using unsanitary water (ORaj = 1.57 [1.02-2.4]). Our finding is consistent with a study carried out in the Uganda capital (Kampala) in 2019 [35] and another in Cameroon in 2013 [36] which indicated that households headed by women were more likely to invest in the effort of 'fetch water, in the treatment compared to men in communities, especially in slums.

Alink strongexisted between the source of water for domestic use and treatment (P <0.001), households using water from traditional pumps (Diambar) and wells were times more inked (ORaj = 2.46 [1, 49-4.06]) to the practice of water treatment than those using a water source from the tap or from the standpipe. Tap water coming from a private management service ensuring access to drinking water, could explain that the good management practices and the treatment of water were done more for the sources of water of origin in situ (Groundwater). In a recent study in 2018 on the improvement of Wash and prevention of diarrhea had found the same trends of practices in the sub-region in Nigeria [37].

Other variables were found in the model and did not show a statistically significant relationship. These were the marital status and the size of households. In Ethiopia, a study found other associations with water treatment, such as education level, income, number of children under five, the means to get drinking water [38].

Conclusion

This study revealed that one in four households practiced water treatment. This practice was more likely if the household is headed by a woman. The perception of the non-drinkability of the water used is a factor associated with the treatment. One of the achievements to be reinforced in this area is the treatment of water coming from the water table by the use of traditional pumps and wells. Remember that in the past some boreholes located in the semi-urban area were closed for reasons of non-potable water, in particular because of the nitrate. In fact, the virtual absence of an adequate sanitation network for the elimination of faeces has led to an increase in the nitrate level, which greatly exceeds the 50 mg / l set by the WHO. It is necessary in the fight against water-borne diseases to maintain good communication for the change of behavior of the community and to strengthen in drinking water supply infrastructure for universal access as part of the achievement of the Objectives of the Sustainable Development SDGs.

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