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Prevalence and major cardiovascular risk factors such as diabetes, high blood pressure and obesity in the municipality of Niakhene (Senegal)

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Non-communicable diseases (NCDs) such as diabetes and high blood pressure pose a significant health and economic burden in low-income countries. This study aimed to examine the prevalence of diabetes, arterial hypertension, and obesity, as well as their associated factors, in the Niakhene commune in rural Senegal. It was a cross-sectional, descriptive, and analytical survey conducted in October 2020 among individuals aged 18 years or older and residing in the Niakhene municipality. A systematic random survey, stratified by sex and sections, was carried out. The questionnaire was developed based on the framework of the STEPS 2015 tools and a literature review. This questionnaire included anthropometric measurements, as well as blood sugar and blood pressure measurements. Descriptive and analytical analyses were performed using R 4.0.2 software. A total of 300 individuals were surveyed. The prevalence of diabetes was 3.7%, including 0.7% newly diagnosed cases. Factors associated with diabetes included advanced age (over 60 years) (ORaj=10.6 [1.32-232]) and a family history of diabetes (ORaj=8.77 [1.16-65.7]). Regarding arterial hypertension, 16.3% of cases were newly diagnosed. Hypertension was associated with age and the presence of overweight or obesity. Individuals aged 40 to 59 had a 4.1 [1.9-9.3] times higher risk of being hypertensive. Overweight and obese individuals were 2.6 [1.25-5.76] times more likely to be hypertensive. Overweight was observed in 10.7% of individuals, and obesity in 3.7%. Both conditions were primarily associated with age, with individuals aged 25-39 being 7.5 [2.35-33.9] times more likely to be overweight or obese. This study highlights the need to strengthen efforts to address the burden of (NCDs) in rural areas and across the country.

Key words: Cardiovascular risk factors, Non-communicable diseases, diabetes, hypertension, obesity, Senegal.

INTRODUCTION

Non-communicable diseases (NCDs) are a priority public health issue. Worldwide, NCDs are the leading cause of death. According to the World Health Organization (WHO), they were responsible for 41 million deaths in 2019, accounting for 74% of all global deaths. Seventeen million people die from NCDs before the age of 70, and 86% of these premature deaths occur in low- and middle-income countries (Organisation Mondiale de la Santé (2022). In these regions, the WHO predicts that by 2030, NCDs will surpass communicable, maternal, perinatal, and nutritional diseases as the leading cause of death. In addition to their health burden, NCDs have a significant economic impact, particularly in middle-income countries, with healthcare costs expected to reach $21.3 trillion by 2030. They also contribute to the loss of economic productivity due to absenteeism and reduced work productivity (Ibrahim et al, (2018). Moreover, premature deaths from NCDs can have a substantial economic impact because of the loss of the potential economic contributions of those who pass away. Targeted investments in the prevention and treatment of NCDs can help reduce these costs and improve both health and economic well-being. NCDs have reached epidemic proportions, even though they could be significantly reduced through risk factor reduction, early detection, and appropriate treatments (Organisation Mondiale de la Santé (2011).

NCDs include cancers, chronic respiratory diseases, cardiovascular diseases (CVD), and diabetes Organisation Mondiale de la Santé (2011). Diabetes, in particular, has emerged as one of the major public health problems, causing death and disability, affecting people in their most productive years, and reducing life expectancy in older individuals Asmelash and Asmelash (2019). According to the WHO, in 2016, more than 422 million people were living with diabetes. Its global prevalence has almost doubled over the past thirty years, rising from 4.7% in 1980 to 8.5% in 2014 among people aged 18 and older. The WHO predicts it will be the seventh leading cause of death by 2030 (Organisation mondiale de la Santé (OMS) (2016) and Mathers and Loncar (2006).

The fact that 30 to 80% of people with diabetes remain undiagnosed, coupled with the fact that hyperglycemia was responsible for 2.2 million deaths, significantly contributes to the challenges posed by this disease (Organisation Mondiale de la Santé (2022); Mathers and Loncar (2006). Organisation mondiale de la Santé (OMS) (2016) and Fédération internationale du diabète (2017). Low-income countries, particularly those in sub-Saharan Africa, are experiencing an epidemiological transition with a double burden of communicable and NCDs (Streatfield et al, (2014). A 2014 multicenter study conducted in fourteen countries across Africa and the Near East estimated the prevalence of diabetes at 25%, with 92% of the population presenting at least one modifiable cardiovascular risk factor, and nearly three-quarters (74%) exhibiting more than one (Alsheikh et al, (2014).

In Senegal, studies conducted in Saint-Louis in 2011 and Louga in 2012 revealed a high prevalence of CVD such as hypertension and diabetes (Duboz et al, (2016); Seck et al, (2015); Duboz et al, (2017); Pessinaba et al, (2013); Mbaye et al, (2018) and Pessinaba et al, (2013). The 2015 STEPS survey confirmed these findings, reporting a nationwide prevalence of 3.4% for diabetes, 24% for hypertension, and 19.2% for hypercholesterolemia (Enquête (2015). Despite significant progress in eliminating major infectious diseases such as malaria, tuberculosis, and HIV/AIDS (ANSD (2017) and Programme National de lutte contre (2012)), Senegal, like other developing countries, faces a dual epidemiological burden of both communicable and NCDs (Moodie et al, (2013); Di Cesare et al, (2013); Bonita et al, (2013) and Dalal et al, (2011).

In this context, the lack of comprehensive epidemiological data on NCDs, particularly disaggregated data at the local or rural level, constitutes a major challenge for managing health issues, including the chronic progression of diseases such as diabetes and hypertension. It is crucial to recognize that these risk factors are often interconnected and can influence one another. For instance, obesity can increase the risk of developing diabetes, which in turn can lead to hypertension. Therefore, it is essential to address all of these risk factors to prevent cardiovascular disease and improve overall health.

This study was conducted to measure the prevalence of key cardiovascular risk factors—such as diabetes, arterial hypertension, and obesity—and to identify the factors associated with them in rural areas. It forms part of the ongoing efforts of the Cheikh Anta Diop University of Dakar's health observatory to develop effective, relevant, and sustainable strategies for controlling NCDs and achieving the objectives of sustainable development.

METHOD

Study framework

The rural commune of Niakhene is part of the Meckhe health district. The district of Meckhe is located in the department of Tivaouane in the region of Thiès in Senegal (Figure 1).

Study type and population

This was a cross-sectional, descriptive and analytical study among people aged 18 or over at the time of the survey, residing in the town of Niakhene in central Senegal. The study was carried out during the second half of October 2020.

Sampling

This study included individuals aged 18 years and older, of Senegalese nationality, who had lived in the study area for at least 6

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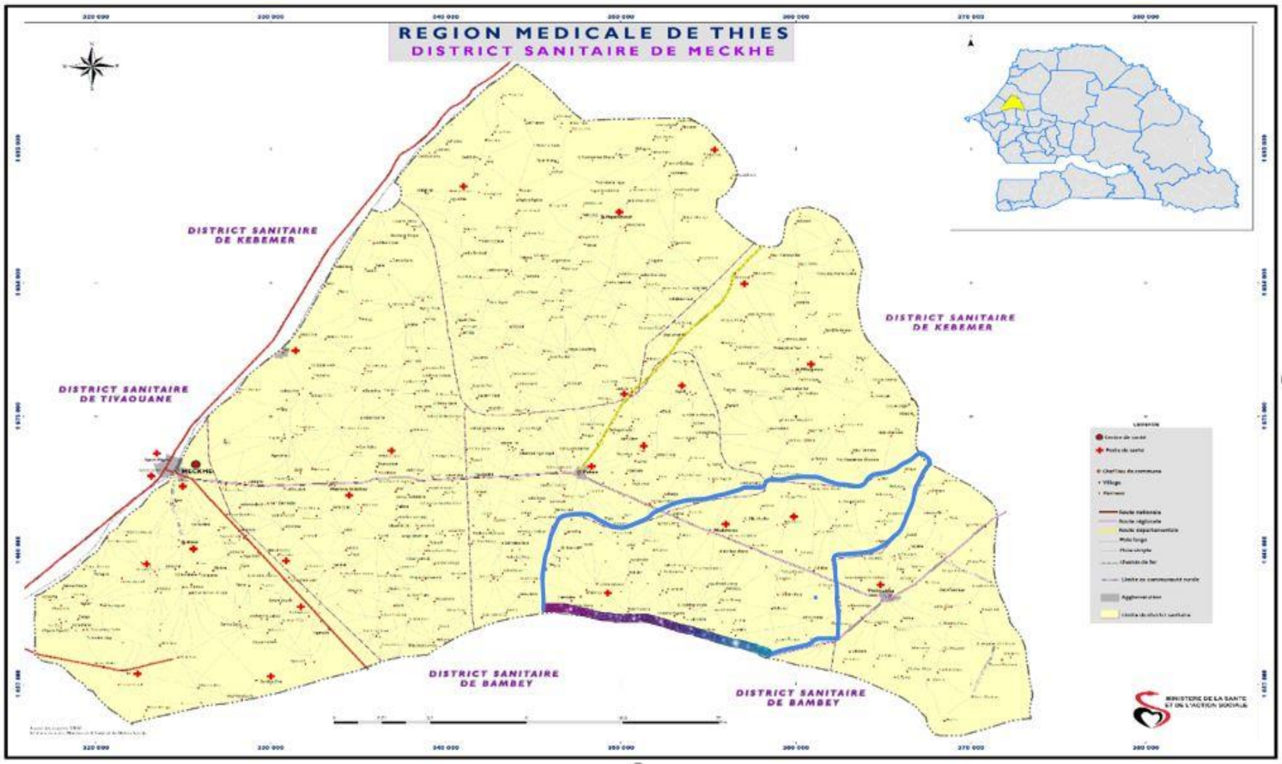

Figure 1. Map of the commune of Niakhene in the health district of Meckhe (MSAS 2017).

months. To achieve significant results that could be used to describe the attitudes and practical knowledge with satisfactory statistical power, the required sample size was calculated using the Schwartz formula:

$N = \varepsilon 2 PQ / i^2$

where Standard error (for a 5% risk of alpha error) = 1.96; Expected prevalence P = 24% (Prevalence of arterial hypertension at the national level found in the 2015 STEP survey in Senegal) (Ministère de la Santé et de l'Action Sociale (2015); Q is the complement of P so Q = 1-P; Accuracy (i) = 5%.

The sampling was based on a systematic random survey, stratified into clusters of 10 individuals, with 30 clusters distributed across the villages of the Niakhene commune. Within each selected cluster, stratification proportional to the population size by age and sex was applied to ensure representativeness. Once within the cluster, a route method was used to guide the investigators to the concessions. After randomly selecting an intersection of multiple lanes, the investigator would use a pen to choose a randomly drawn direction. All concessions on that street/alley were included until the target of 10 individuals per cluster, distributed by sex and age, was reached. If multiple individuals within a household met all the selection criteria, one person was selected by lottery. If the chosen street did not allow the target to be reached, the investigator would move to the first lane on the right and continue until the target was met.

Collection of data

Data collection was conducted using a pre-coded questionnaire to address research questions based on a review of the literature on the theme of NCDs, sourced from reference organizations such as the World Health Organization Organisation Mondiale de la Santé (2005).

The finalized questionnaire was then entered into an electronic terminal using the ODK Collect software (Open Data Kit ODK), which synchronized the data to a server via an Internet connection. This process enabled the recording of data from individual face-to-face interviews within households, with simultaneous transmission to a memory card and a secure server for validation.

Each interviewer followed a pre-established quota system based on sex and age group for each selected cluster (village), after the application of the sampling procedures. During the administration of the questionnaire, blood pressure readings and anthropometric measurements were taken. Blood pressure was measured using an OMRON® M6-type electronic sphygmomanometer. Systolic and diastolic blood pressures were recorded after the subject rested for at least 10 minutes, and measurements were taken at both arms. The highest blood pressure readings were retained (Tougouma et al, (2018).

Weight was measured in kilograms (kg) using a previously tared OMRON® HN286 scale, placed on a stable, flat surface. Measurements were taken on an individual who was lightly dressed and unshod. Height was measured in centimeters using a portable measuring rod, with individuals remaining unshod.

Biological data were collected using an "Accu-Chek® Active" device, employing a lancing device adjustable for skin thickness, after disinfection and drying. A drop of blood was taken for analysis. Used needles were placed in rigid, hermetically sealed containers before being disposed of at local health posts for destruction. These anthropometric and biological measurements were carried out by the head nurses of the health posts in the study area. This ensured the maintenance of strict aseptic conditions and facilitated the acceptability of the samples.

Operational definition of variables

The operational definitions used in this study are as follows:

1. Major cardiovascular risk factors: These include diabetes, high blood pressure, and obesity (Alemayehu and Sisay 2021).

2. Arterial hypertension: This refers to any person known to be hypertensive or anyone presenting at rest with blood pressure readings ≥ 140 mmHg for systolic blood pressure and/or ≥ 90 mmHg for diastolic blood pressure (Alemayehu and Sisay 2021).

3. High blood pressure grades: High blood pressure is categorized as follows:

i) Grade I: Systolic blood pressure (SBP) between 140 and 159 mmHg or diastolic blood pressure (DBP) between 90 and 99 mmHg.
ii) Grade II: SBP between 160 and 179 mmHg or DBP between 100 and 109 mmHg.
iii) Grade III: Systolic blood pressure (SBP) greater than 179 mmHg or diastolic blood pressure (DBP) greater than 109 mmHg.

4. Blood pressure control: This applies to individuals known to be hypertensive, with or without treatment.

i) Hypertension under control: Defined as SBP < 140 mmHg and DBP < 90 mmHg.
ii) Uncontrolled hypertension: Defined as SBP > 140 mmHg and DBP > 90 mmHg.

5. Diabetes: Any person known to be diabetic or anyone with a fasting blood glucose level greater than 1.26 g/l, or a blood glucose level at any time exceeding 2 g/l (Asmamaw et al, (2015); Shafaee et al, (2008).

6. Glycemic control: This has been studied in individuals with known diabetes, with or without treatment.

i) Diabetes under control: Defined as a fasting blood glucose level < 1.26 g/l or a post-prandial glucose level < 2 g/l.
ii) Uncontrolled diabetes: Defined as a fasting blood glucose level > 1.26 g/l or a post-prandial glucose level > 2 g/l.

7. Body Mass Index (BMI): BMI is calculated as the ratio of weight (in kg) to the square of height (in m). The classifications are as follows (Asmamaw et al, (2015):

i) Lean: BMI < 18 kg/m².
ii) Normal: BMI ≥ 18 and < 25 kg/m².
iii) Overweight: BMI between 25 and 30 kg/m².
iv) Obese: BMI ≥ 30 kg/m².

However, for analysis purposes, BMI was categorized into two groups: BMI ≥ 25 kg/m² considered as overweight/obese and BMI below this threshold considered normal (Dereje et al, (2021).

Data analysis

At the end of the survey, the data were extracted, compiled, and cleaned before being analyzed using R 4.0.2 software.

Quantitative variables were described using the mean with its standard deviation, the median with the extremes, and qualitative variables by frequency. For the analytical study, cross-tabulations were performed to address specific concerns outlined in the objectives, particularly the relationships between personal characteristics and major cardiovascular risk factors such as diabetes, hypertension, and obesity. The Chi-squared (Chi²) test was used with an alpha risk of 5%. To account for confounding factors in the multivariate analysis, all variables with p-values less than 0.25 in the bivariate analysis were retained for the initial model (Depot institutionnel de l'Universite Abou Bekr Belkaid Tlemcen UABT (2021). The top-down stepwise selection procedure was applied to construct the final model. Variables that did not improve the model were removed one by one. The likelihood ratio test was used to compare nested models. The adequacy of the model was assessed using the Hosmer-Lemeshow test (Hosmer and Lemeshow 2021).

Ethical approval

The approval of the Research Ethics Committee (CER) of Cheikh Anta Diop University of Dakar was obtained (Approval number O25/2020/CER/UCAD), and the free, informed, and signed consent of each participant was secured. Anonymity was maintained, and personal data were kept confidential and protected.

RESULT

Descriptive study

Personal characteristics

The study was conducted among 300 individuals, with an average age of 35.3 (±16.7) years, a median age of 30 years, and extremes ranging from 18 to 83 years. The most represented age group was between 25 and 39 years, comprising 37.7% of respondents. The majority of respondents were married (65.7%) and uneducated (67.7%). Nearly 75% of the population was unemployed (40%) and primarily belonged to the middle quintile of socio-economic well-being. The most common family history recorded was hypertension (42.0%), followed by diabetes (9.0%) and stroke (5.7%) (Table 1).

Anthropometric and biological parameters

Out of a total of 300 measurements, blood glucose levels were taken at any time of the day in 93.6% of individuals. The average blood glucose measured in the population was 1.02 (± 0.3) g/l, with a minimum of 0.35 g/l and a maximum of 4.15 g/l, and a median of 0.96 g/l (Table 2). Blood pressure was measured after at least 10 min of rest. The mean systolic blood pressure was 134 (± 19) mmHg, and the mean diastolic blood pressure was 80 (± 10.7) mmHg (Table 2).

The average weight was 60.7 kg (± 13.6 kg), the average height was 1.70 m (± 0.1 m), and the average BMI (Body Mass Index) was 20.9 kg/m² (± 4.2 kg/m²) (Table 2).

Diabetes prevalence

Non-diabetics represented 96.3% of the study population. Of the 3.7% of diabetics identified during the Diabetes

Table 1. Distribution according to personal characteristics (n=300).

Variable (modalities)	Absolute frequency (N)	Relative frequency (%)
Age group of respondents		
<25 years old	98	32.7
25-39	113	37.7
40-59 years old	48	16.0
<60 years old	41	13.7
Gender		
Female	157	52.3
Male	143	47.7
Marital status		
Married	197	65.7
Single	83	27.7
Widower	15	5.0
Divorced	5	1.7
Level of education		
Without instruction	203	67.7
Primary	51	17.0
Secondary and more	46	15.3
Profession		
Homeless/unemployed	120	40.0
Grower/breeder	67	22.3
Merchant	42	14.0
Student/Student	19	6.3
Worker	15	5.0
Senior executive	2	0.7
Other	35	11.7
Socio-economic well-being		
Poorer	46	15.3
Poor	46	15.3
Average	75	25.0
Rich	69	23.0
Richer	64	21.3
Family history^{1st} degree		
HTA	126	42.0
Diabetes	27	9.0
Stroke	17	5.7

Prevalence Study, 0.7% were newly diagnosed. Similarly, 3% of those tested self-reported as diabetics, with 1.7% having blood glucose levels under control (Figure 2).

High blood pressure prevalence

Non-hypertensives represented 52.3% of the study population. Of the 47.7% of hypertensives identified, 16.3% were newly diagnosed. Of the 31.4% known hypertensives by self-report, 17.3% had hypertension under control (Figure 3).

Obesity prevalence

The majority (56.3%) of the study population had a normal BMI. Underweight was diagnosed in 29.3%, and

Table 2. Description of glycemic, tensional and anthropometric parameters (n=300).

Measure	N	Means	Standard deviation	Median	Minimum	Maximum
Blood glucose						
Blood sugar at any time	281	1.02	0.301	0.96	0.35	4.15
Blood sugar after a diet of 8 H	19	1.02	0.293	0.95	0.50	1.76
Together	300	1.02	0.300	0.96	0.35	4.15
Tensional figures						
Systolic in mmHg	300	134	19.0	134	98	201
Diastolic in mmHg	300	80	10.7	80	50	136
Anthropometric measurements						
Weight in Kg	300	60.7	13.6	59.0	33.0	125.0
Size in m	300	1.70	0.10	1.70	1.48	1.98
BMI in Kg/m²	300	20.9	4.2	20.2	12.6	38.0

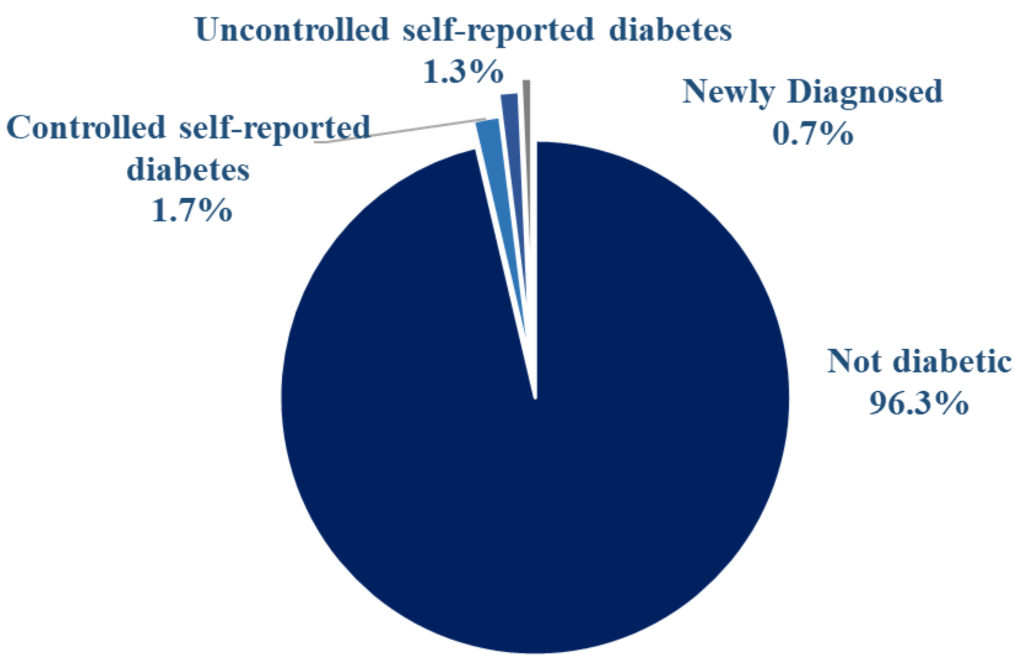

Figure 2. Study of the prevalence of diabetes following screening (n=300).

overweight was noted in 10.7%. Obesity, defined by a BMI ≥ 30 kg/m², was found in 11 individuals, representing 3.7%, including 2.3% with grade I obesity and 1.3% with grade II obesity. A BMI greater than 25 kg/m² was observed in 14.3% of the study population (Table 3).

Analytical study

Analysis of the characteristics associated with diabetes showed that people aged 60 and over were at greater risk of developing diabetes (ORadj = 10.6, 95% CI [1.32–232]), as were those with a family history of diabetes (ORadj = 10.6, 95% CI [1.16–65.7]). Both gender and family history of arterial hypertension were included in the final multivariate model but showed no significant relationship with the onset of diabetes. It is noteworthy that the health status of overweight individuals and those with arterial hypertension, which were significantly associated with the risk of developing diabetes in the bivariate analysis, were no longer significant in the multivariate model (Table 4).

Arterial hypertension was significantly associated with

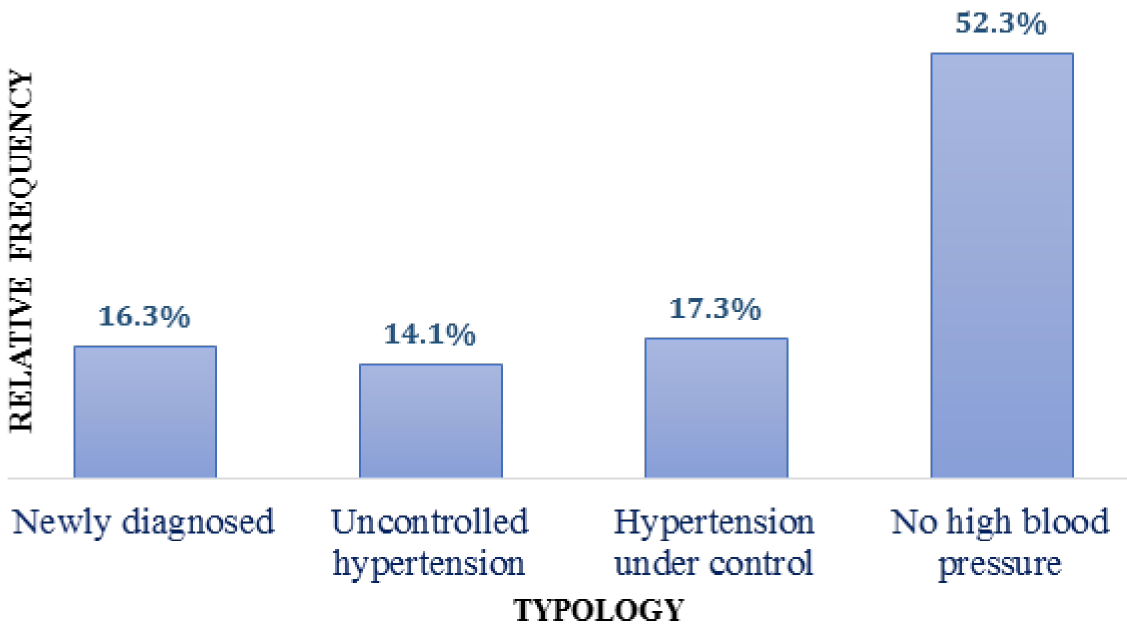

Figure 3. Study of hypertensive prevalence following screening.

Table 3. Classification of obesity by body mass index (n=300).

Variable	Absolute frequency (N)	Relative frequency (%)
Body mass Index		
Underweight (IMC < 18.5 Kg/m²)	88	29.3
Normal (18.5 - 24.9 Kg/m²)	169	56.3
Overweight (25 - 29.9 Kg/m²)	32	10.7
Obesity (BMI ≥ 30 Kg/m²)	11	3.7
BMI greater than 25 kg/m²		
Yes	43	85.7
No	257	14.3

Table 4. Factors associated with diabetes.

Variable	Diabetes		Bivariate		Multivariate final model	
	Yes (%)	No	P value	Crude odds ratio [95 % CI]	P value	Odd ratio adjusted [95 % CI]
Gender						
Male	7 (4.9)	136	0.440	Ref	0.300	Ref
Female	4 (2.5)	153		0.51 [0.14-1.78]		0.47 [0.10-1.84]
Age group of respondents						
Less than 25 years old	1 (1.0)	97	<0.001	Ref		Ref
25-39 years old	0 (0.0)	113		—	—	—
40-59 years old	3 (6.2)	45		6.5 [0.7-63.9]	0.300	3.82 [0.35-91.0]
More than 60 years old	7 (17.1)	34		19.9 [2.4-168.3]	0.042*	10.6 [1.32-232]
Level of education						
Without instruction	10 (4.9)	193	0.331	Ref	—	—

Table 4. Cont'd

Primary and more	**1 (1.1)**	**96**		**0. [0.04-3.08]**		
Socio-economic well-being						
Poorer	3 (6.5)	43	0.483	Ref	—	—
Poor	0 (0.0)	46		—		
Average	2 (2.7)	73		0.39 [0.06-2.44]		
Rich	3 (4.3)	66		0.65 [0.12-3.37]		
Richer	3 (4.7)	61		0.70 [0.13-3.66]		
Family history HTA						
No	9 (5.2)	165	0.127	Ref	0.500	Ref
Yes	2 (1.6)	124		0.29 [0.06-1.39]		0.45 [0.04-3.02]
Family history Diabetes						
No	8 (2.9)	265	0.030	Ref	0.029*	Ref
Yes	3 (11.1)	24		4.1[1.03-16.4]		8.77 [1.16-65.7]
Obesity/overweight						
IMC<25 Kg/m^2	7 (2.7)	250	0.033	Ref	0.300	Ref
IMC≥ 25 Kg/m^2	4 (9.3)	39		3.6[1.02-13.1]		2.29 [0.41-11.1]
High blood pressure						
No	2 (1.3)	155	0.020	Ref	0.290	Ref
Yes	9 (6.3)	134		5.2[1.1-24.5]		2.49 [0.47-20.7]

age. Compared to those under 25, individuals aged 40 to 59 had a 4.1-fold increased risk of being hypertensive (ORadj = 4.1, 95% CI [1.9–9.3]), and this risk increased further with age. Those aged 60 and over had a 5.6-fold greater risk (ORadj = 5.6, 95% CI [2.37–13.9]) of being hypertensive. On the other hand, no significant difference (P = 0.072) was found between individuals under 25 and those aged 25 to 39. Overweight and/or obese individuals with a BMI greater than 25 kg/m² were 2.6 times more likely to develop hypertension (ORadj = 2.6, 95% CI [1.25–5.76]). Although sex, education level, and family history of hypertension were retained in the final multivariate model, no significant relationship was found between these variables and the occurrence of hypertension (Table 5).

The risk of being overweight or obese was associated with age. Individuals aged 25 to 39 were 7.5 times more likely to be overweight or obese (ORadj = 7.5, 95% CI [2.35–33.9]) compared to those aged 18 to 25. Similarly, those aged 40 to 59 had a 10-fold increased risk (ORadj = 10, 95% CI [2.70–49.3]) compared to those under 25, while those aged 60 and over had a 5.1-fold greater risk (ORadj = 5.1, 95% CI [1.12–28.3]). Arterial hypertension was found to be a contributing factor to overweight (ORadj = 2.68, 95% CI [1.26–6.02]) (Table 6).

DISCUSSION

This study provides an estimate of the prevalence of major cardiovascular risk factors, such as obesity, diabetes, and arterial hypertension, in rural Senegal, based on a sample of 300 individuals representative of the commune of Niakhene according to age and sex. The average weight was 60.7 kg (± 13.6 kg), the average height was 1.70 m (± 0.1 m), and the average BMI (Body Mass Index) was 20.9 kg/m² (± 4.2 kg/m²). Almost half (43.7%) of the study population had an abnormal BMI: 29.3% were underweight, 10.7% were overweight, and 3.7% were obese. Those with a BMI ≥ 25 kg/m² (overweight and obesity) accounted for 14.4%. These results are lower than the national figures from the 2015 STEPS survey, which reported 15.8% overweight and 6.4% obesity (16). A study conducted in Saint Louis, Senegal, in 2011 found a higher proportion of overweight and obesity (BMI ≥ 25 kg/m²), by 23% (Mbaye et al, 2011). In contrast, another study conducted in Geoul, also in Senegal, in 2012 in a rural area, found a lower prevalence of BMI ≥ 25 kg/m² at 12.9% (Mbaye et al, 2021). Most studies in Africa have reported higher prevalences of obesity compared to our study (Bushara et al., 2016; Aynalem and Zeleke, 2018).

A BMI exceeding 25 kg/m² is frequently linked to other significant cardiovascular risk factors, including age, diabetes, and arterial hypertension (Hubert et al, 1983), a relationship also observed in our study. Nearly two-thirds (65.7%) of the participants were unaware of their diabetic status because they had never undergone screening. This proportion is much higher than the 36% found in a study by Dereje et al. (2020) in Ethiopia. If diabetes is not

Table 5. Factors associated with high blood pressure.

Variable	High blood pressure		Bivariate		Multivariate final model	
	Yes (%)	No	P value	Crude odds ratio [95 % CI]	P value	Odd ratio adjusted [95 % CI]
Gender						
Male	63 (44.1)	80	0.280	Ref	0.6	Ref
Female	80 (51.0)	77		1.31[0.83-2.07]		1.17 [0.70-1.93]
Age group of respondents						
Less than 25 years	27 (27.6)	71	<0.001	Ref		Ref
25-39 years old	53 (46.9)	60		2.32 [1.3-4.14]	0.072	1.75 [0.95-3.23]
40-59 years old	33 (68.8)	15		5.79 [2.72-12.3]	<0.001*	4.15 [1.9-9.37]
60 years and over	30 (73.2)	11		7.17 [3.16-16.3]	<0.001*	5.58 [2.37-13.9]
Level of education						
Without instruction	111 (54.7)	92	0.001	Ref		Ref
Primary	19 (37.3)	32		0.49 [0.26-0.93]	0.2	0.62 [0.31-1.24]
Secondary and more	13 (28.3)	33		0.33 [0.16-0.66]	0.073	0.50 [0.22-1.05]
Socio-economic well-being						
Poorer	21 (45.7)	25	0.443	Ref	—	—
Poor	24 (52.2)	22		1.29 [0.57-2.94]		
Average	36 (48.0)	39		1.09 [0.52-2.29]		
Rich	27 (39.1)	42		0.76 [0.35-1.62]		
Richer	35 (54.7)	29		1.43 [0.67-3.07]		
Family history HTA						
Yes	60 (47.6)	66	0.989	Ref	0.3	Ref
No	83 (47.7)	91		1.00 [0.63-1.58]		1.33[0.78-2.26]
Family history Diabetes						
Yes	12 (44.4)	15	0.881	Ref	—	—
No	131 (48.0)	142		1.15 [0.52-2.55]		
Obesity/overweight						
IMC<25 Kg/m²	112 (43.6)	145	0.001	Ref	0.013*	Ref
IMC≥ 25Kg/m²	131 (72.1)	12		3.3[1.6-7.1]		2.61[1.25-5.76]
Diabetes						
No	134 (46.4)	155	0.020	Ref	—	—
Yes	9 (81.8)	2		5.3 [1.1-24.5]		

diagnosed in a timely manner and remains undetected, it can lead to serious complications, long-term disabilities, and premature death (Asmelash and Asmelash (2019). This issue may reflect a lack of adequate awareness regarding diabetes screening among community members.

Biological samples allowed us to determine that the prevalence of diabetes was 3.7%, with an incidence of 0.7% (newly diagnosed). Among the 3% of self-reported diabetics, just over half (1.7%) had blood glucose levels under control. This prevalence of diabetes in our study is similar to the national level of 3.4% (Enquête nationale sur les facteurs de risque des maladies non transmissibles STEPS (2015) in 2015 and lower than the 10.4 and 7.2% reported in urban and semi-rural areas of Senegal in 2011 and 2012, respectively (Mbaye et al, 2011; Mbaye et al, 2021). When compared to other African countries, studies show that the prevalence of diabetes remains below 10%. For example, the prevalence was 2.3% in Mali (Koné et al,

Table 6. Factors associated with overweight and obesity.

Variable	Overweight obesity (BMI ≥ 25 Kg/m²)		Bivariate		Multivariate final model	
	Yes (%)	No (%)	P value	Crude odds ratio [95 % CI]	P value	Odd adjusted [95 % CI]
Gender						
Male	16 (11.2)	127 (88.8)	0.138	Ref	0.091	Ref
Female	27 (17.2)	130 (82.8)		1.64 [0.84-3.20]		1.90 [0.92-4.09]
Age group of respondents						
Less than 25 years old	3 (3.06)	95 (96.9)	0.001	Ref		Ref
Between 25 and 39 years old	21 (18.6)	92 (81.4)		7.2 [2.08-25.0]	0.002*	7.51 [2.35-33.9]
Between 40 and 59 years old	12 (25.0)	36 (75.0)		10.5 [2.81-39.5]	0.001*	10.0 [2.70-49.3]
More than 60 years old	7 (17.1)	34 (82.9)		6.5 [1.59-26.6]	0.042*	5.11 [1.12-28.3]
Level of education						
Without instruction	29 (14.3)	174 (85.7)	0.636	Ref	Ref	Ref
Primary	9 (17.6)	42 (82.4)		1.28 [0.56-2.92]	0.063	2.45 [0.93-6.25]
Secondary and more	5 (10.9)	41 (89.1)		0.73 [0.26-2.00]	0.200	2.13 [0.61-6.64]
Socio-economic well-being						
Poorer	4 (8.70)	42 (91.3)	0.347	Ref	—	—
Poor	6 (13.0)	40 (87.0)		0.45 [0.10-1.86]		
Average	8 (10.7)	67 (89.3)		0.35 [0.09-1.37]		
Rich	12 (17.4)	57 (82.6)		0.63 [0.17-2.29]		
Richer	13 (20.3)	51 (79.7)		0.76 [0.21-2.76]		
Family history HTA						
Yes	19 (15.1)	107 (84.9)	0.883	Ref	—	—
No	24 (13.8)	150 (86.2)		0.90 [0.46-1.72]		
Family history diabetes						
Yes	7 (25.9)	20 (74.1)	0.084	Ref	—	—
No	36 (13.2)	237 (86.8)		0.43 [0.17-1.09]		
Diabetes						
No	39 (13.5)	250 (86.5)	0.033	Ref	0.077	Ref
Yes	4 (36.4)	7 (63.6)		3.66 [1.02 -13.1]		3.75 [0.81-16.2]
High blood pressure						
No	12 (7.64)	145 (92.4)	0.001	Ref	0.013*	Ref
Yes	31 (21.7)	112 (78.3)		3.34 [1.64-6.80]		2.68 [1.26-6.02]

*****significant at P<0.05.

2016), 4.9% in Burkina Faso (Séré et al, 2021), and 5.7% in Ethiopia (Dereje et al, (2021).

Age was linked to diabetes, with the risk increasing as age increased. This relationship was also found in a study by Najafipour et al. (2021) in Iran, which showed that the risk of developing diabetes rises with advancing age (Najafipour et al, 2021). Another factor associated with diabetes in our study was having first-degree relatives with diabetes, a finding supported by numerous studies that have shown family history to be a significant predisposing factor for developing diabetes in the medium to long term (Koné et al, 2021; Wery et al, 2014; Tesfaye et al, 2016).

Although a BMI ≥ 25 kg/m² and a personal history of arterial hypertension were significantly associated with diabetes in the bivariate analysis, these factors were no longer significant in the final multivariate model. This is not consistent with the literature, where an abnormal BMI ≥ 25 kg/m² is often associated with diabetes (Dereje et al, 2021; Depot institutionnel de l'Universite Abou Bekr Belkaid Tlemcen UABT 2021; Hosmer and Lemeshow 2021; Mbaye et al, 2011; Mbaye et al, 2021; Bushara et al, 2016; Aynalem and Zeleke 2018; Hubert et al, 1983; Koné et al, 2016; Séré et al, 2021; Najafipour et al, 2021; Koné et al, 2021; Wery et al, 2014; Tesfaye et al, 2016 and Worede et al, 2017), and several studies have found higher proportions of diabetes among hypertensive individuals (Kassa and Woldesemayat 2019; Aynalem and Zeleke 2018). These results suggest that maintaining a healthy weight and normal blood pressure should be considered important interventions for the prevention and control of diabetes (Kassa and Woldesemayat 2019; Aynalem and Zeleke 2018).

The prevalence of self-reported high blood pressure was 31.3%. Among these self-reported hypertensives, 17.3% had blood pressure levels under control, according to the screening results. Of the 47.7% of hypertensives identified (including both old and new cases), 16.3% were newly diagnosed, representing the incidence of the disease. The overall prevalence of 47.7% found in this study is higher than the 24% reported at the national level in the STEPS survey conducted in Senegal in 2015 (Enquête nationale sur les facteurs de risque des maladies non transmissibles STEPS (2015). However, it is comparable to previous studies carried out in Senegal, such as the study in Saint Louis in 2011, which found a prevalence of 46% (Mbaye et al, 2011), and the study in Guéoul in 2012, which found a prevalence of 46.6% (Mbaye et al, 2021). When compared to studies outside Senegal, this prevalence is higher than the 31% reported in Bangladesh (Hasan et al, 2021). 19.5% in Ethiopia in 2016 (Hasan et al, 2021), 30.3% in Uganda in 2015 (Saeed (2015), and 38.9% in South Africa in 2016 (Maimela et al, 2016). Notably, a study in Cameroon by (Dzudie et al, 2012) found a similar prevalence of 47.5%.

This prevalence of hypertension, close to 50%, in our study is partly due to the significant proportion of self-reported cases (31.3%), where hypertensive status was poorly documented. This represents a limitation in determining the true prevalence of the disease. Moreover, an analysis of the blood pressure readings taken during the study (screening results) showed that 30.3% of individuals had high blood pressure, which is consistent with other screening studies conducted in Africa (Bjertness et al, 2021; Mika et al, 2020).

Among the non-modifiable risk factors, age was identified as a key factor in the occurrence of arterial hypertension. The older the individual, the higher the risk of developing high blood pressure. This dose-response relationship between age and hypertension has been supported by numerous studies, which have consistently shown that the likelihood of hypertension increases with age (Maimela et al, 2016; Saeed 2015; Abdissa et al, 2015). This is primarily due to the increase in systolic blood pressure with age, which results from the reduced elasticity of the large vessels (Ausiello 2003 and Buford 2016). An avoidable or modifiable risk factor identified in this study is a high body mass index (BMI ≥ 25 kg/m²), which was found to be a predisposing factor for arterial hypertension. These results align with findings from other studies conducted in Ethiopia, Kenya, and Sudan (Bushara et al, 2016; Asemu et al, 2021; Olack et al, 2015).

In this study, no significant association was found between economic status and arterial hypertension. Previous studies in sub-Saharan Africa have shown contradictory results, likely due to the varying stages of economic development across countries. This variability leads to different associations depending on the country. For example, studies in Ghana and Tanzania found a higher prevalence of hypertension among individuals in the lowest economic quintile (Bovet et al, 2002; Wu et al, 2015), while studies in Nigeria and Kenya found a higher prevalence among the wealthiest groups (Okoduwa et al, 2014; Olack et al, 2015).

Additionally, factors such as family history of diabetes and hypertension were not associated with the occurrence of hypertension in this study. This finding is consistent with the study by Meseret et al. (Asemu et al, 2021), but contrasts with several other studies that have established a significant relationship between family history and the onset of hypertension (Olack et al, 2021; Abdelsatir et al, 2013; Bushara et al, 2016). This discrepancy may be explained by the methodological approach of cross-sectional studies, which are limited in controlling for confounding factors that affect temporally associated variables. Furthermore, individuals may not be aware of their family history of hypertension due to the asymptomatic nature of the disease and sudden death complications, leading to an underestimation of the relationship between family history and disease onset.

As the burden of NCDs grows, adapting health systems to provide adequate management of these diseases is essential. However, this can only be achieved by strengthening health systems to cope with the evolving health challenges. It is critical to integrate the prevention of NCDs into healthcare services through public awareness campaigns and early detection programs. Strengthening the capacity of healthcare personnel to adapt to this new perspective will maximize the potential for informing, preventing, and detecting chronic and CVD at an early stage (Petersen 2021).

Study limit

There is a lack of consideration of lifestyle factors such as fruit and vegetable consumption, physical activity, alcohol use, and tobacco consumption in this study. This limitation is partly due to the socio-cultural context, where discussing issues like tobacco and alcohol use can lead to interruptions during interviews. Moreover, quantifying alcohol consumption, the number of fruits and vegetables consumed, salt intake, and the duration of physical activity is particularly challenging in rural areas.

Additionally, the cross-sectional design of the study limits the ability to establish causal relationships between these factors and the occurrence of disease. However, this study could serve as a foundation for future research aimed at comparing and inferring temporal causality relationships, especially within the context of ongoing population monitoring, such as through the establishment of a health observatory.

Adaptation to the COVID-19 pandemic context

Arrangements were made to ensure the safety of the data collection staff throughout the process during the COVID-19 epidemic. The training of investigators was conducted in strict adherence to safety measures, including social distancing of at least one meter, frequent use of hydroalcoholic gel, and the mandatory wearing of masks. Hydroalcoholic gels and protective masks were provided to the staff free of charge. During data collection in the field, these measures were rigorously followed, including when traveling to the sites in vehicles.

Conclusion

This study, conducted in 2020 in the municipality of Niakhène, Senegal, on major risk factors NCDs, underscores the importance of communication, particularly the awareness-raising efforts carried out by health personnel and during awareness days. These preventive measures have a significant impact on increasing knowledge about the diseases, encouraging the adoption of healthy behaviors, and promoting positive attitudes toward NCDs. The high prevalence of major cardiovascular risk factors such as diabetes, arterial hypertension, and obesity highlights the need for health authorities to prioritize the fight against the burden of NCDs. This is especially critical in the context of an epidemiological transition, where a diet previously dominated by infectious diseases is increasingly being replaced by one driven by chronic diseases.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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