Nanotechnology Perceptions
ISSN 1660-6795
www.nano-ntp.com

The Use of Heated Tobacco and the Health Status of Young Adults in Poland- Preliminary Results

Małgorzata Znyk[1], Dorota Kaleta[2]
[1]*Department of Hygiene and Epidemiology, Medical University of Lodz, Poland*
[2]*Department of Hygiene and Epidemiology, Medical University of Lodz, Poland*
[1]*znyk@poczta.onet.pl;* [2]*dorota.kaleta@umed.lodz.pl*

Abstract— *IQOS (I-Quit-Ordinary-Smoking) is the most frequently chosen heated tobacco product among young people in Poland. The study aimed to investigate the effect of IQOS on blood count parameters, biochemical biomarkers, and lipid profile, as well as to make a comparative assessment between people using IQOS, smoking traditional cigarettes, and non-smokers. This case-control study was conducted in 2022-2024 among 85 young people in Poland (Lodz voivodeship) aged 18-30: 29 people using only IQOS, 15 people smoking traditional cigarettes and 41 healthy people not using nicotine products. A 20 ml blood sample was taken and the blood count (WBC, RBC, MONO, PLT, HGB), biochemical biomarkers (CRP, uric acid, fibrinogen, apo A1, apo B, glucose), and lipid profile (total cholesterol, TG, HDL, LDL). There were no statistically significant differences ($p>0.05$) in the level of blood count, biochemical biomarkers, and lipid profile between the three study groups. Among cigarette smokers, the uric acid level was significantly higher compared to IQOS users and non-smokers: 5.47 vs. 4.77 vs. 4.47 mg/dl ($p=0.01$). Among IQOS users ($n=29$), the level of glucose ($r=-0.41$; $p=0.03$) and uric acid ($r=-0.46$; $p=0.01$) was negatively correlated with the daily number of heated tobacco sticks. Further research is necessary to assess the impact of IQOS use on the health of young people.*

Keywords— "*IQOS, smoking, biomarkers, blood count, lipid profile****"***

I. INTRODUCTION

IQOS (I-Quit-Ordinary-Smoking) is the most frequently chosen heated tobacco product among young people in Poland. Worldwide, the tobacco industry is promoting heated IQOS tobacco products as a less harmful product than smoking cigarettes [1]. With the growing number of users of heated tobacco products and the increase in awareness about them, the number of questions about the health effects they may cause is increasing [2-4].

Data suggest that IQOS may encourage non-smoking young adults and adolescents to start using tobacco [5]. To date, individual independent studies have appeared in the world literature on the potential harm of using IQOS. These are mainly short-term health effects [3,4,6-9]. It has been shown that the use of heated tobacco products can cause inflammation and oxidative stress, increase the risk of respiratory infections [3,10], and impair the diastolic and systolic function of the myocardium in the acute phase, similar to conventional cigarette smoking [11,12].

The study aimed to investigate the effect of IQOS on blood count parameters, biochemical biomarkers, and lipid profile, as well as to make a comparative assessment between people using IQOS, smoking traditional cigarettes, and non-smokers.

II. MATERIAL AND METHODS

This case-control study was conducted in 2022-2024 among 85 young people in Poland (Lodz Voivodeship) aged 18-30: 29 people using only IQOS, 15 people smoking traditional cigarettes and 41 healthy people not using nicotine products. The research tool was a standardized questionnaire taking into account sociodemographic characteristics and information on the use of heated tobacco products. The survey questions were based on the Global Adults Tobacco Survey (GATS) and adapted to the study. Recruitment of people for the study took place via the websites of the Medical University of Lodz and social media. The recruited participants completed the questionnaire on the

first day of the study, and then on the next day of the study they went to the blood collection point (without a meal). A 20 ml blood sample was taken from the subjects and their blood count (WBC, RBC, MONO, PLT, HGB), biochemical biomarkers (CRP, uric acid, fibrinogen, apo A1, apo B, glucose), and lipid profile (total cholesterol, TG, HDL, LDL). All laboratory tests were performed in the Diagnostic Laboratory of the Bonifratry Hospital in Lodz, by qualified medical staff in accordance with the recommendations of the diagnostic test manufacturers. The study received a positive opinion from the Bioethics Committee at the Medical University of Lodz (RNN/290/21/KE). All recruits gave written informed consent to participate in the study. The study was funded by the National Science Center, research project no. 2021/41/N/NZ7/00020.

Statistical analysis was performed in STATISTICA version 13.3 (StatSoft Poland Inc.). The normality of distributions was tested using the Shapiro-Wilk test. Differences in the distribution of quantitative variables between exclusive IQOS users, the group of traditional cigarette smokers, and the non-smoker group were analyzed using the parametric ANOVA test or the non-parametric Kruskal-Wallis test. If statistical significance was demonstrated, additional post-hoc tests were performed for both tests to distinguish different groups. Spearman's rank correlation was used to analyze the correlation between the level of biomarkers in the blood and the daily number of heated tobacco sticks. Statistical significance was assessed at $p < 0.05$.

III. RESULTS

A. Characteristics of the study population

85 people were recruited for the study. The average age of IQOS users was 20.94 ± 1.45 years, of traditional cigarette smokers 20.93 ± 1.44 years, and of non-smokers 20.86 ± 1.45 years. The majority of respondents were women (72.4% of IQOS users, 53.3% of traditional cigarette smokers, and 85.4% of non-smokers) and single (72.4% of IQOS users, 86.7% of traditional cigarette smokers, and 78.0% of non-smokers). Most people had post-secondary education (58.6% of IQOS users, 53.4% of smokers of traditional cigarettes, and 46.3% of non-smokers) and lived in cities with over 200,000 inhabitants. inhabitants (62.1% of IQOS users, 46.7% of smokers of traditional cigarettes, and 46.3% of non-smokers). The socio-demographic characteristics of the study participants are presented in TABLE I.

TABLE I. Socio-demographic Characteristics of Study Participants

Variable	Daily smokers	IQOS smokers	Non-smokers
	n = 15(%)	n = 29(%)	n =41(%)
Age			
mean ± SD	20.93±1.44	20.94±1.45	20.86±1.45
min-max	18-24	19-25	19-24
Gender			
male	7 (46.7)	8 (27.6)	6 (14.6)
female	8 (53.3)	21 (72.4)	35 (85.4)
Place of residence			
city up to 200,000 residents	6 (40.0)	6 (20.7)	9 (22.0)
city above 200,000 residents	7 (46.7)	18 (62.1)	19 (46.3)
village	2 (13.3)	5 (17.2)	13 (31.7)
Marital status			
single	13 (86.7)	21 (72.4)	32 (78.0)
married	-	-	1 (2.4)
informal, stable relationship	2 (13.3)	8 (27.6)	8 (19.6)
Education			
general or vocational secondary schools	5 (33.3)	12 (41.4)	18 (43.9)
post-secondary	8 (53.4)	17 (58.6)	19 (46.3)

At the time of recruitment, IQOS smokers were smokers of IQOS only (at least 6 months before the start of the study, at least 5 sticks of heated tobacco per day), smokers of traditional cigarettes had smoked at least 5 cigarettes a day for at least a year and had not used any other smoking substitutes

for at least a year. Every second IQOS user consumed 6 to 10 heated cartridges a day. Figure 1 shows the number of IQOS sticks used per day.

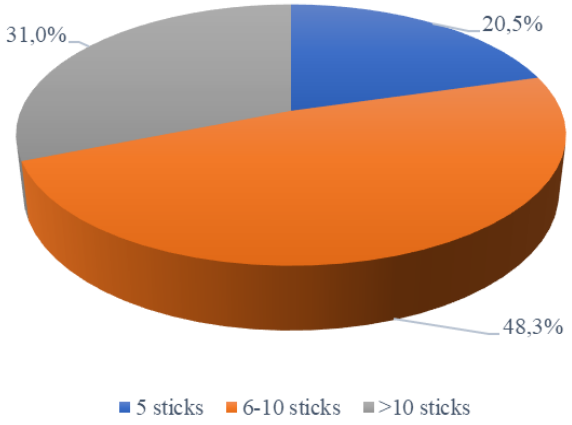

Fig. 1. Number of IQOS sticks consumed daily (n=29).

Most participants had used IQOS for 2 years (41.4%), one-fifth had used IQOS for 3 years, 27.6% had used IQOS for one year, and 10.3% had used IQOS for over 5 years. Figure 2 shows the number of years of using IQOS by study participants.

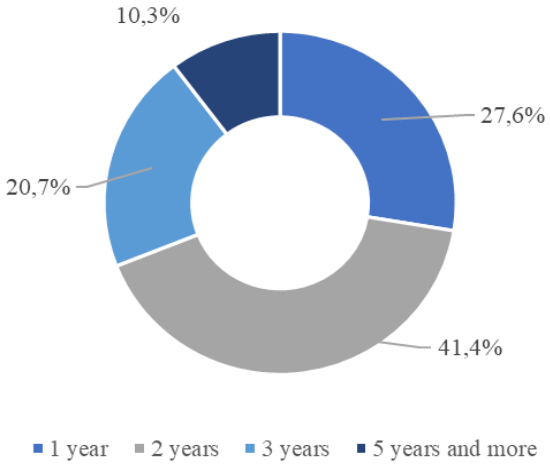

Fig 2. Number of years of using IQOS (n=29).

B. Blood count, biochemical biomarkers, and lipid profile

There were no statistically significant differences ($p>0.05$) in the level of blood count (WBC, RBC, MONO, PLT, HGB), biochemical biomarkers (CRP, fibrinogen, apo A1, apo B, glucose), and lipid profile (total cholesterol, TG, HDL, LDL) between IQOS users who smoke traditional cigarettes and don't use nicotine products. Among cigarette smokers, the uric acid level was significantly higher compared to IQOS users and non-smokers: 5.47 vs. 4.77 vs. 4.47 mg/dl ($p=0.01$). Blood parameters among participants are presented in TABLE II.

TABLE II. Blood Parameters in IQOS Users, Daily Smokers and Non-smokers

	Study group	n	Mean	SD	Median	Min	Max	p
red blood cell count (RBC) [$\times 10^6$/ μL]	IQOS	29	4.76	0.37	4.79	4.26	5.77	0.15
	NS	41	4.62	0.41	4.67	3.97	5.74	
	DS	15	4.76	0.40	4.74	4.20	5.58	
white blood cell count (WBC) [$\times 10^3$/ μL]	IQOS	29	5.86	1.44	5.38	3.51	9.88	0.25*
	NS	41	5.99	1.40	6.02	3.43	11.02	
	DS	15	6.63	1.79	6.08	4.41	9.65	
monocyte number (MONO) [$\times 10^3$/ μL]	IQOS	29	0.49	0.12	0.49	0.28	0.65	0.57
	NS	41	0.50	0.12	0.51	0.29	0.83	
	DS	15	0.58	0.19	0.48	0.28	0.92	
platelet count (PLT) [$\times 10^3$/ μL]	IQOS	29	286.172	68.42	276.00	166.00	422.00	0.12*
	NS	41	259.73	60.85	256.00	162.00	411.00	
	DS	15	282.00	49.99	290.00	218.00	411.00	
hemoglobin concentration (HGB) [g/dL]	IQOS	29	14.23	1.07	14.30	12.70	17.00	0.05
	NS	41	13.52	1.38	13.7	8.60	16.70	
	DS	15	14.14	1.37	14.0	10.9	16.5	
C- reactive protein (CRP) [mg/l]	IQOS	29	1.69	3.29	0.80	0.10	17.60	0.50
	NS	41	1.38	1.94	0.80	0.20	11.50	
	DS	15	1.53	3.06	0.70	0.40	12.50	
uric acid [mg/dl]	IQOS	29	4.77	1.28	4.52	2.71	8.66	**0.01***
	NS	41	4.47	0.87	4.35	2.77	6.82	
	DS	15	5.47	1.35	5.24	2.84	7.66	
fibrinogen [mg/dl]	IQOS	29	240.58	52.09	237.0	172.0	380.0	0.84
	NS	41	239.0	62.18	230.0	157.0	502.0	
	DS	15	232.73	62.21	219.0	140.0	426.0	
Triglycerides (TG) [mg/dl]	IQOS	29	81.66	29.86	70.0	46.0	163.0	0.79*
	NS	41	85.56	42.28	76.0	36.0	187.0	
	DS	15	87.27	60.03	59.0	34.0	271.0	
low-density lipoprotein (LDL) [mg/dl]	IQOS	29	96.55	31.23	91.0	57.0	161.0	0.70
	NS	41	89.29	29.97	87.0	40.0	158.0	
	DS	15	91.33	25.69	96.0	41.0	128.0	
high-density lipoprotein (HDL) [mg/dL]	IQOS	29	61.52	15.03	62.0	37.0	93.0	0.81*
	NS	41	63.68	13.89	63.0	38.0	99.0	
	DS	15	63.4	12.92	64.0	44.0	93.0	
total cholesterol [mg/dL]	IQOS	29	174.34	32.42	168.0	120.0	265.0	0.87
	NS	41	170.07	35.64	170.0	111.0	241.0	
	DS	15	172.47	28.72	172.0	130.0	213.0	
apolipoprotein A1 (apo A1) [g/l]	IQOS	29	1.55	0.29	1.56	1.06	2.25	0.89*
	NS	41	1.57	0.25	1.56	1.14	2.23	
	DS	15	1.58	0.23	1.55	1.28	2.13	
apolipoprotein B (apo B) [g/l]	IQOS	29	0.83	0.23	0.80	0.54	1.39	0.67*
	NS	41	0.78	0.21	0.79	0.44	1.26	
	DS	15	0.83	0.22	0.82	0.50	1.19	
glucose [mg/dL]	IQOS	29	84.3	9.1	83.6	58.6	112.0	0.28*
	NS	41	86.9	5.9	87.0	77.0	99.0	
	DS	15	85.0	5.7	86.0	73.4	94.0	

Legend: Min – minimum; Max – maximum; SD – standard deviation; DS – daily smokers; IQOS – IQOS users; NS – non-smokers; *ANOVA test; significant values are in bold ($p<0.05$).

Among IQOS users (n=29), the level of glucose (r=-0.41; p=0.03) and uric acid (r=-0.46; p=0.01) was negatively correlated with the daily number of heated tobacco sticks (TABLE III).

TABLE III. Correlation Between the Levels of Blood Parameters and the Daily Frequency of Using Nicotine- Nicotine-heated Tobacco Sticks Among IQOS Users (n=29)

	r	p
RBC & daily frequency of using nicotine-heated tobacco sticks	-0.16	0.40
WBC & daily frequency of using nicotine-heated tobacco sticks	-0.33	0.08
MONO & daily frequency of using nicotine-heated tobacco sticks	-0.24	0.21
PLT & daily frequency of using nicotine-heated tobacco sticks	-0.16	0.42
HGB & daily frequency of using nicotine-heated tobacco sticks	-0.35	0.06
CRP & daily frequency of using nicotine-heated tobacco sticks	-0.09	0.64
uric acid & daily frequency of using nicotine-heated tobacco sticks	-0.46	0.01*
fibrinogen & daily frequency of using nicotine-heated tobacco sticks	0.26	0.17
triglycerides & daily frequency of using nicotine-heated tobacco sticks	-0.06	0.75
LDL & daily frequency of using nicotine-heated tobacco sticks	-0.15	0.44
HDL & daily frequency of using nicotine-heated tobacco sticks	0.33	0.08
total cholesterol & daily frequency of using nicotine-heated tobacco sticks	-0.03	0.87
apo A1 & daily frequency of using nicotine-heated tobacco sticks	0.22	0.25
apo B & daily frequency of using nicotine-heated tobacco sticks	-0.16	0.41
glucose & daily frequency of using nicotine-heated tobacco sticks	-0.41	0.03*

Legend: *$p<0.05$; r- the Spearman rank correlation coefficient.

IV. DISCUSSION

This is one of the first case-control studies involving young people, assessing blood counts, biochemical biomarkers, and lipid profiles among IQOS users. Although no statistically significant differences were found in the levels of the analyzed blood parameters, it should be remembered that these are preliminary results, and more advanced analysis will be performed after the research group is closed. Available human research is limited to the short-term health effects of IQOS use. They are based on laboratory measurements after using heated tobacco products [3,4,6-8,10]. In our study, uric acid and glucose levels were observed to be negatively correlated with the number of heated tobacco sticks per day, suggesting a dose-dependent response. This is confirmed by previous results of tobacco research, where the risk of disease is dose-dependent and varies with the number of cigarettes smoked per day [13,14]. Studies show that low serum uric acid levels are associated with a higher incidence of lung cancer and COPD (chronic obstructive pulmonary disease) in cigarette smokers [15]. This study indicates a statistically significant increase in the level of uric acid in people who smoke cigarettes, which may be influenced by diet, dehydration, or alcohol consumption among the respondents. The limitation of the study is the single-point observation. Young people's participation in tests and blood collection points is also low.

Furthermore, due to the limited sample size and the younger age of the study population, our findings should be interpreted with caution and continued in future studies.

V. CONCLUSIONS

There were no differences in the levels of blood counts, biochemical biomarkers, and blood lipid profiles between IQOS users who smoke traditional cigarettes and the group of non-smokers, therefore heated tobacco products may constitute a tobacco product with a modified risk compared to combustible cigarettes. Further research is necessary to assess the health of young users of heated nicotine products.

ACKNOWLEDGEMENT

Funding: This research was funded in whole by the National Science Center, Poland, grant number 2021/41/N/NZ7/00020. For the purpose of Open Access, the author has applied a CC-BY public copyright licence to any Author Accepted Manuscript (AAM) version arising from this submission.

REFERENCES

[1] WHO global report on trends in prevalence of tobacco use 2000- 2025. Geneva. World Health Organization, 2019.

[2] N. Mallock, E. Pieper, Ch. Hutzler, F. Henkler-Stephani, and A. Luch, "Heated tobacco products: A review of current knowledge and initial assessments," Front. Public Health, vol. 7, pp. 287, Oct. 2019.
[3] M. Znyk, M., J. Jurewicz, and D. Kaleta, "Exposure to heated tobacco products and adverse health effects, a systematic review," Int. J. Environ. Res. Public Health, vol. 18, no. 12, pp. 6651, Jun. 2021.
[4] H. Tattan-Birch, J. Hartmann-Boyce, L. Kock, E. Simonavicius, L. Brose, S. Jackson, L. Shahab, and J. Brown, "Heated tobacco products for smoking cessation and reducing smoking prevalence," Cochrane Database Syst. Rev., vol. 1, no. 1, pp. CD013790, Jan. 2022.
[5] S. Li, K. Braden, Y-L. Zhuang, and S-H. Zhu, "Adolescent Use of and Susceptibility to Heated Tobacco Products," Pediatrics, vol. 148, no. 2, pp. e2020049597, Aug. 2021.
[6] M. Jankowski, G. M. Brożek, J. Lawson, Sz. Skoczyński, P. Majek, and J. E. Zejda, "New ideas, old problems? Heated tobacco products- a systematic review," Int J Occup Med Environ Health, vol. 32, no. 5, pp. 595-634, Oct. 2019.
[7] I. Goebel, T. Mohr, P. N. Axt, H. Watz, F. Trinkmann, M. Weckmann, D. Drömann, and K. F. Franzen, "Impact of Heated Tobacco Products, E-Cigarettes, and Combustible Cigarettes on Small Airways and Arterial Stiffness," Toxics, vol. 11, no. 9, pp.758, Sep. 2023.
[8] P. Majek, M. Jankowski, and G. M. Brożek, "Acute health effects of heated tobacco products: comparative analysis with traditional cigarettes and electronic cigarettes in young adults," ERJ Open Res., vol. 9, no. 3, pp. 00595-2022, May 2023.
[9] G. Lyytinen, G. Melnikov, A. Brynedal, E. Anesäter, L. Antoniewicz, A. Blomberg, H. Wallén, J. A. Bosson, L. Hedman, S. Tehrani, and M. Lundbäck, "Use of heated tobacco products (IQOS) causes an acute increase in arterial stiffness and platelet thrombus formation," Atherosclerosis, vol. 390, pp.117335, Mar. 2023,
[10] M. Sawa, A. Ushiyama, Y. Inaba, and K. Hattori, "Increased oxidative stress and effects on inflammatory cytokine secretion by heated tobacco products aerosol exposure to mice," Biochem. Biophys. Res. Commun., vol. 610, pp. 43-48, Jun. 2022.
[11] N. D. Fried, J. D. Gardner, "Heat-not-burn tobacco products: an emerging threat to cardiovascular health," Am J Physiol Heart Circ Physiol., vo. 319, no. 6, pp. H1234-H1239, Dec. 2020.
[12] B. Yaman, O. Akpinar, H. S. Kemal, L. Cerit, Ü. Yüksek, N. Söylemez, and H. Duygu, "Comparison of IQOS (heated tobacco) and cigarette smoking on cardiac functions by two-dimensional speckle tracking echocardiography," Toxicol Appl Pharmacol., vol. 423, pp. 115575, Jul. 2021.
[13] J. T. Chang, G.M. Anic, B. L. Rostron, M. Tanwar, and C. M. Chang, "Cigarette smoking reduction and health risks: A systematic review and meta-analysis," Nicotine Tob. Res., vol. 23, no. 4, pp. 635–642, Mar. 2021.
[14] G. Gallucci, A. Tartarone, R. Lerose, A. V. Lalinga, and A. M. Capobianco, "Cardiovascular risk of smoking and benefits of smoking cessation," J. Thorac. Dis., vol. 12, no. 7, pp. 3866–3876, Jul. 2020.
[15] L. J. Horsfall, I. Nazareth, and I. Petersen, "Serum uric acid and the risk of respiratory disease: a population-based cohort study," Thorax., vol. 69, no. 11, pp. 1021-6, Nov. 2014.

Abbreviations: RBC- red blood cell count; WBC- white blood cell count; MONO- monocyte number; PLT- platelet count; HGB- hemoglobin concentration; CRP- C-reactive protein; TG- triglycerides; LDL- low-density lipoprotein; HDL- high-density lipoprotein; apo A1- apolipoprotein A1; apo B- apolipoprotein B.