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Wpływ wybranych parametrów stylu życia na liczbę plemników u mężczyzn z niepłodnych par

Influence of selected lifestyle parameters on sperm count in men from infertile couples

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Streszczenie

Wprowadzenie: W ostatnich latach obserwuje się narastający problem niepłodności. Szacuje się, że czynnik męski wynosi od 25% do 30%, a styl życia wydaje się mieć z tym związek. Celem pracy było zbadanie wpływu stylu życia na liczbę plemników.

Materiał i metody: Zrekrutowano 116 mężczyzn z niepłodnych par (w wieku 24 – 52 lat). Wszyscy uczestnicy wypełnili ankiety na temat symptomatologii depresyjnej (Skala Depresji Becka – BDI-II) oraz czynników stylu życia, w tym aktywności fizycznej i seksualnej, picia alkoholu i kofeiny oraz palenia. Wykonano pomiar masy i wzrostu i obliczono BMI (ang. *Body Mass Index*). Oceniono liczbę plemników (koncentracja, całkowita liczba) zgodnie z WHO 2010. Przeprowadzono korelację rang Spearmana i test ANOVA Kruskala – Wallisa oraz iloraz szans (OR). Poziom istotności $p < 0,05$.

Wyniki: Wykazano dodatnią korelację zarówno między całkowitą liczbą i koncentracją plemników, a objętością obu jąder ($r = 0,368$; $r = 0,38$), a także skalą libido ($r = 0,25$). Prawidłowy stan psychiczny (wysokie wyniki BDI-II) dodatnio koreluje z koncentracją plemników. Obserwuje się ujemną korelację między liczbą i koncentracją plemników a spożyciem alkoholu ($r = –0,24$; $r = –0,25$). Czynniki stylu życia mogą zwiększać częstość występowanie oligozoospermii, jak wykazano w analizie OR.

Wnioski: Na podstawie zaprezentowanych wyników wykazano, że niskie libido, otyłość, palenie papierosów, picie alkoholu i kofeiny negatywnie wpływają na liczbę plemników. Znaleziono nową interesującą zależność między liczbą plemników a aktywnością seksualną (libido), która wymaga dalszych precyzyjnych badań.

Abstract

Introduction: In recent years, an increasing problem of human fertility is observed. It is estimated that male factor of couple infertility is between 25% and 30% and life – style factors, seem to take part. The aim of the study was investigation which of lifestyle factor influence on sperm count.

Material and methods: A total of 116 males (age: 24 – 52 years) from infertile couples were recruited. All participants completed interviews about depressive symptomatology (Beck's Depression Scale – BDI-II) and lifestyle factors including physical and sexual activity, alcohol and caffeine drinking and smoking habits. Measurement of weight and height was performed and BMI (Body Mass Index) was calculated. Sperm number (concentration, total count) were assessed according to WHO 2010. Spearman's rank correlation and ANOVA Kruskal–Wallis test and Odds Ratio were performed and considered statistically significant with $p < 0.05$.

Results: The results show a positive correlation between total sperm count, as well as sperm concentration and volume of both testes ($r = 0.368$; $r = 0,38$) and also libido score ($r = 0.25$). Additionally, good mental health (high BDI-II scores) positively correlate with sperm concentration. A negative correlation is observed between total sperm as well as sperm concentration and alcohol consumption ($r = –0.24$; $r = – 0.25$). Lifestyle factors may increase the occurrence of oligozoospermia as has been shown by Odds Ratios analysis.

Conclusions: According to this study low libido, obesity, cigarette smoking, alcohol and caffeine drinking negatively affect sperm count. The new interesting association between sperm number and sexual activity (libido) was find but further research in this field should be conduct.

Słowa kluczowe: styl życia, nasienie, alkohol, palenie, zachowania seksualne, Skala Depresji Becka – II, otyłość, kofeina
Key words: lifestyle, semen, alcohol consumption, cigarette smoking, sexual behavior, Beck Depression Inventory – II, obese, caffeine

Introduction

Couple infertility is becoming a considerable socio-medical problem in all countries but is especially pronounced among highly industrialized ones. In Western countries, the problem of subfertility affects 10 – 15% of all couples trying to conceive [1]. The male factor seems to contribute for up to 25 – 30% of the infertility cases and is most often underestimated [2, 3]. Although such infertility can be diagnosed and successfully treated in some cases, in others, neither diagnostics nor treatment yield positive results. Nevertheless, the first aim in treating male factor infertility, is typically associated with optimizing lifestyle factors.

Several factors relating to general health have been studied for their effects on the male reproductive system, including age, alcohol intake, caffeine consumption, cigarette smoking, psychological stress, depression and many others [4-7]. Overweight and obesity have become one of the most frequent problems in the worldwide human population. In Poland, only 38.4% of men aged 20 – 74 years demonstrate normal body mass while 40.4% are overweight and 20.6 % obese [8], and the problem is growing [9]. On the other hand, regular smoking has fallen from 39.0% of men in 2003 to 29.9% in 2014 [10]. While many factors influencing health are not modifiable, lifestyle may be changed.

The aim of this study was to investigate the incidence of different lifestyle factors and their possible influence on sperm count in men from infertile couples.

Material and methods

Study group

The study was performed with the approval of the Ethical Committee of the Medical University of Lodz, Poland (RNN/311/17/KE). A group of 167 Caucasian men was recruited from infertile couples with a history of at least one year of unsuccessful efforts to conceive. They were referred to the Outpatient Clinic of Andrology and Reproductive Endocrinology in the University Hospital in Lodz, Poland. The applied inclusion and exclusion criteria allowed a study group with a high degree of homogeneity to be formed. From the selected group of patients, subjects with azoospermia, Klinefelter syndrome, testis volume below normal value, genital surgery history, anabolic use or during actual treatment of other disease were excluded. Physical activity related to work or sporting activities was analyzed; athletes were excluded from the study group, and none of the participants declared a complete lack of any physical activity. Finally, 116 men took part in the study. Informed consent was obtained from all participants.

Physical examination was performed by andrologists during the study visit. Testicular volume was assessed with the use of the Prader's orchidometer. Normal testicular volume was considered as 12 – 35 mL [11, 12].

Anthropometric measurements were performed. Body mass index (BMI) was calculated as weight divided by squared height. Overweight was defined as BMI 25 – 29.9 kg/m^2 and obesity as BMI ≥ 30 kg/m^2. BMI < 25 kg/m^2 was classified as the normal body mass.

Semen analysis

A semen sample was collected by masturbation after two to seven days of sexual abstinence in a pre-weighed, disposable container. Manual analysis according to WHO (2010) [13] was performed. Semen volume was calculated from the sample weight, assuming the density of semen to be 1 g/ml. Sperm concentration was evaluated using the Neubauer hemocytometer by one technician under the external quality control. According to the WHO recommendations (2010) semen volume ≥ 1.5 mL, total sperm count ≥ 39 x 10^6/ejaculate and sperm concentration ≥ 15 x 10^6/mL were considered as normal.

Questionnaire

Subjects were asked to fill out a questionnaire to collect information on their psychical / emotional health. The first section examined depression symptomatology using the Beck's Depression Inventory II (BDI-II) [14]. Each question had a set of at least four possible responses, ranging in intensity. The total score, ranging from 0 to 63, was compared against a key to determine the severity of depression. The standard cut-off scores were as follows: 0 – 9 (minimal depression), 10 – 18 (mild depression), 19 – 29 (moderate depression), 30 – 63 (severe depression).

The next part of the questionnaire concerned libido (interest and thoughts about having sex) and the actual frequency of having sex. During the examination, 13 participants refused to provide this information. Thinking about sex more often than once a day was assessed as the maximum score when compared to no thoughts or sexual interests. Similar scoring was used for assessing the actual sexual activity. Another question in this topic concerned a change, or loss, of interest in having sexual intercourse during the previous three-month period. Again, thinking about sex more than once a day was rated as the highest score. Total scores were rated from 2 to 14. A quartile analysis was used to divide scores: lower quartile 2 – 9, median quartile 10 – 12, and upper quartile 13 – 14. Participants with the best results of libido (upper quartile) were used as a reference group in the comparative analysis.

Another part of the questionnaire referred to alcohol, coffee and high-caffeine energy drink consumption, and cigarette smoking habits. The consumption of alcohol in g/week, caffeine intake in cups or cups equivalents/week and cigarette smoking in packs/week (1 pack – 20 cigarettes) were calculated. Index pack-years was calculated as 1 pack-year = smoking 20 cigarettes/day during the year [15]. No heavy smoker with a consumption of more than 20 pack-years, participated in the study.

Because alcohol was consumed in various forms, the alcohol intake was estimated as follows: one glass of beer – 500 ml, 5% alcohol (25 g); one glass of wine – 175 ml, 12% alcohol (16.5 g); one glass of vodka – 40 ml, 40% alcohol (16.5 g). Some participants consumed drinks which were estimated as 50 ml of strong alcohol mixed with a non-alcohol drink or juice, and this was estimated as a 20.6 g alcohol intake. Moderate alcohol consumption was considered when ≤ 70 g of alcohol intake per week was declared, and heavy > 70 g per week [16].

Another part of the questionnaire concerned caffeine intake (coffee and energy drinks included). Daily coffee intake was estimated by assuming a cup containing about 150 mL and the caffeine

content to be 117 mg in one cup [17]. The caffeine content of popular energy drinks in Poland is about 80 mg in one can (250 mL).

Statistical analysis

All statistical analyses were performed using Statistica for Windows software, version 13.0 (StatSoft, Tulsa, OK, USA). The normality of the data distribution was analyzed using the Shapiro-Wilk test. As the results were distributed in a nonparametric manner, they were presented as the mean ± standard deviation (SD), median and range, and the ANOVA Kruskal-Wallis test was used to evaluate the difference between groups. The odds ratio (OR) was calculated to quantify the strength of the association between analyzed parameters. Spearman's R-correlation coefficient was calculated for comparisons between groups. $P < 0.05$ was considered significant.

Results

Study group

The general characteristic of the participants is summarized in Table I. The median age of the participants was 32. Only 22% of men were older than 35 years, thus the study group was rather homogenous in this regard. All of them were Caucasian, and all were inhabitants of the city of Lodz, i.e. living in similar environmental conditions. All participants presented good general health. Of these, 22.2% presented a low volume for both testes (< 24 mL), 36 (31.0%) presented normal BMI, 57 (49.1%) overweight and 23 (19.8%) obesity.

Normal volume of ejaculate (≥ 1.5 mL) was observed in 90.2% of participants, normal total sperm count (≥ 39 million/ejaculate) in 57 (49.1%) and normal sperm concentration (≥ 15 million/mL) in 70 (60.3%).

Questionnaire results

The BDI-II questionnaire was completed by only 90 participants. Most demonstrated minimal BDI-II score (78 men, 86.7%) or mild and moderate depression (12 men, 13.3%). None demonstrated severe depression.

Libido median quartile was represented by 48 participants (46.6%). In addition, 35 participants demonstrated results below the lower quartile (34.0%), and 20 in the upper quartile (19.4%).

Only 11 of responders (9.5%) declared not drinking alcohol (two persons refused to answer). The rest of the study group was divided into moderate (50 men, 43.1%) and heavy (53 men, 45.7%) drinkers. Most of the participants drank beer (50.4%), mixed drinks (32.5%) and wine (8.5%), while strong alcohol was drunk only occasionally (2.6%).

Of the participants, 18.1% (21 persons) declared not using caffeine. Most participants (64.1%) consumed one kind of caffeine drink and 22.2% both coffee and energy drinks. They took caffeine mostly in moderate amounts (10.1 cups equivalent per week, i.e. about 1182 mg of caffeine). In total, 75 participants declared consuming less than three cups/day (64.7%), and 20 (17.2%) reported consuming more than three cups/day (117 mg caffeine per cup or equivalent in other drinks).

Only 21 participants (18.1%) declared cigarette smoking. Most were mild smokers, none declared heavy smoking, considered as more than 20 pack-years. As only a few

Table I. Baseline characteristics of men from the study group (n = 116).

Parameter	Mean ± SD	Median	Range
Age [years]	32.9 ± 4.3	32.0	24.0 – 52.0
Body mass index [kg/m^2]	26.9 ± 3.7	32.0	18.8 – 36.0
Volume of both testes [mL]	32,3 ± 8.6	30.0	20.0 – 65.0
Semen volume [mL]	3.6 ± 1.7	3.3	0.3 – 9.3
Total sperm count [10^6/ejaculate]	87.7 ± 131.9	41.3	0.02 – 805.8
Sperm concentration [10^6/mL]	26.1 ± 37.4	12.0	0.01 – 201
BDI-II [points]	5.6 ± 7.1	3.0	0.0 – 28.0
Libido [points]	11.2 ± 2.3	12.0	2.0 – 14.0
Alcohol consumption [g/week]	92.9 ± 89	66.0	0.0 – 423
Caffeine intake [cups/day]	1.5 ± 1.3	1.0	0.0 – 5.1
Cigarette smoking [packs/week]	0.7 ± 1.9	0.0	0 – 8.8

SD – standard deviation

Table II. Incidence of oligozoospermia (< 39 x 10^6/ejaculate) and low sperm concentration (< 15 x 10^6/mL) in obese, overweight and normal weight men (n = 116).

Body Mass Index (kg/m^2)	Obese	Overweight	Normal
	BMI ≥ 30.0	BMI 25.0 – 29.9	BMI < 25.0
All subjects			
N	23 (19.8%)	57 (49.1%)	36 (31.0%)
Median of total sperm count [10^6/ejaculate]	21.6	41.8	38.2
Range of total sperm count [10^6/ejaculate]	0.1 – 582.9	0.14 – 455.3	0.02 – 500.3
Median of sperm concentration [10^6/mL]	5.7	12.0	12.2
Range of sperm concentration [10^6/mL]	0.06 – 201.0	0.01 – 128.0	0.01 – 156.5
Subjects with low total sperm count			
N	14 (60.9%)	27 (47.4%)	18 (50.0%)
Median of total sperm count [10^6/ejaculate]	9.1	7.4	10.4
Odds ratio*	1.56	0.9	-
ANOVA Kruskal-Wallis (N = 116), H = 0.57, p = 0.75			
Subjects with low sperm concentration			
N	14 (60.9%)	36 (63.1%)	20 (55.5%)
Median of sperm concentration [10^6/mL]	2.9	3.9	4.5
Odds ratio**	1.24	1.37	-
ANOVA Kruskal-Wallis: (N = 116), H = 1.03, p = 0.60			

*-Odds ratio of oligozoospermia in comparison to the group with normal BMI < 25.0
**-Odds ratio of low sperm concentration in comparison to the group with normal BMI < 25.0

Table III. Incidence of oligozoospermia (< 39 x 10^6/ejaculate) and low sperm concentration (< 15 x 10^6/mL) in men (n = 103) with a different score of sexual questioner.

Libido	Lower quartile Score: 2 – 9	Median quartile Score: 10 – 12	Upper quartile Score: 13 – 14
All subjects			
N	20 (19.4%)	48 (46.6%)	35 (34.0%)
Median of total sperm count [10^6/ejaculate]	36.4	17.49	78.0
Range of total sperm count [10^6/ejaculate]	0.3 – 378.0	0.02 – 455.3	1.89 – 582.9
Median of sperm concentration [10^6/mL]	11.15	5.8	26.0
Range of sperm concentration [10^6/mL]	0.2 – 140.0	0.01 – 122.8	0.9 – 201.0
Subjects with low total sperm count			
N	10 (50.0%)	31 (64.6%)	11 (31.4%)
Median of total sperm count [10^6/ejaculate]	9.31	9.3	9.7
Odds ratio*	2.18	3.98	-
	ANOVA Kruskal-Wallis (N = 103), H = 11.4, p = 0.0034		
Subjects with low sperm concentration			
N	15 (75.0%)	31 (64.6%)	14 (40.0%)
Median of sperm concentration [10^6/mL]	5.7	2.6	4.7
Odds ratio**	4.50	2.74	-
	ANOVA Kruskal-Wallis: (N = 103) H = 11.4, p = 0.0033		

*-Odds ratio of oligozoospermia in comparison to the upper quartile group.
**-Odds ratio of low sperm concentration in comparison to the upper quartile group.

Table IV. Incidence of oligozoospermia (< 39 x 10^6/ejaculate) and low concentration (< 15 x 10^6/mL) in alcohol users (n = 114).

Alcohol intake	Heavy alcohol drinkers > 70 g/week	Moderate alcohol drinkers 0 – 70 g/week	No alcohol drinkers
All subjects			
N	53 (45.7%)	50 (43.1%)	11 (9.5%)
Median of total sperm count [10^6/ejaculate]	43.8	32.3	83.9
Range of total sperm count [10^6/ejaculate]	0.04 – 805.8	0.02 – 455.3	2.8 – 322
Median of sperm concentration [10^6/mL]	12.9	11.3	24.0
Range of sperm concentration [10^6/mL]	0.01 – 201.0	0.01 – 122.8	0.3 – 128
Subjects with low total sperm count			
N	26 (49.1%)	26 (52.0%)	3 (27.3%)
Median of total sperm count [10^6/ejaculate]	6.7	10.4	9.5
Odds ratio*	2.57	2.89	-
	ANOVA Kruskal-Wallis: (N = 116), H = 2.97, p = 0.23		
Subjects with low sperm concentration			
N	29 (54.7%)	34 (68.0%)	3 (27.3%)
Median of sperm concentration [10^6/mL]	3.2	5.5	4.5
Odds ratio**	3.22	5.67	-
	ANOVA Kruskal-Wallis: (N = 116) H = 4.31, p = 0.12		

*-Odds ratio of oligozoospermia in comparison to the group with no alcohol users
**-Odds ratio of low sperm concentration in comparison to the group with no alcohol users

Table V. Incidence of oligozoospermia (< 39x10^6/ejaculate) and low sperm concentration (< 15 x 10^6/mL) in caffeine users (n = 116).

Exposition to caffeine)	Heavy cafe users ≥ 3 cups per day	Moderate cafe users < 3 cups per day	No-cafe users
All subjects			
N	20 (17.2%)	75 (64.7%)	21 (18.1%)
Median of total sperm count [10^6/ejaculate]	37.9	30.0	51.6
Range of total sperm count [10^6/ejaculate]	0.4 – 378.0	0.02 – 805.8	0.3 – 338.3
Median of sperm concentration [10^6/mL]	8.6	12.0	15.9
Range of sperm concentration [10^6/mL]	0.01 – 140.0	0.01 – 201.0	0.2 – 115.0
Subjects with low total sperm count			
N	10 (50.0%)	40 (53.3%)	6 (28.6%)
Median of total sperm count [10^6/ejaculate]	16.7	9.6	2.5
Odds ratio*	2.5	2.86	-
	ANOVA Kruskal-Wallis (N = 116), H = 0.45, p = 0.80		
Subjects with low sperm concentration			
N	13 (65.0%)	45 (60.0%)	9 (42.8%)
Median of sperm concentration [10^6/mL]	5.7	3.4	2.6
Odds ratio**	2.48	2.0	-
	ANOVA Kruskal-Wallis: (N = 116) H = 0.42, p = 0.81		

*-Odds ratio of oligozoospermia in comparison to the no caffeine users
**-Odds ratio of low sperm concentration in comparison to the no caffeine users

Table VI. Incidence of oligozoospermia (< 39 x 10^6/ejaculate) and low concentration (< 15 x 10^6/mL) in cigarette smokers (n = 116).

Smoking habits	Smokers	Nonsmokers
All subjects		
N	21 (18.1%)	95 (81.9%)
Median of total sperm count [10^6/ejaculate]	18.4	43.9
Range of total sperm count [10^6/ejaculate]	0.04 – 378.0	0.02 – 805.8
Median of sperm concentration [10^6/mL]	9.2	12.5
Range of sperm concentration [10^6/mL]	0.01 – 140.0	0.01 – 201.0
Subjects with low total sperm count		
N	13 (61.9%)	43 (45.2%)
Median of total sperm count [10^6/ejaculate]	9.3	9.7
Odds ratio*	1.97	-
ANOVA Kruskal-Wallis (N = 116), H = 0.50, p = 0.48		
Subjects with low sperm concentration		
N	13 (61.9%)	54 (56.8%)
Median of sperm concentration [10^6/mL]	2.6	4.2
Odds ratio**	1.23	-
ANOVA Kruskal-Wallis (N = 116), H = 0.50, p = 0,48		

*-Odds ratio of oligozoospermia in comparison to the group of nonsmokers
**-Odds ratio of low sperm concentration in comparison to the group of nonsmokers

patients reported smoking less than once a month, this was not taken into account in the analysis. No one reported smoking e--cigarettes, nor cigars.

Total sperm count and concentration

Total sperm count and concentration in the group with obesity were around half those observed in the normal-weight group, although this difference was not significant (Table II). However, no changes of these parameters were observed in the overweight group. The probability of oligozoospermia in obese man was 1.56 times higher than in men with normal weight; however, this was not observed in the overweight group (OR = 0.9). The probability of low sperm concentration in both study groups was only slightly increased compared to men with normal weight (1.24 for obesity and 1.37 for overweight).

In the presented study no changes in sperm parameters were observed between groups of men with different BDI-II scores.

Positive, statistically significant correlations were observed between libido scores and total sperm number, as well as with concentration. In participants with a libido score in the lower quartile, decreased total sperm count was observed in 50%, and lowered sperm concentration in 75% of cases. In the group of patients with a median libido score, reduced total sperm count and sperm concentration was observed in 64.6% of cases. In group with the best libido score, decreased sperm concentration was observed in 40.0%, and decreased total sperm count in 31.4% of cases. Differences between analyzed groups were statistically significant. The probability of reduced total sperm count and concentration was much higher in groups with a libido score below 13 (OR 2.2 – 4.5) (Table III).

No significant differences in median sperm count were observed between groups who consumed different amounts of alcohol and those who did not drink. Low sperm count and concentration was observed in 27.3% (three cases) of abstainers. 52.0% (26 cases) of moderate drinkers and 49.1% (26 cases) of heavy alcohol drinkers, while decreased sperm concentration was observed in 68.0% (34 cases) of moderate drinkers and 54.7% (29 cases) of heavy drinkers. The obtained OR values suggest that the incidence of low sperm concentration is more likely than low total sperm count in both groups of drinkers (Table IV).

Total sperm count and sperm concentration were not significantly lower in subjects who consumed caffeine than those who did not. Low total sperm counts were observed in approximately 50% of caffeine drinkers from both groups but in 28.6% of non-drinkers. Low sperm concentration was more frequent among caffeine users (60 – 65%) than non-users (42.8%). The probability of low total sperm count and low sperm concentration was about 2.5 times higher in both groups of caffeine users (OR 2.0 – 2.86) (Table V).

Total sperm count and sperm concentration were not significantly lower in smokers than non-smokers (Table VI). Low total sperm count and sperm concentration were observed in 61.9% of smokers, and in 45.2% and 54.8% of nonsmokers (Table VI). The smokers were found to be almost twice as likely to display a decreased total sperm count (OR 1.97).

Correlations

Table VII shows correlations between total sperm count and concentration and the various parameters assessed in this study. A significant positive correlation was found between total sperm count or sperm concentration and the volume of both testes, as well as libido score. The BDI-II score significantly correlated only

Table VII. Results of Spearman's R correlation coefficient between age, body mass index (BMI), testicular volume, alcohol consumption, caffeine intake, libido, BDI-II, and total sperm count and sperm concentration.

Parameter	Total sperm count	Sperm concentration
Age	-0.103	-0.040
BMI	-0.117	-0.147
Volume of both testes	**0.368***	**0.375***
Libido score	**0.250***	**0.250***
BDI-II (points)	0.190	**0.215***
Alcohol consumption	**-0.239***	**-0.247***
Caffeine intake	0.009	-0.013
Cigarette smoking	-0.036	0.020

*P < 0.05

with sperm concentration. Significant negative correlations were found between total sperm count, sperm concentration and alcohol consumption.

Discussion

A decline in the number of sperm in the semen of men on all continents has been observed since the 1940s, with this being particularly apparent among especially those living in regions typified by a high level of industrialized development [18]. Although many potential reasons have been proposed for this decline [19], particularly noteworthy are modifiable factors related to lifestyle, and analyses of their impact on sperm quality may be conducive to establishing better rules of prophylaxis related to male fertility status. The presented study examines some of these factors.

Although excessive alcohol consumption has been implicated as a cause of low sperm count; however, the results of studies are ambiguous. A meta-analysis by Ricci et al. [20] found the most popular form of alcohol consumption in Western Europe is beer, and this is also true for the population of young men in Poland. In the present study, most men reported drinking beer (53%) or mixed drinks (35%), while strong alcohol and wine being drunk only occasionally. Our present findings indicate 2.6 times greater probability of oligozoospermia among heavy drinkers and 2.9 – times greater among moderate drinkers. In the case of sperm concentration, the odds ratios were even higher: 3.2 and 5.7 times higher probability of low sperm concentration in heavy or moderate alcohol drinkers respectively; however, no statistically significant correlation was found. A meta-analysis by Ricci et al. [20] suggested that moderate consumption did not adversely affect semen parameters. Wogatzki et al. [21] report that despite the toxic effect of ethanol and its metabolites, beer and wine also contain polyphenols, such as resveratrol or xanthohuminol, which are known to have strong therapeutic and cell-protective potential. A case-referent study [22] also showed no significant association between sperm parameters and alcohol consumption, while a prospective study by Gaur et al. [23] concluded that oligozoospermia was more common among alcoholics than non-alcoholics. Another cross-sectional study [24] revealed a tendency towards worse semen parameters after higher intake of alcohol during the five days before semen analysis, albeit with no statistically significant dose-response association. In the presented study numerous participants declared drinking alcohol various ways. The combination of strong alcohol (whisky, vodka, etc.) with juice, soda or cola entails the effects of both alcohol and caffeine, or with high levels of sugar, leading to overweight and obesity. Thus, it is difficult to consider the factors action separately. To rule out BMI as a potential factor in the relationsip between alcohol and semen characteristics, the two study groups were compared with regard to the numbers of overweight and obese members. However it was found that the two groups were rather similar in this regard i.e. in the heavy drinker group, there were 22% of obesity and 46% of overweight cases, while among moderate drinkers, there were respectively 15% and 51%. Analysis of the action of alcohol is further complicated by the possibility that libido may be negatively influenced by drinking, as has been clearly shown on an animal model [25]. Additionally logistic regression analysis by Boeri et al. [26] shows that concomitant heavy smoking and heavy alcohol drinking has a detrimental impact on sperm concentration and other parameters.

A number of studies have reported that smoking habits have a detrimental effect on sperm quality, particularly on sperm count, motility and morphology [23, 27, 28]. Analyses on human material were mostly observational and are subject to other risk factors such as age, use of medication and lifestyle, which might affect semen quality. Experimental studies on animals allow research to be conducted without any confounding factors. Exposure to cigarette smoking impaired activity of many enzymes (for example sorbitol dehydrogenase and lactate dehydrogenase), led to accumulation of toxins like benzo(a)pyrene and cotinine and altered receptor activity [29]. It was shown that high doses of nicotine induced a significant decrease in sperm count and motility in prepubertal and adult rats. This reduction of sperm count and motility was reversible in adult, but irreversible in prepubertal rats [27].

Our results indicate that the smokers demonstrated a lower total sperm count than non-smokers but a similar sperm concentration, which suggests a difference in the volume of ejaculate. A prospective study by Liu et al. [30] found a significant negative correlation between cigarette smoking and seminal plasma zinc concentration, a marker of prostate function, which may be the underlying cause of the reduced ejaculate volume observed in our study. The American Society of Reproductive Medicine found smokers to demonstrate 22% poorer semen parameters and sperm function than nonsmokers, with the effects being dose dependent [28]. In Poland, a falling trend in smoking habits has recently been observed, and currently less than 30% of the population are smokers [10]; in the presented study, only 18% of the subjects reported smoking. Although 62% of smokers demonstrated a reduction in total sperm count and sperm concentration, the difference with nonsmoker levels was not significant; however, this may be due to the fact that none of the participants reported heavy smoking. Nevertheless, despite the small number of smokers and the lack of statistical difference between compared groups, oligozoospermia was almost twice as common in the smokers group (OR 1.97).

In 2015, the European Food Safety Authority (EFSA) published their Scientific Opinion on the Safety of Caffeine, advising that caffeine intakes from all sources of less than 400 mg per day, and single doses of 200 mg, do not raise safety concerns for adults in the general population [31]. A cross-sectional study [17] on 2554 men found low to moderate caffeine and cola intake not to be associated with semen quality. High cola and/or caffeine intake was associated with reduced sperm concentration and total sperm count, although significant only for cola. However, a meta-analysis based on 28 papers comprising 19 967 subjects [20] have shown no significant difference in total sperm count and sperm concentration in relation to caffeine intake. In Poland, drinking coffee is popular, and it is comparatively rare to find subjects reporting limited use of caffeine-rich products. In our study, although no significant difference in total sperm count and concentration was found between those who use caffeine and those who do not (Table V), the probability of oligozoospermia

was higher in both groups of caffeine users. Unfortunately, in the group of men drinking more than three cups of coffee equivalents per day, the interpretation of the sperm analysis results is complicated by the fact that only four presented a normal BMI. The questionnaire did not ask about the amount of sugar consumed with the coffee or other caffeinated drinks, and it is possible that high sugar supply may influence the findings. Future studies should examine whether by increased body mass or insulin resistance may influence the relationship between caffeine and sperm quality, as noted in our study, or cola and sperm quality, as noted by Jensen et al [17].

Some studies [32, 33] report a significant correlation between sperm count and obesity, which is clearly summarized by a meta-analyses by MacDonald et al. [34]. A prospective study by Steward et al. [35] found obesity i.e. BMI > 30 kg/m^2 to be independently significantly related to total sperm count. Other studies indicate no significant correlation between BMI and sperm number in healthy patients [32, 33]. In a study conducted on 939 subjects, Povey et al. [22] indicate no significant association between obesity and quality of sperm parameters; however, the investigated group included a number of confounding factors, such as a history of testicular surgery, different ethnicities, and a variety of lifestyle factors including type of underwear. In comparison, while the group used for the present study is smaller, one of its advantages is that it is very homogeneous. No statistically significant relationships were found between BMI and sperm count by correlation analysis; however, the incidence of low total sperm count was 1.6 times higher, and sperm concentration only 1.2 times higher, in the obese group than the normal weight group. Only a small probability of reduced sperm concentration was observed in the overweight group (OR 1.4).

It is possible that oxidative stress, inflammation, and insulin resistance may mediate the influence of obesity on sperm parameters, because they are often present in obese men [36, 37]. In addition, obese man frequently display reduced testosterone serum levels [38], which may also lead to oligozoospermia. Overweight and obesity have been shown to affect Leydig and Sertoli cell functions by GnRH-LH/FSH pulse frequency failure, which have been linked with sex hormone production and sperm maturation [39]. Our findings show a positive correlation between libido and total sperm count and concentration. The group with lower libido was more likely to present low sperm concentration than the group with normal libido. Some experimental studies on animals have shown also that sexual behaviour plays an influential role in harvesting semen of good quality and quantity [40]. In humans, most published studies show a correlation between ejaculatory frequency and sperm count. For instance, an extended two-week period of daily ejaculation has been found to influence seminal parameters and reduce total sperm count, but not sperm concentration, motility or morphology [41]. However, the duration of sexual abstinence just before semen examination is often considered [42], while this value is included in the semen analysis report but it is not the result of the natural need for intercourse, but the required period of sexual abstinence before the examination.

Lower libido may be associated with decreased serum testosterone levels and increased body mass [38, 43, 44]. More studies in this topic apply only the duration of sexual abstinence just before the examination [42], but this parameter is not connected with natural ejaculatory frequency in particular man. In a cross-sectional study on 1683 participants, it was revealed that the combination of lifestyle factors, including BMI, ejaculatory frequency and duration of sexual abstinence among others, could have a detrimental impact on sperm parameters, such as decreased total sperm count and sperm motility [21].

Our present findings do not indicate any association between lowered mood and total sperm count, but mood was found to be associated with sperm concentration. Similarly [45] conclude that depression and anxiety in male patients cause decreased semen volume and sperm density; however, other experimental and clinical studies have associated mood status more with motility and morphology [46, 47]. Deterioration in sperm parameters in post-traumatic stress disorder or major depression was identified in veterans from military service, but these results are probably not applicable in the present group, characterized by milder changes in mood. On the other hand, quality of life has been found to positively correlate with sperm concentration in both normozoospermic and oligozoospermic men [48].

Conclusions

Although many studies have been carried out on the effect of lifestyle factors on sperm quality, it is still difficult to clearly determine which of the factors has the greatest influence on sperm count. Our findings reveal that drinking alcohol and caffeine and smoking may decrease total sperm count and/or sperm concentration. The next harmful factors for sperm parameters seem to be obesity and low libido, but not depressive mood, which may be the result of low testosterone levels. However, different lifestyle factors frequently act together in a cumulative way and may well exert a synergistic influence on sperm condition. Further investigations are needed.

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