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ORIGINAL PAPER

Risk factors for ischemic stroke in the elderly in Morocco – a case-control study

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ABSTRACT

Introduction and aim. Ischemic strokes occur most frequently in the elderly (more than 80%). This study aimed to determine the risk factors for ischemic stroke in elderly subjects in the Souss Massa region of southern Morocco.

Material and methods. Two hundred and thirteen cases and four hundred and thirty-two controls of the same age (76.51±2 years vs. 73.90±2 years) and sex were collected. Cases were selected from patients with ischemic stroke hospitalized in the neurology department of the regional hospital Souss Massa. All risk factors have been documented from interviews and review of patient medical records.

Results. Multivariate regression analysis showed that low-income families (odds ratios [OR]=4.19, 95% confidence intervals [95% CI] 2.886–6.09, p<0.001), residence area (urban OR=9.408, 95% CI 4.7133–18.778, p<0.001), high blood pressure (OR=62.984, 95% CI 26.7374–148.367, p<0.001), diabetes (OR=18.138, 95% CI 5.2320–62.880, p<0.001), are risk factors for ischemic stroke. On the contrary, health insurance (OR=0.295, 95% CI 0.1513–0.577, p<0.001) and marital status (in couple OR=0.448, 95% CI 0.284–0.708, p<0.001) are protective factors.

Conclusion. In addition to traditional risk factors of ischemic strokes such as high blood pressure and diabetes, low-income family as well as lack of health insurance and marital status (living with a partner) require particular attention. Integrating these new factors into public health strategies could significantly reduce the risk of stroke in the elderly.

Keywords. aged, ischemic stroke, Morocco, risk factors

Introduction

Stroke is a growing problem in developing countries, yet it receives very little attention.[1] Ischemic strokes account for more than 80% of cases in people 65 and over, and these patients often have less effective treatments and less favorable outcomes compared to younger patients.[2] Around 86% of stroke deaths worldwide occur in low and middle-income countries.[3]

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In Africa, more than half of all stroke patients suffer from hypertension, reflecting trends observed in the Middle East and Eastern Mediterranean regions.[4] In the Arab world, patients often have a lower socioeconomic status, a higher prevalence of diabetes and a higher body mass index than in non-Arab countries, with the incidence of hypertension and the percentage of diabetes exceeding 50%.[5] In the same way, patients with ischemic stroke living in Arab countries had a lower average socioeconomic status, a much higher prevalence of diabetes mellitus, and a higher body mass index than patients in non-Arab countries.[6]

In Morocco, the overall prevalence of ischemic stroke is 284 per 100,000 inhabitants, with a higher incidence in men (306 per 100,000) than in women (278 per 100,000). This prevalence increases significantly with age, reaching 3,409 per 100,000 people over 75 years old.[7] In addition, rural areas (323 per 100,000) and low-income households (346 per 100,000) also have higher prevalence rates.[2] These factors merit research and strategic preventive and curative measures aimed at reducing the risk of ischemic stroke in the elderly population.

Aim

The aim of this study was to determine the risk factors for ischemic stroke in aged subjects in the Souss Massa region of southern Morocco.

Material and methods

Study design

The present study is a retrospective data analysis, a case-control study carried out in the center of the neurology care unit of the university hospital of the Souss Massa region in Morocco. This establishment is the reference hospital at the regional level. The cases and controls belonged to the same base population and had the same reference date.

Case definition and selection of patients

The definition of ischemic stroke was a focal neurological deficit of any duration with evidence of cerebral ischemia on the brain CT scanner or magnetic resonance imaging (MRI).

The diagnosis of ischemic stroke was established on the basis of clinical, biological, and imaging data in all patients included in this study.

Matching

Controls are similar to cases in terms of age (>60 years) and gender. Each case is matched to two controls (2 controls per case) who meet the eligibility criteria. Confounding data was avoidedby matching controls and cases by age and sex.

Inclusion and exclusion criteria for cases

Participants aged 60 and over, according to the World Health Organization (WHO) definition of aging, which generally begins at this age and is characterized by a progressive decline in physical and mental capacities, as well as an increased risk of disease.[8] Patients 60 and over, presenting with a constituted ischemic stroke, admitted to the neurology care unit of the University Hospital Center Souss Massa.

The study excluded patients with hemorrhagic stroke or transient ischemic attack (TIA), defined as transient neurological dysfunction without evidence of infarction on brain imaging.[9]

Selection of controls

The control group was classified as patients in the same age group, aged 60 and older, hospitalized in trauma or visceral surgery units of university hospital center Souss Massa.

Eligibility criteria for controls

Controls were selected based on the absence of the disease in the past, as well as the absence of the disease at the time of the study. The controls come from the same target population as the cases and have a potential risk of exposure similar to that of the cases.

Data collection

A data collection form was completed for each respondent who had given written consent, comprising a first section devoted to sociodemographic characteristics. The second part included questions on risk factors associated with the disease: medical history, personal and family history of brain disease, associated comorbidities, and lifestyle (eating habits and toxic habits). Data was collected for controls in the same way as for cases, with information on sociodemographic variables and risk factors associated with ischemic stroke.

Risk factors for ischemic stroke

All traditional risk factors have been documented from interviews and review of patient medical records; incomplete records were rejected. The analysis concerns the diagnostic workup performed on admission, vital parameters, and laboratory tests. Patients diagnosed with blood pressure (BP) (>140/90 mmHg) or with antihypertensive medication before or at the time of stroke. Patients diagnosed with diabetes or taking anti-diabetic medication, or with fasting blood glucose levels above 120 mg/dl. Patients were considered smokers if they smoked or if there was the notion of smoking during the year preceding the stroke. Hyperlipidemia was defined based on history and lipid-lowering treatment, or a total cholesterol level greater than 200 mg/dL or a low-density lipoprotein level greater than 120 mg/dL.

The notion of obesity was raised or diagnosed based on body mass index (BMI) calculations in certain cases where weight and height were recorded. A previous diagnosis of vascular risk factors or cerebrovascular damage is retained if confirmed by specialists during the patient's hospitalization.

We evaluated from medical records the notion of heart disease; family history of stroke; personal history of unspecified brain injury; alcohol consumption or report of alcoholism; use of oral contraception was mentioned based on patient history, given that the study population was comprised of elderly patients. For COVID-19, human immunodeficiency virus (HIV) and hepatitis C (HCV), serology, and syphilitic serology; we noted patients who had already contracted the disease at least once before suffering from ischemic disease. Patients were interviewed about their diets: diabetic, low salt, both, or no diet at all.

Sample size and calculation method

In this study, the desired statistical power was 80% with a confidence level of 95% confidence intervals, the control/case ratio is two (2), and alpha risk α is 5%.

There was one case for every two controls, because the prevalence of exposure is not very high in the target population and these controls are easy to obtain.

The sample size is calculated according to the open Epi standards of the epidemiological statistics software, the result obtained was as follows:

Sample size two hundred and thirteen (213) cases aged 60 and over. For the controls, two controls/1 case±10 are set, for a total of 460 two (432) controls. An increase of 10 controls was added to the sample size obtained to compensate for patients who did not wish to participate in the study.

Statistical analysis

Data will be entered and analyzed using JAMOVI 2.3.21 software. Categorical variables are expressed as headcount and percentage, while quantitative variables are expressed as mean and standard deviation and median (25% quartile, 75 per cent quartile). The Chi2 test was used to compare groups (Chi2) or the Fisher exact test according to the application conditions of each. The results will be obtained in the form of univariate and multivariate analysis. The degree of association between risk factors and disease will be measured by odds ratios (OR) and 95% confidence intervals (95% CI). All independent variables with a $p<0.25$ in the univariate analysis were taken into account in the multivariate logistic regression analysis. $p<0.05$ were considered to indicate statistical significance.

Ethical considerations

The study has been approved by the Ethics Committee for biomedical research of the Mohammed V Faculty of Medicine and Pharmacy in Rabat (N/R: Folder Number 03/23), and informed consent was obtained from each subject. In this study, the ethical standards of the institutional and/or national research committee were applied in all procedures carried out with human participants. The confidentiality and anonymity criteria were respected as charted in the Declaration of Helsinki and its subsequent amendments.

Results

Socio-demographic

This study included two hundred thirteen (213) cases experiencing ischemic stroke for the first time and four hundred and thirty-two (432) age- and sex-matched controls. The mean age was 76.51± 2 years for cases (median 68.0 years) of patients with ischemis stroke and 73.90±2 years (median 68 years) for controls. The male/female ratio was 0.6 in each group.

There is a statistically significant difference between the case and control groups regarding sociodemographic characteristics: sex ($p=0.006$), marital status ($p<0.001$), professional occupation ($p<0.001$), residential location ($p<0.001$), health coverage ($p<0.001$), and living conditions ($p=0.008$) (Table 1).

Comorbidities, medical history, and lifestyle factors (diet and substance use)

Significant differences were observed between the case and control groups in terms of associated comorbidities, medical history, and lifestyle (dietary habits and substance use): history of hypertension ($p<0.001$), diabetes ($p<0.001$), hypercholesterolemia ($p<0.001$), other cardiac diseases ($p<0.001$), smoking ($p<0.001$), adherence to a dietary regimen ($p<0.001$), regular physical exercise ($p=0.001$), previous infection COVID-19 infection ($p<0.001$), HCV ($p<0.001$), HIV serology ($p<0.001$) and adherence to diet ($p=0.001$) (Table 2).

Sociodemographic factors, comorbidities, and lifestyle associated with ischemic stroke in the aged: univariate logistic regression

According to the univariate logistic regression analysis, the following factors were significantly associated with ischemic stroke in the aged: low income (OR=13.97; 95% CI: 5.87–33.26; $p<0.001$), urban residence (OR=9.41; 95% CI: 4.71–18.78; $p<0.001$), health insurance (OR=0.30; 95% CI: 0.15–0.58; $p<0.001$), marital status (married) (OR=0.45; 95% CI: 0.28–0.71; $p<0.001$), living condition: not alone, (OR=0.36; 95% CI: 0.16–0.79; $p<0.011$), hypertension (OR=39.75; 95% CI: 24.88-63.53; $p<0.001$), diabetes (OR=18.14; 95% CI: 12.26–28.29; $p<0.001$), dyslipidemia (OR=4.48; 95% CI: 2.95–6.82; $p<0.001$), cardiac disease (OR=3.03; 95% CI: 1.97–4.66; $p<0.001$), smoking (OR=2.28; 95% CI: 1.91–2.73; $p<0.001$), alcohol use (OR=0.87; 95% CI: 0.50–1.52; $p<0.001$), lack of dietary regimen (OR=0.15; 95%

CI: 0.07–0.32; p<0.001) and regular physical exercise (OR=4.88; 95% CI: 3.06–7.79; p<0.001) (Table 3).

Table 1. Socio-demographic characteristics of the study sample*

Variables	Case, n (%)	Control, n (%)	p
Age			
60–70	55 (8.5)	120 (18.6)	
>70	158 (24.5)	312 (48.4)	0.599
Sex			
Male	97 (15)	148 (22.9)	
Female	116 (18)	284 (44)	0.006
Marital status of the patient			
With partner or without partner	170 (26)	388 (26.2)	
Marital status of the patient			<0.001
Married	121 (26.5)	389 (60.3)	
Single	2(0.3)	0.00	<0.001
Divorced	5 (0.8)	11 (1.7)	
Widowed	35 (5.4)	32 (5)	
Level of education of patient			
Illiterate	180 (27.9)	373 (57.8)	
With instruction	33 (5.1)	59 (9.1)	0.531
Illiterate patient			
Yes	182 (22.2)	376 (58.3)	
No	31 (4.8)	56 (8.7)	0.578
Professional occupation			
Employed	12 (1.9)	1 (0.2)	
Self-employed	27 (4.2)	296 (45.9)	<0.001
Inactive (unemployed)	143 (22.2)	132 (20.5)	
Retired	31 (4.8)	3 (0.5)	
Professional occupation DOT			
classification	12 (1.9)	0	
Manual	31 (4.8)	291 (45.1)	<0.001
Non manual	170 (26.4)	141 (26.4)	
Inactive			
Socioeconomic level (family income)	4 (0.6)	0	
Rich	58 (9.0)	367 (57)	<0.001
Middle class	150 (23.3)	65 (10.1)	
Poor			
High income family	5 (0.8)	8 (1.2)	0.674
Yes	208 (32.2)	424 (65.7)	
No			
Middle income family	52 (8.1)	79 (12.2)	
Yes	161 (25)	353 (54.7)	
No			
Low-income family	164 (25.5)	194 (30.1)	0.069
Yes	48 (7.5)	238 (37)	
No			
Residential location (rural or urban)	136 (21.1)	86 (13.4)	<0.001
Yes	76 (11.8)	346 (53.7)	
No			
Health coverage (insurance)	79 (12.2)	237 (36.7)	<0.001
Without insurance	134 (20.8)	195 (30.2)	
With insurance			
Living conditions	8 (1.2)	42 (6.5)	0.008
Alone	202 (31.7)	390 (60.6)	
Not alone			

* Chi2 test (Fisher's exact test)

Factors associated with ischemic stroke in the aged: multivariate logistic regression

According to multivariate logistic regression analysis, the following factors were significantly associated with ischemic stroke in the aged: low income (OR=13.97; 95% CI: 5.87–33.26; p<0.001), urban residence (OR=9.41; 95% CI: 4.71–18.78; p<0.001), health coverage (OR=0.30; 95% CI: 0.15–0.58; p<0.001), hypertension (OR=62.98; 95% CI: 26.74–148.37; p<0.001), diabetes (OR=18.14; 95% CI: 12.26–28.29; p<0.001) and marital status (married) (OR=0.45; 95% CI: 0.28–0.71; p<0.001) (Table 4).

Table 2. Characteristics related to associated comorbidities, medical history and lifestyle (eating habits and toxic habits)*

Variables	Case	Control	p
Past history of hypertension (comorbid diseases)			
Yes/No	145 (22.5)–64 (9.9)	64 (9.9)–368 (57.1)	<0.001
Diabetes			
Yes/No	73 (11.3)–140 (21.7)	45 (7.0)–387 (60.0)	<0.001
Past history of hypercholesterolemia (comorbid diseases)			
Yes/No	57 (8.9)–157 (24)	47 (7.3)–385 (59.9)	<0.001
Past history of other cardiac diseases			
Yes/No	1 (0.2)–31 (4.8)	8 (1.2)–16 (2.5)	<0.0001
Notion of smoking			
Yes/No	20 (3.1)–192 (29.8)	46 (7. 1)–386 (59.9)	0.419
Alcoholism			
Yes/No	50 (7.8)–14 (2.2)	48 (7.5) –12 (1.9)	0.633
Regular physical exercise (life style behaviors)			
Yes/No	5 (0.8)–208 (32.2)	0–432 (67)	0.399
Syphilis serology			
Yes/No	207 (32.1)–6 (0.9)	–	<0.001
Previous notion of COVID-19 status			
Yes/No	0–213 (33)	432 (67)	<0.001
Serology HCV status			
Yes/No	0–213 (33)	0–432 (67)	<0.001
HIV serology status			
Yes/No	0–213 (33)	0–432 (67)	<0.001
History of stroke family			
Yes/No	29 (4.5)–184 (28.5)	39 (6)–393 (60.9)	0.074
Psychoaffective history			
Yes/No	209 (32.4)	3 (0.5)–429 (66.5)	0.172
Past history of others brain diseases			
Yes/No	8 (1.2)–201 (31.4)	12 (1.9)–420 (65.5)	0.474
History of smoking (toxic habits)			
Occasional smoker	1 (0.2)	8 (1.2)	<0.001
Daily smoker	31 (4.8)	16 (2.5)	
Ex-smoker	60 (9.4)	11 (17.3)	
Never smoked	149 (23.2)	321 (50.1)	
Alcoholism			
Yes/No	50 (7.8)–14 (2.2)	48 (7.5)–12 (1.9)	0.633
Followed diet			
Diabetic diet	4 (0.6)	13 (2)	<0.001
Hyposode diet	209 (32.4)	419 (65)	
Diabetic diet and hyposode diet	5 (0.8)	0	
No diet	208 (32.2)	432 (67)	

* Chi2 test (Fisher's exact test)

Discussion

Ischemic stroke is a multifactorial disease governed by modifiable and non-modifiable risk factors. Other less well-documented risk factors include geographical location and socio-economic status.[10] Identifying these risk factors in the elderly is crucial to reducing the incidence of disability and the costs associated with stroke.

This study of elderly people in the Souss Massa region of Morocco confirms that the main modifiable risk factors for ischemic stroke are hypertension, diabetes, smoking, and heart disease.

Table 3. Sociodemographic, comorbidity and lifestyle, dietary habits, toxicity, and ischemic stroke associated with ischemic stroke (univariate logistic regression)

Variables	OR	95% CI		p
Education level patient: with instruction – illiterate	0.86	0.544	1.37	0.531
Professional occupation:	1.47	0.57	4.25	0.978
Manual – no manual	1.30	0.87	3.87	0.981
Inactive – no manual				
High-income family: no – yes	1.27	0.41	3.94	0.674
Middle-income family: no – yes	1.44	0.91	2.15	0.070
Low-income family: nes – no	13.97	5.87	33.25	<0.001
Residence area: urban –rural	9.40	4.71	18.77	<0.001
Health insurance: with assurance – without assurance	0.29	0.15	0.57	<0.001
Living condition: not alone – alone	0.36	0.16	0.79	0.011
Marital status: no partner – partner	0.44	0.28	0.70	<0.001
Stroke history in the family	1.59	0.95	2.65	0.076
Arterial hypertension				
Yes/ No	39.75	24.87	63.52	<0.001
Diabetes				
Yes/No	18.14	12.26	8.28	<0.001
Dyslipidemia				
Yes/No	4.48	2.95	6.81	<0.001
Cardiac disease				
Yes/No	3.03	1.974	4.66	<0.001
History of cerebral disease				
Yes/No	1.39	0.56	3.46	0.475
Stroke history in family				
Yes/No	0.07	0.95	2.65	0.076
History of personnel disease cerebral	1.39	0.56	3.46	0.475
Psycho-affective history				
Yes/No	2.73	0.60	12.34	0.190
BMI class: obesity – overweight	1.02	0.68	1.53	0.918
History of hormonal contraception				
Yes/No	2.11	1.05	4.23	0.093
Notion of smoking				
Yes/No	2.28	1.90	2.73	<0.001
History of alcoholism				
Yes/No	0.87	0.503	1.52	<0.001
Diet followed				
Yes/No	0.14	0.0678	0.31	<0.001
Regular exercise				
Yes/No	4.88	3.06	7.78	<0.001

Table 4. Factors associated with ischemic stroke (multivariate logistic regression)

Variables	**OR**	**95% CI**		**p**
Low-income family (yes)	13.97	5.87	33.25	<0.001
Residence area (urban)	9.40	4.71	18.77	<0.001
Health insurance (with assurance)	0.29	0.15	0.57	<0.001
High blood pressure (HBP) (yes)	62.98	26.73	148.36	<0.001
Diabètes (yes)	18.13	5.23	62.88	<0.001
Marital status (couple)	0.44	0.28	0.70	<0.001

In this study, the main modifiable risk factors for ischemic stroke in elderly people in the Souss Massa region of Morocco were: hypertension (OR=62.984), diabetes (OR=18.138) and dyslipidemia (11.3%). Smoking and alcoholism were not considered risk factors for ischemic stroke in the study population. This may be due to the age and socioeconomic status of the study population. On the other hand, and in the same vein, studies have reported that smoking and alcoholism are risk factors for ischemic stroke.[11,12]

In this study, hypertension was significantly associated with stroke, as in other studies of this kind.[13,14] In addition, heart disease and ischemic stroke share modifiable risk factors such as hypertension, lipid abnormalities, smoking, sedentary lifestyle, obesity, and diabetes.[15]

In the same vein, a systematic review of ischemic stroke in Morocco reports that hypertension (31–65.4%), diabetes (12–41.8%), smoking (4–41.8%), and heart disease (7–44.3%) are the four main risk factors for ischemic stroke. In fact, another study reports that this was due to the westernization of Moroccan behavior and eating habits.[16]

This study reports that certain risk factors were not included. On the other hand, one study reported that associated heart disease (2.5–22%), dyslipidemia (0–61.8%), obesity (10.7–26.1%), previous stroke (5–26.6%), alcoholism, oral contraceptives (6.6–12.2%), and migraine (6.5%) were all risk factors.[17] Similarly, more than half of ischemic stroke patients in Africa suffered from hypertension.[18] These results are consistent with studies carried out in the Middle East between 1980 and 2000, and with data from Eastern Mediterranean countries where hypertension and diabetes are prevalent at rates in excess of 50%.[19]

These results underline the importance of adopting prevention strategies targeted at these risk factors, and promoting healthy lifestyles among this vulnerable population, in order to reduce the incidence and burden of the disease.

In another sense, the results of this study showed that living conditions, marital status and place of residence were risk factors for ischemic stroke in the study population. These results are in line with those reported in other studies, and at odds with other countries in North Africa and the Middle East.[6,21,20] In fact, around 80% of strokes could be prevented by simple lifestyle changes. Further research into the role and interaction between living conditions, marital status and place of residence will improve our understanding of ischemic stroke and help develop more effective prevention programs for high-risk groups.[10]

Our study indicates that, for the population studied, living in an urban environment offers protection against ischemic stroke. In fact, the region's population is divided into 1,505,896 urban dwellers and 1,170,951 rural dwellers. Although the region remains predominantly rural, it is nevertheless undergoing strong urbanization, reflected in an urban growth rate of 3.2%, compared with a decrease of -0.5% in rural areas.[20] In fact, studies report that the high frequency of this risk factor is due to rapid urbanization (60.3% of the population) and lifestyle changes in the Moroccan population that allow rapid access to healthcare.[21] In addition, one study indicates that living in rural areas is associated with an increased risk of stroke and death. Therefore, future efforts should not only focus on controlling

known vascular risk factors, but also examine other determinants of health in rural areas.[7]

Living environment influences the risk of ischemic stroke due to factors such as access to care, lifestyle habits, and socioeconomic conditions.[22–24] In another sense, this study reports no association between ischemic stroke and a family history of ischemic stroke. Similarly, two other studies confirm these results, indicating that the correlation between this risk factor and the disease is not representative.[25,26] With regard to marital status, the study shows that living with a partner and having social security coverage are protective factors against ischemic stroke among elderly people in the Souss Massa region. According to the present study, living as a couple attenuates the increased risk of stroke. Although our results do not suggest a significant gender difference in stroke risk after marital transition. In addition, another study showed the same result in young subjects, and that living alone without being married was one of the independent risk factors for ischemic stroke.[27] On the other hand, one study reported that an increased risk of stroke was observed in men and women who had undergone a matrimonial transition (married or unmarried), Participants in matrimonial transition and living with children had an increased risk of stroke and in particular among those with an average level of education.[28] In terms of social security coverage, the incidence of multidimensional poverty in the study area is 8.2%, the national average, and higher in rural areas (13.7%) than in urban areas (2.1%). Despite significant progress, Morocco's social protection system faces a number of challenges, including unequal access to health coverage, financial difficulties and disparities between different insurance schemes. In addition, the lack of access to high-performance diagnostics and care has given rise to some discontent.[29] in the same sense that uninsured patients were less likely to take appropriate control medication prior to stroke, to use an ambulance to get to the emergency room, or to arrive promptly after the onset of symptoms. As a result, these uninsured patients had a higher in-hospital mortality rate than privately insured patients, with a relative risk (OR) of 1.33 for those under 65 (95% CI 1.22–1.45) and 1.54 for those 65 and over (95% CI 1.34–1.75).[30] Similarly, the disproportionate increase in stroke incidence in low and middle-income countries has been attributed to environmental factors.[5] Furthermore, in a cohort study of a population of six million with universal access to medical and hospital services, stroke risk factors were widespread but less well controlled in rural residents.[5]

Study limitations

The present study represents the first investigation in Morocco which attempted to explore the risk factors of cerebral ischemia with a case-control design, in line with the findings of a systematic literature review in Morocco and which explained the cross-sectional nature of the majority of included studies.[17] Nevertheless, some limitations were raised in relation to the methodological and empirical aspect of the study. In this respect, the case-control study opted for a hospital reference population. In addition, risk factors, particularly those related to atrial fibrillation and carotid artery stenosis, were not specifically studied, due to a traceability constraint. The study was limited to the presence or absence of any notion of heart disease in the patient's medical record.

Conclusion

In addition to traditional risk factors for ischemic stroke, such as high blood pressure and diabetes, this study revealed that living in a low-income family is also a risk factor for this disease. On the other hand, having social security coverage and living in urban areas and in couples are protective factors for the elderly. Integrating these elements into public health strategies and future research could significantly improve the quality of life of elderly people affected by ischemic stroke.

Declarations

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Author contributions

Conceptualization, A.H., C.L. and N.A, Methodology, A.H., M.A.B. and A.N.; Software, A.L.; Validation, A.H., A.N. and M.A.B.; Formal Analysis, A.H. and A.N.; Investigation, A.H. and C.L.; Resources, None; Data Curation, A.H. and A.L.; Writing - Original Draft Preparation, A.H.; Writing - Review & Editing, A.H., C.L., A.L., M.A.B. and N.A.; Visualization, A.H., C.L. and A.L; Supervision, A.N.; Project Administration, A.H. and N.A.

Conflicts of interest

The authors declared no conflicts of interest for this paper.

Data availability

Data available on request from the authors.

Ethics approval

The ethical approval was granted by the Ethics Committee for Biomedical Research of the Faculty of Medicine and Pharmacy Mohammed V in Rabat, Morocco (Reference: CERB 03/23).

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