

Tobacco and Alcohol as Factors for Male Infertility – a Public Health Approach

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Research

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Abstract

The study of reproductive characteristics of 430 male subjects of different age, fertility status and educational level who were covered by the program of extracorporeal fertilization at the Gynecological-Obstetric Clinic in Niš, examined knowledge, attitudes and behaviour regarding tobacco and alcohol consumption as predictors of infertility risk.

The **methodology** consisted of analyses of spermiograms and a survey on the patients' reactions to smoking and alcohol use.

Results: Statistical analysis, expressed by Hi-square test and a unilateral regression analysis, yielded the following results: the proportion with higher tobacco consumption and more severe forms of infertility increased significantly with ageing ($p < 0.001$); the highest consumption of daily doses of alcoholic beverages and the incidence of intoxication is with azoospermic patients; the level of awareness of tobacco harmfulness is highest in normozoospermic ones, and the most significant degree of determination to quit smoking in the future is with azoospermic subjects. The determination to quit alcohol in the future does not correspond to the most vulnerable categories of respondents. Belonging to educational groups does not coincide with their expected health behaviour. In all categories of subjects concerning fertility status, smoking was found to be a risk factor for its deterioration. Smokers are 12 times more likely to develop oligospermia than non-smokers (OR 12.331).

Conclusion: appropriate use of health promotion activities in relation to alcohol and tobacco use is through specially designed programs.

Plain English Summary

Health risk factors such as smoking, alcohol and substance abuse, obesity and exposure to the adverse elements of living and working environment are considered to be the dominant risk factors for male infertility today. From the corpus of patients examined by embryologists a sample of 430 male subjects with different fertility rates (oligozoospermia, azoospermia, normozoospermia) was isolated.

In comparison to tobacco consumption in the study population, the smoking frequency was statistically significantly different concerning age ($p < 0.001$). Regardless of the age category involved, awareness on the effect of smoking on one's own health as well as on the health of a female partner concerning pregnancy is consistent ($p = 0.163$). Judging from the answers received regarding the frequency of alcohol consumption, awareness of its effects and plans in relation to future behaviour and its use, no statistically significant differences were found concerning age categories, as shown by the Chi-square test ($p = 0.077$, $p = 0.082$, $p = 0.568$).

It has been concluded that the most appropriate use of health promotion activities in relation to alcohol and tobacco use is through specially designed programs.

Introduction

According to the WHO definition, a man is infertile (sterile) if his sperm parameters are lower than the parameters prescribed by the relevant criteria (1).

The majority of research in developed countries has adopted the view that about 10–15% of couples (one in six) cannot conceive offspring, regardless of whose "responsibility" it is, male or female. These figures are relatively constant and have been a growing problem for individuals, families and communities for decades.

The tendency of male infertility increasing is has been observed in developed countries as well as in our country. At the global level, a wide range of differences between individual WHO regions and at the national level has been identified so that rates of up to 70% of male infertility could be found in the literature (2).

There are numerous causes to male infertility, starting with those that can be obtained by anamnesis and include irregularities in the anatomy of the male genital tract and associated glands, endocrine, genetic immunohistochemical and other factors, for many of which mechanisms of their action are not completely clear (3).

Health risk factors such as smoking, alcohol and substance abuse, obesity and exposure to the adverse elements of living and working environment (4–7) are considered to be the dominant risk factors for male infertility today.

The mechanisms of adverse effects on male fertility caused by the harmful effects of certain ingredients of cigarettes on sperm parameters are complex and include effects on the secretion of reproductive hormones-androgens and testosterone, thereby compromising the impact on spermatogenesis and sperm quality. This causes a decrease in concentration, motility, total sperm count, an increase in intrastructural abnormalities, with an attack on the seminal epithelium, association with oxidative stress and specific metabolic changes Tobacco use is more responsible (than in non-smokers) for the consequences for male fertility status, partner health, pregnancy, and even the possibility of a successful assisted reproduction as well as for future fertility (8–11)

Methodology

From the corpus of patients examined by embryologists at the Obstetrics and Gynecology Clinic in Niš (Department for Assisted Reproduction) due to problems with partner pregnancy, a sample of 430 male subjects with different fertility rates (oligozoospermia, azoospermia, normozoospermia) was isolated.

After a preliminary examination of the semen analysis and obtaining results, compared with the adopted reference values of the individual elements of semen and sperm, a committee chose couples to realize the appropriate assisted reproduction procedure. All respondents were surveyed regarding age, educational

status, knowledge, attitudes, current and further predicted behaviour concerning alcohol and cigarette consumption.

Comparison of response distribution between the studied groups was performed by the Chi-squared test. Unilateral logistic regression was used to determine risk factors for developing a degree of fertility. The hypothesis was tested with a significance threshold of $p < 0.05$. EPI INFO v 7.2.2.6 software was used for statistical processing.

Research Results

The study included 430 subjects, with an average age of 33.98 ± 9.99 years (Min 17, Max 55), with the following age structure: 77 (17.9%) in the group < 21 years, 196 (45.6%) in the group 21–39 years, while 157 respondents belonged to the category over 40 (36.5%).

In the surveyed population, there were 77 students and pupils (17.9%), 65 with completed primary education (15.1%), 159 with completed secondary education (37.0%) and 124 men who have completed higher school or college (28.8%). Such data was not obtained for five subjects (1.2%).

In comparison to tobacco consumption in the study population, the smoking frequency was statistically significantly different concerning age ($p < 0.001$). Regardless of the age category involved, awareness on the effect of smoking on one's own health as well as on the health of a female partner concerning pregnancy is consistent ($p = 0.163$).

When considering answers to questions about the state of awareness of the effects of smoking for fertile health, we registered as "fully" having knowledge about the consequences to the general health of the respondents themselves, as well as their own fertile health due to tobacco consumption and their partners' by providing positive information (at least three pieces of information, with examples regarding male gender: effects on the heart, blood pressure, lungs, potency, fertility, etc., and factors related to females: fertility, pregnancy, fetal status, risks of miscarriage, or bleeding in pregnancy).

Also, there were no statistically significant differences regarding their plans for future behaviour in relation to smoking ($p = 0.134$).

Judging from the answers received regarding the frequency of alcohol consumption, awareness of its effects and plans in relation to future behaviour and its use, no statistically significant differences were found concerning age categories, as shown by the Chi-square test ($p = 0.077$, $p = 0.082$, $p = 0.568$).

Knowledge and awareness of the impact of tobacco on general and fertile health with regard to alcohol consumption is uniform with respect to age categories, that is, there is no statistically significant difference in relation to age ($p = 0.082$) (Table 1).

Table 1
Current behaviour, knowledge and further plans concerning tobacco and alcohol consumption by age category

	Age (years)						χ^2	p ¹
	< 20 %		21–40 %		≥ 41 %			
Current tobacco-related behaviour								
Not smoking	41	23.2	87	27.6	51	38.9	43.43	< 0.001
Up to 10 cigarettes a day	20	42.9	54	44.4	45	51.0		
Up to 2 packs a day	13	2.6	35	17.9	48	8.3		
Over 2 packs a day	0	0.0	5	2.6	13	1.9		
Without response	3	0.0	15	7.7	0	0.0		
Awareness of the effects of smoking on health								
Fully informed about effects on their health	48	42.3	107	70.9	101	77.1	8.78	0.163
Partially informed about effects on their health	25	32.5	81	25.5	50	21.0		
Without basic knowledge	0	0.0	3	1.0	3	0.0		
Without response (unknown)	4	5.2	5	2.6	3	1.9		
For smokers: prediction of behaviour								
Quitting smoking	20	14.3	25	24.0	26	19.7	10.16	0.137
Decreasing the number of cigarettes	21	14.3	44	22.4	44	22.3		
No change in behaviour	27	62.3	24	50.0	17	54.1		
Without response (unknown)	9	9.1	6	3.6	10	3.8		
Current alcohol-related behaviour								
No consumption	25	45.5	59	31.6	54	40.1	11.38	0.077
Up to 2 drinks a day	43	49.4	104	55.1	84	53.5		
Regularly over 2 drinks a day	6	3.9	22	9.2	14	5.7		
Intoxicated at least once a month	1	1.3	8	4.1	3	0.6		
Without response (unknown)	2	0.5	3	0.0	2	0.1		
Knowledge of the effects of alcohol consumption								

¹ Chi-square test

Fully informed about effects on their health	48	62.3	110	66.3	102	77.7	11.23	0.082
Partially informed about effects on reproductive health	24	31.2	67	29.1	42	20.4		
No information	3	0.0	12	1.0	10	0.0		
Without response (unknown)	2	6.5	7	3.6	3	1.9		
Future behaviour concerning alcohol								
Quitting alcohol	6	10.4	20	10.7	22	12.1	4.81	0.568
Decreasing consumption	39	20.8	84	20.9	78	15.3		
No change in behaviour	26	58.4	82	61.7	46	67.5		
Without response (unknown)	6	10.4	10	6.6	11	5.1		
Fertility diagnosis								
Oligospermia	6	7.8	54	27.6	49	31.2	24.08	< 0.001
Azoospermia	1	1.3	14	7.1	14	8.9		
Control group	70	90.9	128	65.3	94	59.9		
¹ Chi-square test								

Statistical indicators on smoking, knowledge of its effects and prediction of further behaviour according to a fertile status of the respondents are as follows: The frequency of smoking is statistically significantly different in relation to a diagnostic status, with the highest proportion of smokers among infertile subjects.

Awareness of smoking effects was statistically significantly different concerning the study groups ($p = 0.003$). Subjects with normozoospermia were well-informed, while the least informed ones were among the subjects with azoospermia. Intentions for further behaviour in relation to their fertility status differ statistically significantly ($p < 0.001$), with the majority of subjects in the control group not intending to change their behaviour, with a significantly smaller proportion of subjects with azoospermia not intending to change their behaviour.

The majority of subjects with azoospermia planned to quit smoking completely, while oligospermic patients were more likely to express themselves in terms of reducing their consumption.

The incidence of alcohol consumption is statistically significantly different in relation to the diagnoses tested, with the least frequent consumption in people with normozoospermia. Azoospermic patients have more than 2 drinks a day regularly, while almost a third of this category get intoxicated.

Knowledge of the effects of alcohol was statistically significantly different from fertility diagnoses ($p < 0.001$). The category of normozoospermic subjects had full knowledge about health effects.

Future alcohol-related behaviour was statistically significantly different in relation to diagnoses ($p < 0.001$). The majority of subjects with azoospermia (one in two) spoke in favour of quitting alcohol completely, while the majority of those with oligospermia stated they would decrease consumption of alcohol in the future (Table 2).

Table 2

Frequency of smoking and alcohol consumption, awareness on health effects of smoking and the further behaviour in the study population in relation to diagnoses

	Dg						χ^2	p
	Oligospermia		Azoospermia		Control group			
Smoking*								
Not smoking	24	4.6	0	0.0	131	44.9	227.78	< 0.001
Up to 10 cigarettes a day	57	49.5	11	37.9	129	44.2		
Up to 2 packs a day	17	36.7	11	37.9	24	8.2		
Over 2 packs a day	3	2.8	7	24.2	0	0.0		
Without response	8	6.4	0	0.0	8	2.7		
Awareness of the effects of smoking on health								
Fully aware	72	66.1	12	41.4	224	76.7	16.10	0.003
Partially aware	32	29.4	8	27.6	66	22.6		
None	5	4.5	9	31.0	2	0.7		
Without response	0	0.0	0	0.0	0	0.0		
Future smoking-related behaviour ¹								
Quitting smoking	16	18.4	12	48.0	31	17.8	37.82	< 0.001
Decreasing the number of cigarettes	47	54.0	17	51.9	49	16.8		
No change in behaviour	24	27.6	0	0.0	29	65.4		
Without response	*	*			*	*		
Alcohol								
No consumption	21	19.3	0	0.0	139	47.6	105.78	< 0.001
Up to 2 drinks a day	72	66.0	10	34.5	148	50.7		
Regularly over 2 drinks a day	13	11.9	12	41.4	5	1.7		
Intoxicated at least once a month	3	2.8	7	24.1	0	0.0		
Awareness of the effects of alcohol on health**								
¹ Chi-square test, *16 respondents did not answer, ¹ out of 233 smokers, 205 (88.0%) answered in relation to further smoking behaviour, **15 respondents did not answer, ¹ 29 respondents did not answer								

	Dg						χ^2	p
	Oligospermia		Azoospermia		Control group			
Fully aware	64	58.7	10	45.5	226	78.2	26.03	< 0.001
Partially aware	29	26.6	18	50.0	66	21.8		
None	1	0.9	1	4.5	0	0.0		
Without response	15	13.8	0	0.0	0	0.0		
Future alcohol-related behaviour ¹								
Quitting alcohol	16	14.7	11	37.9	21	7.2	50.45	< 0.001
Decreasing consumption	31	28.4	4	13.8	46	15.8		
No change in behaviour	53	48.6	7	24.1	212	72.6		
Without response	9	8.3	7	24.1	13	4.4		
¹ Chi-square test, *16 respondents did not answer, χ^2 out of 233 smokers, 205 (88.0%) answered in relation to further smoking behaviour, **15 respondents did not answer, χ^2 29 respondents did not answer								

It was found that there was a statistically significant difference in the incidence of concurrent consumption of cigarettes and alcohol compared to the study groups ($\chi^2 = 91.97$, $p < 0.001$). At the same time, tobacco and alcohol were consumed by all azoospermic subjects, 76.8% of those with oligospermia and the least of controls. (Graph 1).

Smoking awareness is statistically significantly different depending on the level of education ($p < 0.001$). It increases in line with the increase in educational level, but at the same time, there is no statistically significant difference concerning further behaviour related to cigarette consumption. Also, knowledge about alcohol is statistically significantly different in relation to education level ($p < 0.001$), with the highest level of knowledge shown by the most educated respondents. However, the availability of adequate information did not significantly lead to the adoption of healthier lifestyles in relation to the risk factors considered ($p = 0.060$; $p = 0.617$ and $p = 0.742$, respectively) (Table 3).

Table 3
Behaviour, awareness and intentions for future behaviour in relation to education level

	Education level						χ^2	p ¹
	Primary		Secondary		University			
Smoking								
Not smoking	62	43.7	50	31.4	43	33.3	14.972	0.060
Up to 10 cigarettes a day	63	44.4	70	44.0	62	48.1		
Up to 2 packs a day	8	5.6	27	17.0	16	12.4		
Over 2 packs a day	6	4.2	6	3.8	2	1.6		
Without response	3	2.1	6	3.8	6	4.7		
Awareness of the effects of smoking on health								
Fully aware	65	45.8	120	75.5	128	99.2	102.558	< 0.001
Partially aware	71	50.0	39	24.5	1	0.8		
None	2	1.4	0	0.0	0	0.0		
Without response	4	2.8	0	0.0	0	0		
Future smoking-related behaviour								
Quitting smoking	21	14.8	39	24.5	24	18.6	19.664	0.003
Decreasing the number of cigarettes	24	16.9	38	23.9	38	29.5		
No change in behaviour	93	65.5	82	51.6	67	51.9		
Without response	4	2.8	0	0.0	0	0.0		
Alcohol								
No consumption	51	35.9	59	37.1	48	37.2	4.445	0.617
Up to 2 drinks a day	76	53.5	80	50.3	73	56.6		
Regularly over 2 drinks a day	10	7.0	16	10.1	6	4.7		
Intoxicated	5	3.5	4	2.5	2	1.6		
Awareness of the effects of alcohol on health								
Fully aware	64	45.1	115	72.3	126	97.7	94.029	< 0.001
Partially aware	71	50.0	43	27.0	3	2.3		
None	2	1.4	0	0.0	0.0	0.0		
Without response	5	3.5	1	0.6	0	0		

Future alcohol-related behaviour								
Quitting alcohol	15	10.6	20	12.6	15	11.6	3.517	0.742
Decreasing consumption	35	23.9	31	19.5	32	24.8		
No change in behaviour	89	62.7	106	66.7	81	62.8		
Without response	4	2.8	2	1.3	1	0.8		

Logistic regression analysis showed that independent statistically significant risk factors for azoospermia were age, knowledge about smoking and alcohol. For oligozoospermia, statistically significant independent risk factors are age, smoking, and alcohol consumption. The most influential risk factor for oligozoospermia is smoking. Smokers are 12 times more likely to develop oligozoospermia than non-smokers (OR 12.311). Risk factors for disturbed normozoospermia are age, smoking, alcohol consumption, and insufficient knowledge of the effects of alcohol in relation to complete knowledge of the impact of alcohol. For a disorder of normozoospermia, smoking is also the strongest risk factor. Smokers are 14.5 times more likely to endanger normozoospermia than non-smokers (OR 14.493) (Table 4).

Table 4

Risk factors for azoospermia, oligozoospermia and normozoospermia (univariate logistic regression)

Risk factors	Azoospermia			Oligospermia			Control group		
	OR	95%CI	p	OR	95%CI	p	OR	95%CI	p
Univariate model									
Age	1.072	1.026–1.120	0.002	1.053	1.031–1.076	< 0.001	1.069	1.046–1.092	< 0.001
University degree	0.882	0.380–2.046	0.769	1.097	0.712–1.691	0.673	1.056	0.695–1.606	0.797
Smoking	5.911	0.742–47.121	0.093	12.311	6.492–23.344	< 0.001	13.279	7.136–24.710	< 0.001
Awareness of smoking effects									
Fully aware	RC			RC			RC		
Partially aware	2.408	1.090–5.319	0.030	1.399	0.893–2.190	0.142	1.753	1.132–2.715	0.012
None	19.867	1.184–333.271	0.038	2.130	0.132–34.401	0.594			
Alcohol				1.571	1.257–1.963	< 0.001	1.820	1.458–2.272	< 0.001
Awareness on alcohol effects									
Fully aware	RC			RC			RC		
Partially aware	2.808	1.261–6.253	0.012	1.538	0.989–2.390	0.056	1.987	1.290–3.061	0.002
None	22.462	1.330–379.457	0.031	2.211	0.137–35.716	0.576	–		0.999
Multivariate model									
Age	1.255	1.072–1.471	0.005	1.104	1.070–1.138	< 0.001	1.138	1.099–1.178	< 0.001
University degree	1.034	0.139–7.688	0.974	0.704	0.387–1.281	0.251	0.657	0.353–1.225	0.187

OR – odds ratio, 95%CI – 95% confidence interval

Risk factors	Azoospermia			Oligospermia			Control group		
	OR	95%CI	p	OR	95%CI	p	OR	95%CI	p
Smoking	-			16.002	7.850–32.622	< 0.001	22.828	10.70–48.701	< 0.001
Awareness of smoking effects									
Fully aware	RC			RC			RC		
Partially aware	0.172	0.009–3.405	0.248	1.179	0.382–3.643	0.775	0.642	0.195–2.108	0.465
None	-		1.000	43899	0.000–	1.000	-		
Alcohol	-			1.940	1.105–3.404	0.021	2.556	1.414–4.620	0.002
Awareness of alcohol effects									
Fully aware				RC			RC		
Partially aware									
None	5.577	0.321–96.900	0.238	1.103	0.367–3.312	0.861	2.209	0.692–7.053	0.181
Hosmer-Lemeshow test	0.975			0.290			0.718		
OR – odds ratio, 95%CI – 95% confidence interval									

Discussion

Our research was related to aggravating circumstances concerning the emotional and distressing psychological situation of the subjects, especially those who had previously received adverse sperm results, as similar studies (19).

Alcohol

The Special Eurobarometer of 331 Commission reports that alcohol consumption slightly increased in recent years, with the highest rate in Italy, Greece and Portugal (20).

Interpreting the effects of alcohol on male reproduction requires the determination of socially acceptable amounts of standard drinks, that is, a concentration that is not accompanied by adverse effects on testicular metabolism and fetal development (21).

According to a 2013 study of the public health of the population of Serbia, alcohol consumption in our country was estimated by the authors in terms of an increase compared to the previous research period, with 8.3% of men drinking daily. At least once a month, 27% of men were excessively intoxicated, with such behaviour observed in 17% of adolescents (more than 6 drinks in a row). According to WHO, such data are less favourable than in most countries in the surrounding area. As a criterion for medium health risk, our researchers adopted a dose of alcohol: 40 milligrams of ethanol per day and 20 milligrams a day for women (22).

Smoking

Considering the situation in the European region concerning tobacco consumption, WHO reported in 2015 that there were 37% of regular smokers in this territory, with a tendency for an increase, which is linked to the decline in sperm quality by the researchers (23).

The study of the exposure of the population of Serbia to the harmful factors for male fertility over a five-year period through the aforementioned analytical study of the Institute of Public Health of Serbia identified an increasingly important role of adopted lifestyles, among which, in addition to alcohol consumption, is smoking. In Serbia most men smoked during their lifetime, of whom as many as 81.7% were daily smokers, one third smoked every day, with the largest proportion of them at working and reproductive age (45%). Our study shows that smoking consumption is major lifestyle factor on male infertility. In Serbia Republic male infertility in last years is up of 50%, with rising tendency (24).

The WHO comparison used for this study places Serbia 9th in smoking prevalence in the selected countries group (24).

Similar results were obtained in a study in the Canadian and US literature, where respondents were required to identify fertility risk factors from a group of offered risks, including alcohol and cigarette consumption (25, 26).

Health promotion program

Bearing in mind the importance of the considered issues for individuals and society not only globally, but also in our country, in practice, the problem of some couples with male infertility is mostly approached through individual health-promotion activities through sporadic activities. In the field of tobacco smoke protection, only 35.2% of smokers received information on the harmfulness of smoking through counselling work (survey on the health status of the population of Serbia, 2014).

Hofman et al. advocate a health promotion program as the first step to modify behaviour to achieve reproductive success (27) but, there is no single, universally acceptable program (28).

The success of decades of US campaigns with a significant decline in the prevalence of smokers proves the benefit of promoting healthy lifestyles without which the desired protection goals against tobacco would not be achieved (29).

The introduction of up-to-date information technologies (applications for the Internet, CD-ROMs) has contributed to a successful implementation of actions against alcohol abuse in New York (30).

In 2011 Australian government was established fertility health promoting programme, that shows a need of targeted, evidence-based accessible fertility-related information, partnerships with their collaborative activities to up the 5 000 000 user(31).

The above example of health promotion at its best relies on WHO recommendations that require education of population throughout the whole life, as well as training of educators themselves, with an involvement of all segments of the community health (target 3,7 Sexual and reproductive health)(32).

Conclusions

Although the youngest respondents showed the best results in our study, it would be of particular importance that all categories at risk of alcohol abuse and smoking become aware of their consequences to their fertility.

Continuing our research will require comprehensive monitoring and innovation of preventive measures in our area so as to achieve not only raising health awareness and culture, and behavioural changes in terms of abandoning risk factors, but also predicting and increasing possibilities of becoming a parent for male population at an early stage, as well as planning further counselling activities by the health system and the community. To achieve this, it is required to implement a specially designed health promotion program which would be designed and implemented by a multidisciplinary team of experts and scientists following additional procedures involving financial, media and political support.

Declarations

As far as funding is concerned, we authors financed our own research, we had no sponsors for that.

All authors declare they have no conflict of interest.

Marin Bašič designed the research and application of the appropriate methodology. He also researched the results of other (mostly newer) analyzes of the effects of tobacco and alcohol on male fertility. Mirjana Krstić and Jovana Cvetković participated in data collection and the establishment of the research base. Dejan Mitic contributed to the analysis of male infertility on a global and national level.

I enclosed the decision of the ethics committee

I have the approval of all authors that the manuscript may be published

All materials related to the manuscript are available

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Figures

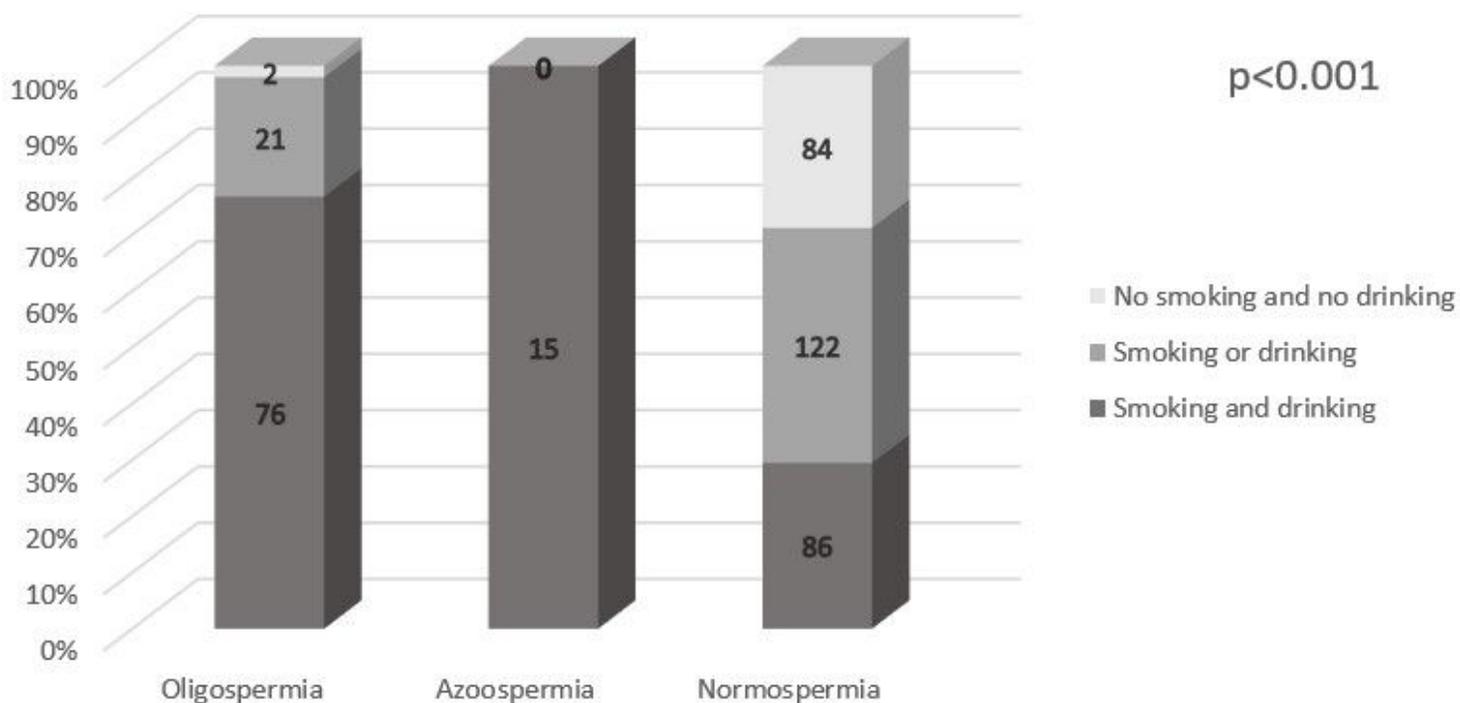


Figure 1

Graphical representation of response structure by observed types of health behaviour