Assessment the Influence of Tobacco Use on Blood Cadmium Levels among JIJEL University Students

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Abstract : Nowadays, smoking is increasingly associated with young people. Smoking, a form of nicotine addiction, is considered a disease and usually begins in high school or college. Cadmium is a heavy metal found in cigarette smoke, which can be extremely harmful.

The aim of this study was to evaluate the influence of smoking on blood cadmium levels in 15 smokers and 15 non-smokers students who were chosen from Jijel University in Northeast Algeria, and to evaluate the most common associated risk factors. Blood cadmium levels were determined using Flame Atomic Absorption Spectrometry (FAAS). In parallel, the questionnaire was carried out to estimate the relationship between these levels and the associated risk factors, , which included questions about age , smoking status of student, smoking status of entourage, smoking history (age when started smoking and daily average number of cigarettes smoked) and state of health.

The results showed common to alarming blood cadmium level for all smokers and non- smokers students; nevertheless, smokers levels are substantially higher—with a geometric mean of 82.52µg/l—than those of non-smokers (67.97µg/l). Correlation tests showed that among smokers, age at smoking initiation and type of consumption were the most common risk factors. In contrast to non-smokers, entourage was the most associated risk factor.

Keywords: - Smoking; smoker's students; blood cadmium level; Risk factors; Jijel University.

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Introduction

According to the World Health Organization (WHO) definition in 1957 which qualifies the smoking syndrome as «a state of periodic or chronic intoxication caused by the repeated consumption of tobacco (natural or synthetic)» [1].The tobacco epidemic, especially use among young people, is one of the biggest public health threats the world has ever confronted, murdering over 8 million individuals a year around the world. Further than 7 million of those deaths are the result of direct tobacco consumption while around 1.3 million are the result of non-smokers being exposed to second-hand smoke [2].

In Algeria, the prevalence of current smoking tobacco use is 16.5%. It is 32.2% for men and 0.4% for women. The average daily consumption of manufactured smoked tobacco is 15 cigarettes per day [3]. Smoking causes 15,000 fatalities in Algeria annually, with 40 smokers dying before their time each day [4].

There are over 7000 chemicals in tobacco smoke, at least 69 of which are carcinogenic [5]. Each time someone smokes, the chemicals that build up are split up among various components, such as mainstream smoke, sidestream smoke, exhaled MS [6], secondhand smoke, and thirdhand smoke [7,8]. Cadmium (Cd) is one of the most worrisome and toxic chemicals found in tobacco cigarette smoke. This can be explained by the tobacco plant's (Nicotiana tabacum L.) ability to accumulate Cd in its leaves, which it takes from contaminated soil. Due to the intensive use of chemical fertilizers in tobacco plants [9], cigarettes contain cadmium at concentrations ranging from 1.56 to 1.96 µg/cigarette [10]. Therefore, it is commonly known that smoking is the primary way that the general public gets exposed to cadmium [10, 11]. Numerous investigations have demonstrated that cigarette smoke is a source of cadmium in the blood, tissues, and organs of the human body [12, 13, 14].

Cadmium, a non-essential, potentially toxic metal, accumulates in human tissues with increasing age. It is classified as an IARC group 1 human carcinogen [15]. Consequently, cadmium is extremely harmful to the renal, skeletal, neurological, respiratory, and cardiovascular systems [16]. A higher prevalence of peripheral artery illness is significantly correlated with elevated blood cadmium levels [17]. Pancreatic cancer has been associated with smoking and elevated urine cadmium levels [18]. Moreover, it is suggested that elevated cadmium/zinc ratios in smokers' serum are a key factor in predicting their probability of developing prostate cancer [19].

Worldwide, data on cadmium uptake in the general smoking and non-smoking population are widely available. On the other hand, and to our knowledge, this is the first preliminary biomonitoring study of biological cadmium concentrations in a general smoking and non-smoking population in Algeria, and more precisely in Jijel.

First, we measure the level of cadmium in the whole blood of volunteer students to examine the impact of smoking on blood cadmium levels in the University of Jijel student population. Through

an epidemiological analysis, the second strategy aims to evaluate the relationships between blood levels of cadmium and the most influential risk factors, including age, smoking status, and entourage effect.

Materials and methods

Ethical approval

The Department of Molecular and Cell Biology Department, *Faculty of Nature and Life Sciences*, University of Jijel, was given ethical approval. Every participant filled out an informed permission form, and all human blood samples were examined at Jijel University.

Epidemiological survey questionnaire

This is a smoking risk study on blood cadmium levels with two groups of volunteers (control and exposed). The methodology adopted is that of an epidemiological study that took place between 15 April and 15 May 2023 on students from the University of Jijel chosen at random.

All participants received a multiple-choice questionnaire to assee their age, gender, smoking status of student, smoking status of entourage, smoking history (age when started smoking and daily average number of cigarettes smoked) and state of health. To ensure data quality, we collected data through face-to-face interviews.

The study was carried out at Mohammed Seddik Benyahia University, in Jijel. Currently Jijel University is divided into two sites: Tassoust University and Jijel Central University. This year, the last site (the site of present study) hosts a total of 7,716 students [20]. Jijel is a city in the northeast region of Algeria. With more than 634,412 inhabitants. It is 360 km from the capital Algiers. It spreads over an area of 2,577 km², with a seafront of 120 km [21].

Blood sampling

A venous blood students samples were collected, from preventive medicine section of the University of Jijel, in 4 ml of tetra-acetic acid ethylene diamine (EDTA) as an anticoagulant. In order to prevent micro-clots from forming, the samples are homogenized with mild agitation. Blood samples for cadmium analysis were frozen (–20°C) until analysis in isothermal pouches in the toxicology laboratory at Jijel University.

Sample Extraction

In order to mineralize whole blood, two milliliters of 10% triton x-100 and one milliliter of 10% ammonium phosphate solution are added to one milliliter of blood in a test tube. Finally, the volume was adjusted to 05 ml with the bidistilled water.

All of the samples were dried by evaporation in a sand bath beneath the hood, and the dried residues were then removed and filtered in 04 milliliters of bidistilled water. Blood extracts were kept until the day of analysis at 4°C in a freezer [22].

Blood cadmium determination

After mineralization, cadmium determination in the specimens was carried out using Flame Atomic Absorption Spectrophotometry (FSAA); model SAA-6800 (Shimadzu®, Tokyo,

Japan), under the conditions described in Table 1. The limit of detection (concentration of an element that gives a signal equal to three standard deviations of the background noise) varied from 0.001 to 0.02 µl with an accuracy of 1 to 2 % on relative error.

Table1. FAAS measurement conditions

Parameters / Metals	Wave length (nm)	Light intensity (mA)	Slit width (nm)	Burner height (mm)	Fuel gas (C2H2) flow (l/min)
Lead (Pb)	283.3	10	0.5	7	**0.8**
Cadmium (Cd)	228.8	8	0.5	7	**0.8**
Copper (Cu)	324.7	6	0.5	7	**0.8**
Zinc (Zn)	213.9	8	0.5	7	**0.8**

The results, extrapolated from a calibration curve, are displayed by the FSAA per µg unit of cadmium per litre of blood (µg/l). Standard solutions of Cd at 1g/l in 0.01 M nitric acid HNO3 65% w/w (SIGMA-ALDRICH, Germany) were used to calculate calibration curves. The standards diluted solutions were prepared with high purity metal, HNO3 and water according to the range of cadmium concentrations commonly encountered in biological matrices.

Statistical analysis

Statistical analyses were carried out using the Statistical Package for the Social Sciences (SPSS, version 20). The dependent variable of this study is the level of cadmium obtained by the blood samples analysis. The descriptive analysis of this variable is presented in the form of arithmetic means and their standard deviation (mean ± SD), geometric means, maximum values, minimum values and percentiles 25, 50; 75 and 90emes at an interval confidence (IC) 95% to better value our results statistically. Correlations tests were studied using the Pearson correlation method. The significance level was set at p-value 0.05. To obtain a general idea of the differences between the levels of cadmium in smokers and non-smokers students according to the different risk factors, nonparametric tests are applied on the results obtained. In addition, multifactor variance analysis was used to study the difference between individuals in each class. The level of significance was set to $p \leq 0.05$.

Results

Characteristics of the study population

The average age of student smokers is 21.13 years with an average age of 22.93 years for non-smoking students and a dominance of young student smokers between 18 and 20 years was recorded. Almost the majority of students who smoke (73.33%) report their passive exposure to tobacco in their immediate environment against only 26.66% are not passively exposed to tobacco smoke in their family environment, while the close entourage of the majority of non-smokers students does not smoke versus a minority smoker. The category of heavy smokers with more than 10 cigarettes per day was recorded with 66.66% compared to smokers who consume between

05 and 10 cigarettes per day (33.33%), while no smoker is limited to the consumption of less than five cigarettes per day. regarding the age at which smoking initiation occurs. Just 20% of student smokers began smoking during their university training, but the majority (80%) began during their their lycian and middel formation training. A marked preference of smokers for smoking cigarettes was recorded in the present study where 86.66% of student smokers report their regular consumption of smoking cigarettes against only 13,33% of students report their use of other different forms of tobacco. Finally, our results showed an absence for almost all students surveyed of the pathologies generally considered related to smoking. Only one exception was reported with epilepsy as a pathology developed by a student smoker.

Blood cadmium levels

Of a total population of 30 smoking and non-smoking students, 100% detection was recorded for blood cadmium levels. The geometric mean blood cadmium of smokers was 82.52 µg/l with a minimum concentration of 52.84 µg/l and a maximum concentration of 116.4 µg/l with a 90th percentile of 106.53 µg/l (fig.1a). Blood level from non-smokers students reached a maximum of 102.84 µg/l and a 90th percentile of 91.92 µg/l with 67.97 µg/l as the geometric mean. The one-factor ANOVA test revealed significant differences between the levels of the smokers and non-smokers students (table 2 and fig.1b).

Table.2. Geometric and arithmetic mean cadmium blood level values of smokers and non-smokers students.

blood Cd level (µg /l)	N	Arith mean± SD	geom mean	Max	Mini	IC 95%		centiles			
						Lower	upper	25th	50th	75th	90th
Smokers	15	84,29 ±17,36	82,52	116,4	52,84	74,67	93,9	71,42	87,11	96,40	106,53
Non-smokers	15	69,31 ±14,42	67,97	102,84	48,91	61,32	77 ,3	59,28	66,06	78,53	91,92
ANOVA P value						0,025 *					

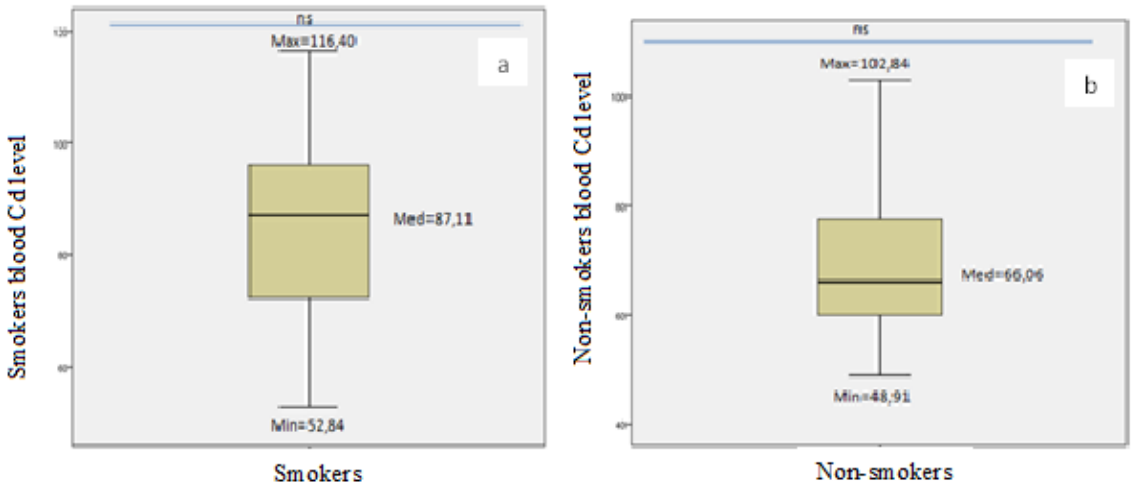

Fig. 1. Blood cadmium levels in smokers (a) and non-smokers students(b).

Relationship between cadmium blood levels and the associated risk factors

According to related risk variables, there are differences in blood cadmium level between students who smoke and those who don't as shown in table 2 and Fig 2.(a) and (b).

The age at which smoking began and the method of consumption are the most important risk factors for smokers' students. These two factors resulted in a substantial increase in blood cadmium levels (p 0.035). The emergence of smoking-related diseases coincided with this increase, which was very significant (p 0,001). There was no statistically significant effect from other factors. The results of the analysis of multiple correspondence (AMC) indicate that there is a significant correlation between blood cadmium levels in smokers and the age at which they started smoking, the frequency of smoking, and the diseases associated with smoking. On the other hand, there is a considerable correlation between the environment and the method of consuming.Only students who have been exposed to passive smoking exhibit noticeably elevated blood cadmium levels among nonsmoking students; blood cadmium levels are not statistically correlated with age or pathology. According to multiple correspondence analysis (MCA), the smoking environment is the main cause of elevated cadmium levels in students who do not smoke.

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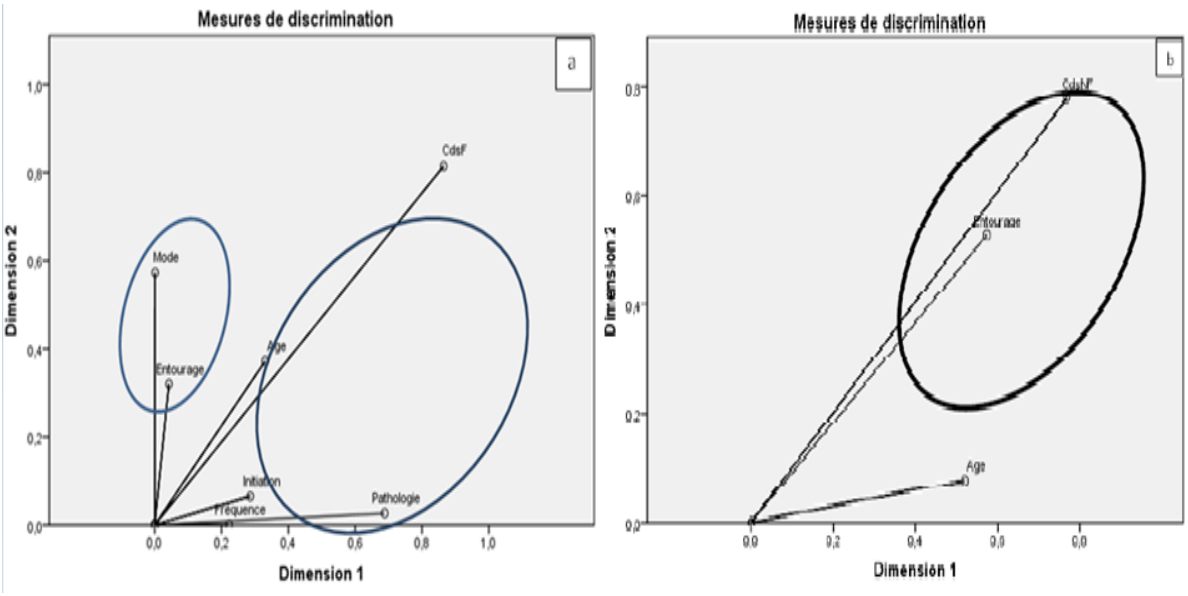

Fig.2. Analysis of the correlation between the blood cadmium level of smoker's (a) and non-smoker's (b) students and the various associated risk factors.

Table.2. Arithmetic means of blood cadmium levels (µg/l) in the smokers and non-smokers students. The data are represented by their average (95% IC) and grouped according to the selected risk factors.

Sujets	Cd mean (95% IC)	
	Smoker's students	Non-smoker's students
Age		
[18.-20]	86,30(65,54-107,07)	-
[21-23]	79,80(65,42-94,17)	66,45(54,72-78,18)

[24-26]	90,68(45,26-136,109)	75,05(65,29-84,80
Non-parametric test	Chi-deux 0,247	Binomial 0,302
Exposure to second-hand smoke and smoking environment		
Smoking entourage	90,33(81,27-99,39)	71,95(60,67-83,22)
Non-smoking entourage	67,66(40,21-95,11)	67,84(55,40-80,27)
Non-parametric test	Binomial 0,118	Chi-deux 0,015*
Means ages of initiation of smoking		
INT 1	86,35(75,19-97,50)	-
INT2	76,05(33,92-118,17)	-
Non-parametric test	Binomial 0,035*	-
Frequency of smoking among smokers		
F1 [01-05] cigarettes	-	-
F2 [05-10] cigarettes	83,42(67,02-99,83)	-
F3 > à>10 cigarettes	84,86(70,00-99,93)	-
Non-parametric test	binomial 0,607	-
consumption mode		
CIG T	66,77 (36,24-97,29)	-
CIG F	88,66(78,59-98,74)	-
Non-parametric test	binomial 0,035*)	-
Pathologies related to smoking		
P1	-	-
P2	-	-
NP	-	69,31(61,32-77,30)
P3	81,99 (73,05-90,93)	-
Non-parametric test	binomial 0,001**	kolmogorov-smirnove 0,978

Adopted threshold of significance P 0.05 for nonparametric tests used. ns = non-significant effect (p>0.05): (*): significant effect (p 0.05). (**): very significant effect (p<0.01), (***): refers to a highly significant effect (p<0.001). INT 1: Before entering university, INT2: During studies, CIG T: Ready-made cigarettes, CIG F: Smoking cigarettes, F1: [01-05] cigarettes, F2: [05-10] cigarettes, F3: to>10 cigarettes, P1: Respiratory pathology, P2: Cardiovascular pathology, P3: other pathology, NP: no pathology.

Discussion

The aim of this study was to determine the cadmium blood levels in smokers and non-smokers students of Jijel University as a biomarker of exposure to both active and passive smoking. Furthermore, we identified the risk factors that may affect cadmium exposure and were most closely linked to the levels of blood cadmium in the selected students using data from epidemiological questionnaires.

First, the data analysis revealed that all participants' blood levels of cadmium, both non-smokers and smokers students were very higher than the minimal detection limit set by the SAAF (2µg/l). Also, the cadmium values found in the blood of non-smokers exceed highly the reference value found in the general population not exposed to smoking (1 µg/l). The finding validates that

this cohort is exposed to cadmium from other sources than cigarettes. Far from being a smoker, there is, in fact, substantial evidence [23] that young children are particularly susceptible to cadmium exposure from the following foods: shellfish, cereals, potatoes, liver and/or other red offal, green salads, leafy greens, nuts, and seeds. The study's authors found that Canadians consumed 0.22 µg of cadmium per kilogram of body weight on average each day through eating.

It should be noted, though, that exposure to passive smoking can also raise blood cadmium levels in non-smokers. The correlation between passive smoking and blood cadmium levels found in this study is in line with the findings of a previous study by Gardner et al. (2016) [23], which found that individuals who had never smoked had significantly higher levels of cadmium due to daily or nearly daily exposure to secondhand smoke at home, in a private vehicle, at work, or in a public place.

Of note, subsequent research has revealed high levels of environmental contamination impacting various environmental components, including the region's sediment and vegetation[24] drinking water [25, 26] and goat milk supplies that include cadmium [27, 28]. So, the sources of this high concentration of Cd in Jijel province, can be due to both natural sources (altered bedrock) and anthropogenic (road traffic, activities related to the Tabellout dam and local farming), also the use of fertilizers in Jijel could be a potential source of Cd contamination [28, 29].

Overall, our investigation showed that smokers had 1.25 times more cadmium in their blood than non-smokers did. Furthermore, these levels are abnormally high and well beyond the 5 µg/l cut-off limit for smokers that have been reported globally in the literature [30]. The same result was observed in the study by (Nicolle-Mir, 2016) [31], where blood cadmium concentrations in non-smokers were found to be 0.13 µg/l, whereas those in smokers were found to be 0.99 µg/l.

Regarding the investigation of the risk factors related to cadmium blood levels, it appeared to be highest in students who smoked between the ages of 23 and 26. However, the age groups included in this study did not differ statistically. More than 73% of smokers students surveyed said that their friends and family smoke. Therefore, our research confirms that the risk of becoming a smoker is closely and promptly related to entourage. Moreover, the number of cigarettes smoked per day had a significant correlation with the highest level of blood cadmium. Our results are in perfect coordination with those of (Hecht et al., 2016) [32]. In the same for former smokers, the number of cigarettes smoked was positively correlated ($p < 0.1$) with blood and urine Cd concentrations [33]. The geometric mean of students who started smoking cigarettes before entering university was superior to that of students who started smoking during studies. A significant association was found between blood Cd and age of onset of smoking experience, this association was also mentioned by the study of [32]. The same finding was also reported in the study of [34], with an increase in average blood cadmium concentration found in all subjects, based on age and duration of smoking. The results of this study show a significant association between blood cadmium and the mode of consumption with a geometric mean of 88.66µg/l for students consuming smoked cigarettes which represent 80%. Last but not least, the small sample sizes and

relatively young volunteer ages may help to explain the lack of smoking-related pathologies in nearly all smokers (apart from one smoker) and all non-smokers in the current study.

Conclusion

Despite the negative effects, smoking is a scourge that keeps becoming worse, especially in emerging nations like Algeria. This research is an initial effort to assess the impact of smoking among Jijel University students on blood cadmium levels and to identify the correlation between these levels and related risk factors. The blood cadmium levels of smokers students were found to be significantly higher than those of non-smokers students. Therefore, smoking-related exposure to cadmium would represent a real health concern for smokers. Nevertheless, these amounts are much more than the reference levels for non-smokers and smokers, indicating concurrent exposure to cadmium from other sources such food and water. Lastly, we conclude by suggesting that public health interventions for young smokers should emphasize smoking cessation in family and social contexts in addition to educational institutions in order to reduce the hazards associated with smoking.

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