Behavioral and biological risk factors of non-communicable diseases: Results of a nationally representative cross-sectional survey in Algeria

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ABSTRACT

INTRODUCTION There is a need to strengthen the evidence base for context-specific heterogeneities in factors that may potentiate or reduce adverse outcomes of non-communicable disease (NCDs). The study aimed to estimate the prevalence of behavioral and biological risk factors for NCDs among adults in Algeria.

METHODS We conducted a secondary analysis of nationally representative cross-sectional population-based data from the Algeria STEPS survey 2016–2017 with a sample size of 6989 adults aged 18–69 years. The STEPS instrument comprised three levels: the questionnaire, physical and biochemical measures, which were used to assess the NCDs' behavioral and biological risk factors, including current tobacco use, inadequate fruit and vegetable (FV) intake, low physical activity (PA), sedentary behavior, overweight/obese, hypertension, diabetes, and elevated total cholesterol. Adjusted binary logistic regressions assessed the associations between sociodemographic and health factors and specific NCD risk factors. Adjusted Poisson regressions were used to assess the predictors of multiple NCD risk factors.

RESULTS The proportion of the population with inadequate fruit/vegetable (FV) consumption was 85.2%, followed by overweight/obese (55.6%), low physical activity (PA) (36.6%), hypertension (23.6%), current tobacco use (21.8%), elevated total cholesterol (18.2%), sedentary behavior (8.9%), diabetes (8.8%), and current alcohol use (2.1%). In total, 46.9% of participants had three or more of eight assessed NCD risk factors. Male sex (AOR=109.24; 95% CI: 66.92–178.31) was positively associated, while older age (45–69 years) (AOR=0.63; 95% CI: 0.51–0.78) and higher level of education (≥12 years) (AOR=0.49; 95% CI: 0.38–0.64) were negatively associated with current tobacco use. Higher level of education (≥12 years) (AOR=0.64; 95% CI: 0.49–0.84) was negatively associated with insufficient FV intake. Older age (45–69 years) (AOR=1.53; 95% CI: 1.27–1.84), higher level of education (≥12 years) (AOR=1.94; 95% CI: 1.53–2.46), and urban residence (AOR=1.22; 95% CI: 1.02–1.47) were positively associated, while male sex (AOR=0.45; 95% CI: 0.38–0.53) was inversely associated with low PA. Older age, female sex, urban residence, and lower level of education were associated with 2–4 biological NCD risk factors (overweight/obese, hypertension, diabetes, and/or elevated total cholesterol).

CONCLUSIONS In the current study, almost half of the participants had three or more risk factors for NCDs. Older age and urban residence increased the risk for a higher degree of NCD risk factors. Therefore, there is a need to develop and strengthen the effectiveness of policies and programs to mitigate the burden of NCDs and related risk factors.

INTRODUCTION

Worldwide, non-communicable diseases (NCDs) continue to be a growing health problem and the key driver of premature death[1]. Across low- and middle-income countries (LMIC), 17 million deaths are attributable to NCDs each year[1]. In Algeria, an LMIC in the Eastern Mediterranean, NCDs contributed to 76% of the population mortality in 2018[2]. Algeria has a population of 43.5 million, 77.8 years of life expectancy at birth, 74.8% urbanization, and 81.4% are literate[3]. The leading causes of death from NCDs globally are

cardiovascular diseases, cancers, respiratory diseases, and diabetes[1].

Behavioral risk factors, such as smoking, alcohol use, sedentary lifestyle, and unhealthy diets, significantly increase the risk of NCD mortality[1]. As previously reviewed[4], other factors associated with NCD risk factors include gender, older age, marital status, geographical region, urban residence, low or high level of education, and higher economic level[4]. The Eastern Mediterranean region is experiencing a rapid increase in NCDs, and it is crucial to have a careful understanding of the local drivers of NCDs5, especially given the fact that they are co-morbid conditions for respiratory diseases, such as COVID-19, which are high on the public health agenda. This necessitates the assessment of behavioral and biological risk factors of NCDs in Algeria[6,7].

In 2003, a subregional (Setif and Mostaganem) STEPS survey in Algeria found that among people aged 25–64 years, the prevalence of current smoking tobacco was 15.1%, there were no current drinkers, inadequate fruit and vegetable (FV) intake was 87.1%, low physical (PA) was 40.7%, overweight/obese was 46.7%, hypertension was 29.3%, diabetes was 10.0%, and elevated total cholesterol (≥190 mg/dL) was 45.4%8.

In an urban and rural population survey (≥20 years) in the Wilaya of Tlemcen, Algeria, the prevalence of elevated total cholesterol was 6.6%, hypertension (28.0% in urban and 16.8% in rural areas), diabetes among women (21.4% in urban and 15.4% in rural areas), obesity among women (24.7% in urban and 28.3% in rural areas), and the prevalence of smoking among men was 45.8%[9]. The prevalence of diabetes in Algeria increased from 6.8% in 1990 to 12.3% in 2005[10]. A recent review of national and regional studies in Algeria over 15 years showed a significant increase in the prevalence of type 2 diabetes (from 6 to 12%), obesity (from 16 to 24%), and hypertension (from 26 to 44% depending on the region)[11].

Looking at two NCD risk factors (inadequate FV intake and diabetes), data from the latest national STEPS survey in Lebanon show that the proportion of inadequate FV intake was 73.4% among Lebanese and 93.2% among Syrian refugees, and diabetes 10.5% and 9.4%, respectively12. In the 2017 Oman STEPS survey, the prevalence of inadequate FV intake was 60.7% and diabetes 11.8%[13]; in the Kenya STEPS survey in 2015, 99.8% had inadequate FV intake, and 2.6% had diabetes[14], in the Nepal STEPS survey in 2013, the prevalence of insufficient FV consumption was 98.9% and diabetes 3.6%[15], while in Bolivia, the prevalence of inadequate FV intake was 76.7%[16].

Extensive research has been documented regarding NCDs and their risk factors in Algeria. However, there is still a scarcity of data that estimates the prevalence of NCDs' behavioral and biological risk factors from a previous national survey conducted in Algeria. In this regard, there is a need to strengthen the evidence base for context-specific heterogeneities in factors that may potentiate or reduce adverse outcomes of non-communicable diseases (NCDs). Therefore, the current study aimed to estimate the prevalence and associated risk factors of behavioral and biological NCDs among adults in Algeria. We hypothesize that there will be a high prevalence of all NCDs' behavioral and biological risk factors in Algeria among adults aged

18–69 years.

METHODS

Sample and procedures

Within this secondary dataset analysis, national cross-sectional secondary data from participants (N=6989) of the 2016–2017 Algeria STEPS household survey[17] were analyzed, and the overall response rate to the study was 93.8%[18]. A multi-stage cluster sampling design was applied to generate representative national data for participants aged 18–69 years in Algeria. At the household level, an adult (aged 18–69 years) was randomly selected[18]. Inclusion criteria were a household member aged 18–69 years and the provision of informed consent. The household survey was conducted by trained interviewers (pairs of investigators, doctors, and paramedics) who undertook face-to-face interviews in households using questionnaires in electronic format[19]. A pilot test was conducted with the translated versions of the Algeria-specific questionnaire and all other interview materials on a community sample[18]. The Ethics Committee of the Algerian Ministry of Health approved the study. Participants provided written informed consent.

According to the STEPS survey procedures, sociodemographic, behavioral information was collected in Step 1. Physical measurements such as height, weight, and blood pressure were collected in Step 2. Detailed information regarding the study's behavioral and biochemical assessment has been previously published[19]. In brief, height was measured in centimeters with portable standard stature tape (Seca, German) while the participant was in a standing position, weight was measured in kilograms with a portable digital weighing scale (Seca, Germany), and blood pressure was measured with a digital automated blood pressure monitor (OMRAN digital device) with universal cuff size. Biochemical measurements were collected to assess blood glucose and cholesterol levels and were measured using capillary whole blood. The assessment was done the following day after the participants went through steps 1 and 2 after an overnight fast of 12 hours. The participants read and signed the informed consent[18,19].

Behavioral outcome variables of NCD risk factors included tobacco smoking (yes/no), current smokeless tobacco use such as snuff and chewing tobacco (yes/no), current alcohol use (yes/no), low PA and sedentary behavior (<8 h/day) based on the Global Physical Activity Questionnaire[20], and inadequate FV consumption (<5 servings/day) (using show cards)[19]. Self-reported physical activity levels in the work, transportation, and leisure domains were classified into low, moderate, and high physical activity (<600, 600–1500,

and >1500 MET-min/week, respectively) according to the GPA[21]. To improve recall in terms of dietary habits, food cards with portion size estimation were used during the administration of the food frequency questionnaire. Picture samples of alcoholic beverages were used to estimate alcohol consumption.

Biological outcome variables of NCDs' risk factors included body mass index (BMI), which was calculated from measured height and weight, and overweight/obese was defined[18] as ≥25.0 kg/m^2. Diabetes was defined as: fasting plasma glucose levels >7.0 mmol/L (≥126 mg/dL) or using insulin or oral hypoglycemic drugs[18]. Hypertension/raised blood pressure (BP) was defined as: systolic BP ≥140 mmHg and/or diastolic BP ≥90 mmHg or where the participant is currently on antihypertensive medication[22]. Elevated total cholesterol was classified[23] as: being on antilipidemic medication or having elevated total cholesterol ≥5.17 mmol/L (200 mg/dL).

Statistical analysis

STATA software version 17 (Stata Corporation, College Station, TX, USA) was used for statistical analyses, considering the multi-stage sampling and weighting of the data. Descriptive statistics were used to describe NCD risk factors. Logistic regressions assessed the associations between sociodemographic and health factors and specific NCD risk factors. Poisson regressions were used to assess the predictors of multiple NCD risk factors. Adjusted odds ratios or prevalence ratios with 95% confidence interval were calculated. The covariates of this study were selected based on previous reviews[4], including age, sex, residence, and socioeconomic status. Taylor linearization methods were utilized to account for the multi-stage sample design. A p<0.05 was considered significant. The Svy commands in STATA were applied to adjust for sampling design, sampling weights, stratification, and the calculation of standard errors. Taylor linearization methods were used for variance estimation in which linear approximates (i.e. the estimated variance) of a nonlinear function (i.e. the true variance) were derived using the first-order Taylor series of the approximation. Analysis weights were calculated by taking the inverse of the probability of selection of each participant. These weights were adjusted for differences in the age-sex composition of the sample population compared to the target population[18]. The variance inflation factor (VIF) was calculated to check for multicollinearity, and none was found between the study variables.

RESULTS

Sample characteristics among those aged 18–69 years in Algeria, 2016–2017

The sample consisted of 6989 people aged 18–69 (median=37 years, IQR: 27–47); 55.9% were female, 67.5% lived in urban areas, and 33.8% had ≥12 years of education (Table 1).

Distribution of behavioral and biological non-communicable risk factors in weighted percent

The proportion of inadequate FV consumption is 85.2%, followed by overweight/obese (55.6%), low PA (36.6%), hypertension (23.6%), current tobacco use (21.8%), elevated total cholesterol (18.2%), sedentary behavior

Table 1. Sample characteristics among community dwelling participants aged 18–69 years in Algeria, 2016–2017 (N=6989)

Characteristics	Category	Male	Female	All
		n (%)[a]	n (%)[a]	n (%)[a]
Total		3082 (44.1)	3907 (55.9)	6989 (100)
Age (years)	18–29	649 (21.1)	859 (22.0)	1508 (21.6)
	30–44	1185 (38.4)	1562 (40.0)	2747 (39.3)
	45–59	908 (29.5)	1021 (26.1)	1929 (27.6)
	60–69	340 (11.0)	465 (11.9)	805 (11.5)
Education level (years)	0–5	478 (15.6)	1188 (30.4)	1666 (23.9)
	6–11	1535 (50.0)	1418 (36.3)	2953 (42.3)
	≥12	1060 (34.5)	1296 (33.2)	2356 (33.8)
Number of adult household members	1–2	1247 (40.6)	1711 (43.9)	2958 (42.4)
	3–4	972 (31.7)	1211 (31.1)	2183 (31.3)
	≥5	851 (27.7)	977 (25.1)	1828 (26.2)
Interview language	French	236 (7.7)	284 (7.3)	520 (7.4)
	Arabic	2485 (80.7)	3141 (80.4)	5626 (80.5)

aUnweighted.

(8.9%), diabetes (8.8%), and current alcohol use (2.1%). In total, 46.9% of participants had three or more of the eight assessed NCD risk factors. Moreover, the age group 30–44 years was more likely to report a higher prevalence of tobacco use (24.3%) and inadequate FV (86.0%), while the age group (18–29 years) had a higher prevalence of alcohol intake (2.6 %) and sedentary behavior (10.3 %). The age group 45–59 years presented only one of the biological risk factors and had a higher prevalence of being overweight/obese (69 %) compared to other age groups. The age group 60–69 years almost had all the biological risk factors since it presented a higher prevalence of hypertension (62.0%), diabetes (24.9 %), and elevated total cholesterol (36.5%). Subsequently, males had a higher prevalence of tobacco use (42.6%), alcohol intake (4.1%), and sedentary behaviors (8.7%). In comparison, the female counterpart had a higher prevalence of inadequate FV (85.7%), low PA (46.5%), overweight/obese (63.3 %), hypertension (24.1%), diabetes (9.2%), and elevated cholesterol (20.4%). Middle education of 6–11 grade used tobacco more (29.2%) and alcohol use (3.4%) compared to those with primary/lower education (15.3%) and a higher institution education (16.6 %). Lower education people (0–5) had a higher prevalence of inadequate FV (87.2 %), overweight/obese (63.0%), hypertension (39.8%), diabetes (14.4%), and elevated total cholesterol (24.3%) compared to middle and higher education people. Higher education ≥12 years showed a higher prevalence of low PA (43.5 %) compared to other education categories. Communities who reside in rural areas had a higher prevalence of tobacco use (22.1%) and hypertension (24.0%). In contrast, those who reside in the urban areas had a higher prevalence of alcohol intake (2.0%), inadequate FV (85.4%), low PA (39.1%), sedentary behaviors (9.1%), overweight/obese (56.8%), diabetes (10.0%) and elevated cholesterol (18.9%) (Table 2).

Associations with behavioral non-communicable disease risk factors

In multivariable logistic regression, adjusted for age, sex, education level, number of adult household members, interview language and residence status, the male sex (AOR=109.24; 95% CI: 66.92–178.31) was positively associated, and older age 143 (45–69 years) (AOR=0.63; 95% CI: 0.51–0.78), and higher education (≥12 years) (AOR=0.49; 95% CI: 0.38–0.64) were negatively associated with current tobacco use. Higher education (≥12 years) (AOR=0.64; 95% CI: 0.49–0.84) was negatively associated with insufficient FV intake. Older age (45–69 years) (AOR=1.53; 95% CI:

Table 2. Distribution of behavioral and biological non-communicable risk factors in weighted percent among community dwelling participants aged 18–69 years in Algeria, 2016–2017 (N=6989)

Variable	Category	Current tobacco use	Current alcohol use	Inadequate fruit and vegetable intake	Low physical activity	Sedentary behavior	Overweight or obese	Hypertension	Diabetes	Elevated total cholesterol
Total		21.8	2.1	85.2	36.6	8.9	55.6	23.6	8.8	18.2
Age (years)	18–29	22.5	2.6	85.3	36.6	10.3	35.7	8.5	3.8	8.1
	30–44	24.3	2.1	86.0	32.7	6.5	62.0	17.7	5.7	18.3
	45–59	18.5	1.9	84.2	39.7	6.8	69.1	41.0	15.1	25.6
	60–69	17.0	0.7	83.6	47.1	9.5	66.5	62.0	24.9	36.5
Sex	Female	0.7	0.0	85.7	46.5	7.4	63.3	24.1	9.2	20.4
	Male	42.6	4.1	84.7	29.3	8.7	48.4	23.2	8.4	16.1
Education level (years)	0–5	15.3	0.5	87.2	33.3	7.9	63.0	39.8	14.4	24.3
	6–11	29.2	3.4	86.1	32.0	6.2	54.8	22.0	7.9	17.3
	≥12	16.6	1.4	83.0	43.5	10.3	52.6	16.9	6.8	16.1
Number of adult household members	1–2	20.6	2.2	85.6	35.9	6.9	63.1	23.6	8.5	21.5
	3–4	21.6	1.7	83.6	38.5	8.6	52.4	23.6	9.2	16.1
	≥5	23.8	2.4	86.4	35.4	9.0	48.9	23.6	8.6	15.9
Interview language	French	19.8	2.0	81.6	42.9	6.3	52.2	22.7	12.9	16.4
	Arabic	22.0	1.4	85.6	36.3	8.4	55.1	23.3	8.5	18.2
	Tamazight	22.1	6.7	84.2	34.6	6.8	61.5	26.6	7.7	19.4
Residence	Rural	22.1	2.0	84.7	31.5	5.8	53.2	24.0	6.5	16.9
	Urban	21.7	2.2	85.4	39.1	9.1	56.8	23.5	10.0	18.9

Table 3. Associations with behavioral non-communicable disease risk factors among community dwelling participants aged 18–69 years in Algeria, 2016–2017 (N=6989)

Variable	Category	Current tobacco use	Insufficient fruit/ vegetable intake	Low physical activity	Sedentary behavior
		AOR (95% CI)[a]	AOR (95% CI)[a]	AOR (95% CI)[a]	AOR (95% CI)[a]
Age (years)	18–29 ® 30–44 45–69	1 1.09 (0.88–1.34) 0.63 (0.51–0.78)***	1 0.99 (0.82–1.20) 0.80 (0.64–1.00)	1 0.93 (0.77–1.12) 1.53 (1.27–1.84)***	1 0.66 (0.50–0.85)** 0.71 (0.53–0.95)*
Sex	Female ® Male	1 109.24 (66.92–178.31)***	1 0.94 (0.78–1.13)	1 0.45 (0.38–0.53)***	1 1.24 (0.99–1.55)
Education level (years)	0–5 ® 6–11 ≥12	1 1.04 (0.82–1.31) 0.49 (0.38–0.64)***	1 0.84 (0.66–1.06) 0.64 (0.49–0.84)**	1 1.26 (1.01–1.58)* 1.94 (1.53–2.46)***	1 0.64 (0.46–0.89)** 1.05 (0.69–1.60)
Number of adult household members	1–2 ® 3–4 ≥5	1 1.00 (0.82–1.23) 1.02 (0.84–1.23)	1 0.88 (0.73–1.08) 1.08 (0.84–1.38)	1 1.03 (0.68–1.21) 0.98 (0.82–1.18)	1 1.05 (0.81–1.35) 1.09 (0.84–1.43)
Interview language	Arabic ® French Tamazight	1 0.89 (0.67–1.18) 1.12 (0.83–1.50)	1 0.78 (0.45–1.35) 0.93 (0.50–1.73)	1 1.19 (0.82–1.73) 0.91 (0.73–1.14)	1 0.66 (0.37–1.18) 0.86 (0.47–1.57)
Residence	Rural ® Urban	1 1.15 (0.96–1.38)	1 1.17 (0.75–1.80)	1 1.22 (1.02–1.47)*	1 1.58 (0.89–2.80)

a AOR: adjusted odds ratio. Adjusted for all variables in the table. ® Reference categories. ***p<0.001. **p<0.01. *p<0.05.

Table 4. Associations with biological non-communicable disease risk factors among community dwelling participants aged 18–69 years in Algeria, 2016–2017 (N=6989)

Variable	Category	Overweight/obese	Hypertension	Diabetes	Elevated total cholesterol
		AOR (95% CI)[a]	AOR (95% CI)[a]	AOR (95% CI)[a]	AOR (95% CI)[a]
Age (years)	15–29 ® 30–44 45–69	1 2.83 (2.48–3.23)*** 3.99 (3.44–4.63)***	1 2.29 (1.83–2.86)*** 8.61 (6.85–10.82)***	1 1.55 (1.04–2.31)* 4.85 (3.28–7.16)***	1 2.34 (1.77–3.09)*** 4.44 (3.40–5.80)***
Sex	Female ® Male	1 0.52 (0.46–0.58)***	1 1.01 (0.88–1.15)	1 0.96 (0.79–1.16)	1 0.76 (0.66–0.87)***
Education level (years)	0–5 ® 6–11 ≥12	1 1.12 (0.96–1.31) 1.16 (0.98–1.38)	1 0.75 (0.64–0.88)*** 0.65 (0.55–0.78)***	1 0.75 (0.59–0.94)* 0.70 (0.54–0.92)*	1 0.96 (0.80–1.15) 1.01 (0.83–1.23)
Number of adult household members	1–2 ® 3–4 ≥5	1 0.80 (0.70–0.92)*** 0.79 (0.69–0.90)***	1 0.96 (0.84–1.11) 1.24 (1.05–1.47)*	1 1.00 (0.79–1.26) 1.09 (0.85–1.41)	1 0.74 (0.63–0.88)*** 0.86 (0.71–1.04)
Interview language	Arabic ® French Tamazight	1 0.89 (0.69–1.15) 1.30 (1.10–1.54)**	1 0.96 (0.84–1.11) 1.09 (0.87–1.36)	1 1.57 (1.00–2.47) 0.89 (0.58–1.38)	1 0.86 (0.60–1.22) 1.03 (0.77–1.40)
Residence	Rural ® Urban	1 1.21 (1.05–1.39) **	1 0.97 (0.82–1.15)	1 1.54 (1.18–1.92)*	1 1.13 (0.92–1.39)

a AOR: adjusted odds ratio. Adjusted for all variables in the table. ® Reference categories. ***p<0.001. **p<0.01. *p<0.05.

Table 5. Poisson regression with eight NCDS risk factors among community dwelling participants aged 18–69 years in Algeria, 2016–2017 (N=6989)

Variable	Category	Both sexes	Men	Women
		APR (95% CI)[a]	APR (95% CI)[a]	APR (95% CI)[a]
Age (years)	15–29 ® 30–44 45–69	1 1.59 (1.44–1.76)*** 2.66 (2.39–2.95)***	1 1.75 (1.52–2.02)*** 2.70 (2.35–3.10)***	1 1.38 (1.21–1.57)*** 2.61 (2.22–3.06)***
Sex	Female ® Male	1 1.04 (0.96–1.12)		
Education level (years)	0–5 ® 6–11 ≥12	1 1.01 (0.91–1.12) 0.97 (0.86–1.09)	1 1.00 (0.86–1.16) 0.98 (0.83–1.16)	1 1.02 (0.89–1.16) 0.96 (0.81–1.13)
Number of adult household members	1–2 ® 3–4 ≥5	1 0.92 (0.83–1.03) 0.96 (0.87–1.07)	1 0.93 (0.80–1.07) 1.03 (0.90–1.18)	1 0.94 (0.82–1.08) 0.87 (0.75–1.00)
Interview language	Arabic ® French Tamazight	1 0.94 (0.77–1.15) 1.04 (0.88–1.24)	1 0.93 (0.74–1.16) 1.04 (0.83–1.29)	1 0.95 (0.74–1.22) 1.04 (0.85–1.27)
Residence	Rural ® Urban	1 1.23 (1.11–1.37)***	1 1.27 (1.11–1.46)***	1 1.18 (1.03–1.35)*

a APR: adjusted prevalence ratio. Adjusted for all variables in the table. ® Reference categories. ***p<0.001. *p<0.05.

1.27–1.84), higher education (≥12 years) (AOR=1.94; 95% CI: 1.53–2.46), urban residence (AOR=1.22; 95% CI: 1.02–1.47) and male sex (AOR=0.45; 95% CI: 0.38–0.53) were negatively associated with low PA. Older age (45–69 years) (AOR=0.71; 95% CI: 0.53–0.95) and 6–11 years of education (AOR=0.64; 95% CI: 0.46–0.89) were negatively associated with sedentary behavior (Table 3).

Associations with biological non-communicable disease risk factors

In the adjusted logistic regression analysis, adjusted for age, sex, education level, number of adult household members, interview language and residence status, older age (45–69 years) (AOR=3.99; 95% CI: 3.44–4.63), Tamazight interview language (AOR=1.30; 95% CI: 1.10–1.54), and urban residence (AOR=1.21, 95% CI: 1.05–1.39) were positively associated with overweight/obese and hypertension. Male sex (AOR=0.52; 95% CI: 0.46–0.58) and having a higher number of adult household members (≥5) (AOR=0.79; 95% CI: 0.69–0.90) were negatively associated with overweight/obese. Older age (45–69 years) (AOR=8.61; 95% CI: 6.85–10.83), having a higher number of adult household members (≥5) (AOR=1.24; 95% CI: 1.05–1.47) and higher education (≥12 years) (AOR=0.65; 95% CI: 0.55–0.78) were negatively associated with hypertension. Older age (45–69 years) (AOR=4.85; 95% CI: 3.28–7.16), and urban residence (AOR=1.54, 95% CI: 1.18–1.92) and higher education (≥12 years) (AOR=0.70; 95% CI: 0.54–0.92) were negatively associated with diabetes. Older age (45–69 years) (AOR=4.44; 95% CI: 3.40–5.80) and male sex (AOR=162; 95% CI: 0.66–0.87) and having 3–4 adult household members (AOR=0.74; 95% CI: 0.63–0.88) were negatively associated with elevated total cholesterol (Table 4).

Poisson regression with eight NCDS risk factors

In the adjusted Poisson regression analysis, adjusted for age, sex, education level, number of adult household members, interview language and residence status, in both sexes, older age (45–69 years) (adjusted prevalence ratio, APR=2.66; 95% CI: 2.39–2.95), and urban residence (APR=1.23; 95% CI: 1.11–1.37) were positively associated with a higher number of NCDS risk factors. Similar results were found in sex-stratified analysis (Table 5).

DISCUSSION

The current study aimed to estimate the prevalence and associated risk factors of behavioral and biological NCDs among adults in Algeria. The study found that the five most prevalent NCD behavioral and biological risk factors were inadequate FV intake (85.2%), being overweight/obese (55.6%), low PA (36.6%), hypertension (23.6%), and current tobacco use (21.8%). The high prevalence of insufficient FV consumption (85.2%) was similar to the 2003 Algerian sub-regional STEPS survey (87.1%)[8], lower than in Kenya (99.8%)[14], Nepal (98.9%)[15], and higher than in Oman (60.7%)[12], and Bolivia (76.7%)[16]. This might be attributed to the underlying environmental and urbanization factors, which is no exception to the Algerian country and encourages

unhealthy food intake[15]. The prevalence of being overweight/obese (55.6%) was higher than in the Algerian subregional STEPS survey of 2003 (46.7%)[8] and in Nepal (21.3%)[15], like Bolivia (56.3%)[16], and lower than in Lebanon (73.4%)[16] and Oman (66.1%)[13]. Policies addressing the rise in obesity in Algeria appear to be limited. Occasionally televised advertisements call attention to the negative health effects of cheap, processed food. However, taxes are not levied on such junk food, and there is no regulation on food advertising to children[10].

The prevalence of low PA (36.6%) was lower than in the 2003 Algerian sub-regional STEPS survey (40.7%)[8], lower than in Oman (38.6%)[13], Kenya (80.3%)[14] and Bolivia (64.8%)[15], but higher than in Nepal (3.4%)[15]. The low PA among these populations can result from the absence of sports culture, as well as religious and social practices that prohibit engagement in physical activity, especially among women[24]. According to Algeria's PA profile by the World Health Organization[25], Algeria has PA communication campaigns and national mass participation events on PA, promotes PA in workplaces, through community sports, and in public open spaces, and school-based approaches (quality physical education) and a national PA policy are not available.

The prevalence of current tobacco use (21.8%, 16.4% current smoking) was higher than in the 2003 Algerian subregional STEPS survey (15.1% current smoking)[8], in Oman (8.5%)[13], in Kenya (10.2%)[14], in Nepal (18.5%)[15] and in Bolivia (11.6%)[16], but lower than in the Jordan Global Adult Tobacco Survey (GATS) in 2011 (42.2%)[26]. The high prevalence rate of tobacco use might be due to the affordable prices of tobacco and the fact that tobacco is readily available in the markets[26,27]. Therefore, implementing and strengthening tobacco control policies is necessary in Algeria, including increases in exercise tax and the price of tobacco products, running a National Anti-Tobacco Campaign, and enforcing bans on tobacco advertising[27].

The prevalence of hypertension (23.6%) was lower than in the 2003 Algerian sub-regional STEPS survey (29.3%)[8], and national and regional recent estimates in Algeria (from 26% to 44% depending on the region)[11], lower than in Oman (33.3%)[13], similar to Kenya (24.8%)[14], Nepal (25.7%)[15] and higher than in Bolivia (17.5%)[16]. The prevalence of diabetes (8.8%) was similar to the 2003 Algerian sub-regional STEPS survey (10.0%)[8], lower than national and regional recent estimates in Algeria (≥12%)[10,11], and the Oman STEPS survey (11.8%)[13], but higher than in Kenya (2.6%)[14], and Nepal (3.6%)[15]. The prevalence of elevated total cholesterol (≥200 mg/dL (18.2%) was lower than in the 2003 Algerian sub-regional STEPS survey (≥190 mg/dL, 45.4%)[8], higher than in a local survey in Algeria (Tlemcen) (6.6%)[9], and lower than in Lebanon (65.4%) among Lebanese and 48.8% among Syrian refugees)[12], and in Oman (≥190 mg/dL, 35.5%)[13].

Sociodemographic factors may elevate NCD risks in certain sub-populations, given the variations observed. The study found that sociodemographic factors (male sex, younger age, and lower level of education) increased the likelihood of current tobacco use. Higher level of education was protective against insufficient FV intake. Older age, female sex, higher level of education, and urban residence increased the odds of low PA. In terms of biological NCD risk factors, older age was positively associated with being overweight/obese, hypertension, diabetes, and elevated total cholesterol. This might be attenuated by aging, which is associated with the deterioration of the body's immune system and thus increases the risk of various diseases. Older adults and those living in urban areas should be targeted in the early detection and management of NCD risk factors in Algeria and other African countries[28]. The female sex was positively associated with being overweight/obese and elevated total cholesterol. Similar results were found in the Kenya STEPS survey[15]. Women may have higher rates of being overweight/obese than men due to biological, comorbidity, and lifestyle factors[29,30]. Moreover, the study by Houti et al.[31] reported that 32.5% of Algerian women had more than four pregnancies and 26.6% were in menopause, which might also contribute to excessive weight gain and increased risk of being overweight/obese. In targeting interventions, these sex differences should be considered[31] because of the physiological and physical structure differences in each sex. Regarding the eight NCD risk factors evaluated, older age and urban residence were associated with a higher number of NCD risk factors. This study reaffirms the Algerian NCDs 2015–2019 control plan[32], which recommends healthy eating and PA to prevent being overweight or obese, as well as education and screening programs. Hence, the ability and success in preventing NCDs and associated risk factors will contribute greatly to achieving the sustainable development goal of reducing the premature deaths attributed to NCDs by 2030. This study will improve, inform, and guide the decision-making of the policymaker and the implementation and evaluation program, by collaborating to provide valuable evidence and generate new knowledge for the body of scientific research.

Strengths and limitations

The findings of this study should be interpreted within its strengths and limitations. The first strength of the study is that it utilized a relatively larger sample size of a nationally representative sample of adults in Algeria. The analysis focused on the main NCD risk factors identified by WHO in the global action plan for NCDs; these findings are vital in policy evaluation and formulation within Algeria. By identifying the determinants of the NCD risk factors, this analysis offers opportunities for informing the public health response to NCDs in Algeria. The use of secondary data allows for the optimization of existing data to inform programs and policies since, in most cases, existing data are underutilized. Study limitations included the cross-sectional design, which precludes causative inferences. Additionally, self-reporting for some variables, such as

physical activity, smoking, and alcohol use, as well as dietary habits, were liable to information and recall bias due to ethnicity, language, education, and health status. However, the Global Physical Activity Questionnaire used in the WHO STEPwise survey has been validated and found suitable and acceptable for monitoring physical activity in population health surveillance systems in developing countries[33]. Several outcome variables were measured, such as fasting blood sugar, lipids, blood pressure, and waist circumference. The variable on household income had too many missing cases and was therefore excluded from the analysis.

CONCLUSIONS

In this national sample of adults in Algeria, almost half of the participants had three or more prevalence of behavioral and biological NCD risk factors (inadequate FV, overweight/obese, low PA, hypertension, and tobacco use). Males were at greater risk of current tobacco use, and women were at greater risk of low PA, being overweight/obese, and elevated total cholesterol. Increased multisectoral NCD risk reduction strategies are needed in Algeria. The results of the current study will assist in providing up-to-date data on NCDs and related risk factors to strengthen and improve the effectiveness of the existing policies and intervention programs to predict and track future NCD risk factors for better management and prevention strategies in Algeria.

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All authors: conception and design, acquisition of data, or analysis and interpretation of data, and drafting the article or revising it critically for important intellectual content: All authors read and approved the final version of the manuscript.

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