

Prevalence of hypertension among chronic smokers: findings from the early lung cancer detection programme MOLTEST BIS

Rozpowszechnienie nadciśnienia tętniczego w grupie przewlekle palących — wyniki programu wczesnego wykrywania raka płuc MOLTEST BIS

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Abstract

Introduction. Arterial hypertension (AH) and cigarette smoking are a leading health and social problem in Polish population. Still around 24% of Poles are chronic smokers. Despite the high risk of cardio-vascular and oncological complications the number of papers assessing wellbeing and health condition of chronic smokers is low.

Material and methods. As part of the Moltest Kardio+ program 425 citizens of pomorskie voivodeship (223 males, 52.47%) were examined. Inclusion criteria were age between 50 and 79 years and history of smoking with more than 30 pack years. Program consisted of one visit during which medical history, anthropometric measurements and three separate blood pressure measurements were taken. The results were then compared to the general population (NATPOL 2011 study).

Results. There were no differences between SBP and DBP values in Moltest Kardio+ and NATPOL 2011 populations. Prevalence of AH was not significantly different in both populations. Significant differences in SBP according to number of pack years were noted. In Moltest study women had significantly lower BMI than those in general population, whereas men's BMI was significantly higher.

Conclusions. Mean SBP and DBP values and prevalence of AH are not significantly different in these two groups. Number of pack years had a significant effect on SBP values in smokers. Entirely opposite relations between smoking and BMI index values were observed in female and male smokers. Higher prevalence of body mass disorders and concomitance of AH and chronic smoking in male smokers resulting in increased cardiovascular risk requires to undertake more intense preventive measures.

Key words: hypertension, smoking, chronic smokers, prevalence, risk factors

*Arterial Hypertens. 2018, vol. 22, no. 2, pages: 74–80
DOI: 10.5603/AH.a2018.0006*

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Streszczenie

Wstęp. Nadciśnienie tętnicze oraz palenie papierosów stanowią istotny problem zdrowotny i społeczny w populacji polskiej. Wciąż około 24% Polaków nałogowo pali papierosy. Mimo wysokiego ryzyka powikłań naczyniowo-sercowych i onkologicznych, istnieje niewielka liczba publikacji oceniających stan zdrowia wieloletnich palaczy.

Materiał i metody. W ramach programu Moltest Kardio+ zbadano 425 mieszkańców (223 mężczyzn, 52,47%) województwa pomorskiego. Do badania kwalifikowano osoby w wieku od 50 do 79 lat, z wywiadem tytoniowym powyżej 30 paczkolet. Badanie składało się z jednej wizyty, podczas której zebrano wywiad, wykonano pomiary antropometryczne oraz 3-krotny pomiar ciśnienia tętniczego. Otrzymane wyniki porównano z populacją ogólną (badanie NATPOL 2011).

Wyniki. Nie zaobserwowano różnic pomiędzy wartościami SBP i DBP w populacji Moltest Kardio+ i NATPOL 2011. Rozpowszechnienie nadciśnienia tętniczego nie różniło się istotnie w obu populacjach. Zauważono istotne statystycznie różnice w SBP w zależności od wypalonych paczkolet. Kobiety z grupy Moltest miały istotnie niższe BMI od kobiet z populacji ogólnej, natomiast u mężczyzn wartości BMI były istotnie wyższe.

Wnioski. Średnie wartości SBP i DBP oraz rozpowszechnienie nadciśnienia tętniczego nie różni się istotnie w badanych grupach. Liczba paczkolet w wywiadzie miała znaczący wpływ na wartości SBP wśród palaczy. Zaobserwowano całkowicie odmienne związki palenia papierosów i wartości wskaźnika BMI u kobiet i mężczyzn. Większe rozpowszechnienie zaburzeń masy ciała i współwystępowanie nadciśnienia tętniczego i nałogowego palenia tytoniu w populacji mężczyzn wymaga wzmoczonych działań prewencyjnych ze względu na wysokie ryzyko sercowo-naczyniowe.

Słowa kluczowe: nadciśnienie tętnicze, palenie, nałogowi palacze, rozpowszechnienie, czynniki ryzyka

Arterial Hypertens. 2018, vol. 22, no. 2, pages: 74–80

DOI: 10.5603/AH.a2018.0006

Introduction

Hypertension is the most common cardiovascular condition, present in about 32% of adult Poles [1, 2]. When untreated, it may lead to severe complications such as coronary artery disease, myocardial infarction, peripheral arterial disease, and stroke. Both hypertension and smoking are modifiable risk factors for cardiovascular disease [3], which remain major causes of mortality among adults despite advances in prevention and treatment. Substances present in tobacco smoke irritate the endothelium and have a proinflammatory and prothrombotic effect, which accelerates development of atherosclerotic lesions [4], and increase the risk of lung cancer and other malignancies. In addition, nicotine present in tobacco activates the sympathetic system, leading to an acute increase in blood pressure and heart rate [5]. However, few studies were reported on the long-term effect of smoking on blood pressure values.

Widespread initiatives aiming to reduce the prevalence of smoking have not yet achieved the desired effects in Poland, with about 24% of adult Poles continuing to smoke [6]. It has been shown that reduction in tobacco use is the most cost-effective strategy to prevent cardiovascular disease [7]. Smoking itself results in a twofold increase in the risk of cardiovascular disease, and this risk is increased four times in the presence of one additional independent risk factor (e.g., hypertension).

The aim of our study was to evaluate the prevalence of hypertension among chronic smokers from the Pomeranian voivodeship who participated in the Moltest Kardio+ programme and to compare these data with the findings in the general population at the same age range (based on the NATPOL 2011 study results) [8].

Material and methods

The present analysis is based on the results of the Moltest Kardio+ research project undertaken in 2016–2017 at the Department of Preventive Medicine and Education, Chair of Hypertension and Diabetology, Faculty of Medicine, Medical University of Gdańsk. Within this project, 425 residents of the Pomeranian voivodeship (223 men, 52.47%) who participated in the lung cancer screening programme (Moltest BIS) undertaken by the Department of Thoracic Surgery at the Medical University of Gdańsk were examined. The study included subjects aged 50–79 years with a smoking history of more than 30 pack-years, including both active and past smokers. Each participant gave a written informed consent for participation in the study. The Moltest Kardio+ research project was approved by the Ethics Committee at the Medical University of Gdańsk (approval No. NKBBN/173/2016). All procedures were performed in accordance with the

Declaration of Helsinki on the treatment of human subjects. The cardiology module of the study was based on a single visit that included history taking based on standardized questionnaire, anthropometric measurements, and 3 blood pressure measurements. The questionnaire included detailed questions on the history of smoking and cardiovascular risk factors including hypertension. Body weight, height, and neck, waist, and hip circumference were measured. Blood pressure measurements were performed during the single visit in accordance with the Polish Society of Hypertension guidelines [9], in the sitting position, on the right arm, and after the subject rested for several minutes. The interval between subsequent measurements was at least one minute. The subjects had to refrain from smoking and drinking coffee for at least 30 minutes before the assessment. Blood pressure measurements were performed using an automated device (UA-787+ Blood Pressure Monitor, A&D Medical), with the mean of the second and third measurement taken as the blood pressure value. For comparison of blood pressure values between the Moltest and NATPOL study population, measurements from only one visit in the NATPOL 2011 study were taken. All the data from NATPOL 2011 study necessary for the purposes of our research, was provided by the authors of afore-mentioned study. The design of the NATPOL 2011 was reported elsewhere [10].

For the purpose of statistical analysis, the study population was divided into three groups based on the number of pack years: Group A ≤ 35 pack years, Group B 36–45 pack years, and Group C ≥ 45 pack years.

Statistical analysis

Statistical analysis was performed using the R statistical package (version 3.2.3).

Qualitative variables were expressed as percentages. Quantitative variables were expressed as the arithmetic mean and 95% confidence interval (95% CI).

Normal data distribution was verified using the Shapiro-Wilk test and by visual interpretation of the Q-Q plot. Variance homogeneity assumption was

verified using the F test and the Brown-Forsyth test, respectively, for two groups and multiple ($n > 2$) groups.

Significance of the effect of a continuous variable in two independent groups was verified using the Student t test or nonparametric Mann-Whitney *U* test. Univariate ANOVA was used for three groups. The Tukey's HSD Tukey was used for post-hoc analysis. Analysis of covariance was used to evaluate the effect of the number of pack years and gender on blood pressure. Age was used as covariate.

Differences between qualitative variables were evaluated using the chi-square test or the exact Fisher test. Research hypotheses were verified using two-sided tests. Statistical significance was set at $P < 0.05$.

Results

The mean age did not differ between the two population both in men (61.67 ± 6.51 years in the Moltest study group vs. 61.29 ± 7.96 years in the NATPOL study group) and in women (61.47 ± 5.91 years in the Moltest study group vs. 62.81 ± 8.14 years in the NATPOL study group).

The mean systolic blood pressure (SBP) was higher in men compared to women (137.0 ± 17.3 mmHg vs. 133.7 ± 18.4 mmHg, $P = 0.03$), while no difference was seen for diastolic blood pressure (DBP) (81.9 ± 6.5 mmHg vs. 80.8 ± 8.9 mmHg, $P = 0.27$) (Table I).

No differences were found between SBP and DBP in the Moltest Kardio+ and NATPOL 2011 study populations. The prevalence of hypertension, defined as SBP ≥ 140 mmHg or DBP ≥ 90 mmHg or use of antihypertensive drugs, did not differ between the two populations in both men (Moltest Kardio+: 67.82% vs. NATPOL 2011: 62.47%, $P = 0.3$) and women (Moltest Kardio+: 56.43% vs. NATPOL 2011: 63.72%, $P = 0.08$). The characteristics of the compared populations are shown in Tables II and III.

Differences in SBP were found in relation to the number of pack years. After eliminating the effect of age, post-hoc tests showed that SBP increased

Table I. Comparison of mean SBP and DBP in men and women in the Moltest cohort

MOLTEST			
	Women	Men	P value
SBP [mmHg] Mean (95% CI)	133.7 (131.1–136.3)	137.0 (134.6–139.2)	0.03
DBP [mmHg] Mean (95% CI)	80.8 (79.6–82.1)	81.9 (80.6–83.2)	0.27

Table II. Baseline characteristic of the study population — WOMEN

Women			
	MOLTEST (n = 202)	NATPOL (n = 576)	P value
Age			
Mean (95% CI)	61.4 (60.6–62.2)	62.81 (62.1–63.5)	0.17
SBP [mmHg]			
Mean (95% CI)	133.7 (131.1–136.3)	136 (134.3–137.7)	0.26
DBP [mmHg]			
Mean (95% CI)	80.84 (79.6–82.1)	82.3 (81.5–83.1)	0.08
BMI			
Mean (95% CI)	27.13 (26.46–27.80)	28.73 (28.28–29.18)	< 0.01
Waist circumference [cm]			
Mean (95% CI)	91.6 (89.9–93.2)	93.6 (92.5–94.7)	0.08
BMI			
20–30 (%; 95% CI)	70.79; 64.00–76.96	62.63; 58.51–66.62	0.04
> 30 (%; 95%CI)	26.73; 20.76–33.40	34.21; 30.32–38.27	0.06
AH* (%; 95% CI)	56.43; 49.30–63.38	63.72; 59.64–67.65	0.08
Pack-years			
Mean (95% CI)	38.1 (36.6–39.6)	10.0 (8.8–11.3)	< 0.01

*SBP \geq 140 or DBP \geq 90 or diagnosed AH; CI — confidence interval**Tabela III.** Baseline characteristic of the study population — MEN

MEN			
	MOLTEST (n = 223)	NATPOL (n = 469)	P value
Age			
Mean (95% CI)	61.7 (60.8–62.5)	61.3 (60.6–62.0)	0.16
SBP [mmHg]			
Mean (95% CI)	137.0 (134.7–139.2)	139.3 (137.5–141.1)	0.24
DBP [mmHg]			
Mean (95% CI)	81.9 (80.6–83.2)	82.8 (81.9–83.7)	0.33
BMI			
Mean (95% CI)	29.45 (28.83–30.07)	28.35 (27.96–28.75)	< 0.01
Waist circumference [cm]			
Mean (95% CI)	105.60 (103.97–107.29)	102.32 (101.31–103.33)	< 0.01
BMI			
20–30 (%; 95% CI)	59.46; 52.68–65.98	63.85; 59.29–68.24	0.29
> 30 (%; 95%CI)	39.64; 33.16–46.40	32.47; 28.21–36.95	0.08
AH* (%; 95% CI)	66.82; 60.22–72.96	62.47; 57.92–66.87	0.30
Pack-years			
Mean (95% CI)	47.0 (44.6–49.3)	21.0 (19.1–22.9)	< 0.01

*SBP \geq 140 or DBP \geq 90 or diagnosed AH; CI — confidence interval

with the number of pack years. A difference was shown between Groups A (< 35 pack years) and C (> 45 pack years) ($P < 0.05$). The difference between Groups A and B was of borderline significance ($P < 0.051$). Such an effect was not shown for DBP (Table IV).

After eliminating the effect of age due to significant differences, analysis of covariance did not show differences in blood pressure (both SBP and DBP) between active and former smokers (Table V).

When comparing the two populations, differences regarding body weight were noted between chronic

Table IV. Comparison of SBP and DBP values in active and past smokers (age adjusted) in the Moltest cohort

	Active smokers		Past smokers		P value
	W	M	W	M	
SBP [mmHg]					
Mean (95% CI)	133.4 (130.7–136.9)	135.6 (133.4–139.4)	134.3 (129.8–137.8)	138.7 (133.7–141.6)	0.19
DBP [mmHg]					
Mean (95% CI)	80.6 (78.7–81.9)	81.6 (79.7–82.7)	81.2 (79.6–83.7)	82.2 (80.9–85.0)	0.65

*P values of Active smokers in general (both women and men) vs Past smokers in general (both women and men) analysis in terms of SBP and DBP respectively

Table V. Correlations between number of pack-years and SBP and DBP values in study cohort (Moltest)

	Pack-years			P value	Post hoc P value		
	≤ 35 (A) (n = 174)	36–45 (B) (n = 130)	45 (C) (n = 121)		A vs B	A vs C	B vs C
SBP [mmHg]							
Mean (95% CI)	132.5 (130.0–135.0)	137.4 (134.2–140.5)	137.6 (134.1–141.1)	0.02	0.051	0.045	0.99
DBP [mmHg]							
Mean (95% CI)	81.4 (80.1–82.7)	81.2 (79.7–82.7)	81.6 (79.6–83.5)	0.95	—	—	—
Age							
Mean (95% CI)	59.8 (58.9–60.7)	62.3 (61.4–63.4)	63.1 (61.9–64.3)	< 0.01	< 0.01	< 0.01	0.62

smokers and the general population. Women in the Moltest study population had lower body mass index (BMI) compared to those in the general population (27.1 ± 4.8 vs. 28.7 ± 5.5 , $P < 0.01$), while the reverse was true in men (29.5 ± 4.7 vs. 28.4 ± 4.4 , $P < 0.01$).

Discussion

Some studies showed that, paradoxically, active smokers had lower blood pressure values compared to past smokers or never smokers [10, 11]. In our study, SBP and DBP values were not significantly different than these in general population based on NATPOL 2011 (Table II and III). Multiple studies attempted to explain this phenomenon [12]. Despite this, the role of smoking as a risk factor for hypertension remains unclear. Ambulatory blood pressure monitoring (ABPM) showed that over 24 hours, smokers had higher blood pressure values compared to non-smokers but this was not evident in office measurements [13, 14]. These differences may be explained by a short-term effect on the sympathetic system after a cigarette is smoked [15]. This may have no effect on office blood pressure measurements but in heavy smokers, it may affect the mean daytime blood pressure in ABPM. Short-term blood pressure-raising effect of a smoked cigarette might have had no effect on our findings as in the Moltest study, the time from the initial patient presentation

to the first blood pressure measurement was more than 30 minutes and the patients did not smoke during that time.

In our study group, a higher prevalence of hypertension was noted in male smokers compared to the general population (66.82% vs. 62.47%, $P = 0.30$), while hypertension in female smokers was less prevalent (56.43% vs. 63.72%, $P = 0.08$) but these differences were not significant. Considering often contradictory results of previously published studies and trends noted in our analysis, it is worth pursuing research on the associations between smoking and hypertension, as well as comorbidities and cumulative risk factors in this group.

An important rationale for our analysis is the synergistic effect of smoking and hypertension on the risk of cardiovascular events. It has been shown that concomitant presence of smoking and hypertension increases the risk of myocardial infarction and ischemic and hemorrhagic stroke more than it could be expected based on the sum of separate effects of these risk factors [17].

According to the CDC data for 2005–2009, the annual mortality due to smoking-related disease in the United States was 437,000, including 34.52% of deaths due to cardiovascular disease, 29.19% of deaths due to lung cancer, and 22.99% of deaths due to chronic obstructive lung disease [18]. The remaining causes of death included smoking-related malignancies other than lung cancer, other lung disease such as emphysema or pneumonia, and complications of diabetes.

In comparison to other European countries, the prevalence of smoking in Poland, i.e. about 20% depending on the study, which is close to the overall European median. During the last 30 years, the rates of smoking in the Polish population decreased significantly (65% of men and 32% of women in 1980 vs. 32.6% of men and 21.9% of women in 2015) [19]. However, this trend has been halted among women. In 2000–2010, the rate of smoking among men was reduced by 12%, compared to only 3% among women, based on the NATPOL 2011 study findings. As a result, Poland is among countries with the highest rate of smoking among women [20]. Thus, identification of female smokers, monitoring their health status including blood pressure values, and offering support and motivation for smoking cessation seem particularly important.

Multiple studies showed that body weight in regular smokers is lower compared to non-smokers [21, 22]. This is probably related to the actions of nicotine that increase energy expenditure and reduce appetite [23]. In our study, we found the same relation in women, while smoking men had significantly higher body mass compared to the general population. As the number of pack years was higher in men (mean 46.84 vs. 37.19 in women), this might have reflected a special subset of the population engaging in multiple unhealthy behaviours (e.g., smoking for many years, low physical activity, poor diet etc.). Available studies confirm higher BMI in heavy smokers compared to light and moderate smokers [24, 25]. The observed relations deserve further studies and more widespread analyses.

Despite lacking evidence for a direct effect of chronic smoking on the development of hypertension, continuing high prevalence of this habit, its negative effect on life expectancy, and synergistic effects of risk factors in smokers all call for particular attention, educational efforts, and screening in this group in regard to not only malignancies but also cardiovascular disease.

Limitations

Analysis based on blood pressure measurements performed during a single visit was a limitation of our study. It has been shown that blood pressure decreases during subsequent visits, thus reducing the size of the subset with the diagnosis of hypertension [16]. Some subjects would require a second visit to confirm the diagnosis of hypertension. Of note, the Moltest study was performed in voluntarily recruited participants. For this reason, the study cohort might have been characterized by an increased interest in personal health, resulting in a lower prevalence of

hypertension and lower blood pressure values compared to a randomly selected sample, such as the one used in the NATPOL 2011 study.

Conclusions

1. Mean systolic and diastolic blood pressure values did not differ between chronic smokers and the general population.
2. Comparison of the prevalence of hypertension, defined as increase blood pressure values or taking antihypertensive medications, did not show significant differences between smokers and a representative sample of the general Polish population.
3. No differences in the rate of hypertension were noted between active and past smokers. After eliminating the effect of age, our analysis showed higher systolic blood pressure values with an increasing number of pack-years.
4. Different directions of the relation between smoking and BMI were observed in women and men but elucidating the determinants of these relations would require a comprehensive analysis of all risk factors.
5. Due to a higher prevalence of abnormal body mass and concomitant presence of hypertension and chronic smoking in a large proportion of men, this group is at a particularly high risk of cardiovascular disease and should be a target for intensified preventive efforts.

Funding

Study was supported by (1) Medical University of Gdańsk, Faculty of Medicine, Department of Preventive Medicine and Education statutory work means, and (2) Medical University of Gdańsk, Young Scientist's grant.

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