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The role of age, environmental and occupational factors on semen density

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Abstract

The problem of effect of the environment on human reproduction has been in the focus of researchers' interest for many years.

Objective: To examine the relationship between semen density in males with reproduction problems, and their age, living and working conditions.

Material and method: The study covered 224 males with reproduction problems. The study had a prospective character and was conducted in three stages – the first stage was carried out using the questionnaire devised by the authors; the second and the third stages consisted in the examination and evaluation of male semen density. Statistical analysis was used to search for the relationship between these groups and variables adopted in the study, i.e. age, occupation performed, place of residence, self-reported housing conditions and material standard, reporting by the males in the study of arduousness of work or health hazards perceived by the males examined, and duration of employment in such conditions.

Results: The males in the study were divided into three groups according to their semen density. Group I (20×10^6 mln/ml or more) included 62 (27.7%) respondents, Group II (below 20×10^6 mln/ml) covered 121 males (54.0%), while Group III (only single spermatozoa or none) – 41 males (18.3%). Male semen density are significantly correlated with men's ages and jobs as well as the general evaluations of the jobs held by the men ($p<0.05$). No significant relationship is observed between living conditions, arduous work conditions and occupational hazards as perceived by males, or duration of employment in such conditions, and male semen density ($p>0.05$).

Conclusions: The results obtained encourage continuation of the studies and cover a larger group of males with reproduction problems.

Key words

male infertility, semen density, environmental and occupational factors

INTRODUCTION

Fertility problems occur in industrialized countries in approximately 10-15% of partners who want to have a baby [1]. In comparison to past decades, increasingly higher importance is attributed to the disorders of reproductive functions in males. It is even estimated that in about 30-50% of the cases these disorders are the main cause of the lack of children in a relationship [1-3].

Semen parameters may deteriorate in various circumstances; however, determination of the actual cause is not easy in clinical conditions. A review of the relevant literature implies that the living conditions of males play a significant role in spermatogenesis and hormonal metabolism disorders due to the pollution of air, water, earth, food, drinks, drugs and/or items in everyday use [4-9]. This is caused by intensive industrialization, urbanization, overpopulation and chemicalization of agriculture. The association between occupation and male fertility has not been fully explained, and has long been of interest to researchers.

The aim of the study was to examine the relationship between the semen density of males with reproduction problems and their age, as well as living and working conditions.

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MATERIAL AND METHOD

The study covered 224 males who reported with reproduction problems (together with their female partners) to the Andrology Consultation Centre of the Andrology and Reproduction Clinic, Medical University of Lublin during the period of one year. The conditions of enrollment into the study group were as follows:

1. Reporting to the Centre for the first time.
2. Making a decision to begin the process of diagnosing and treatment.
3. Consent to participate in the study.

The study was prospective in character and carried out in three stages – the first stage was conducted using a questionnaire devised by the authors; the second and third stages were the examination and evaluation of male semen.

The questionnaire used in the study consisted of two sections. The first section was designed to collect information on respondents' age, place of residence, and self-reported material standard and housing conditions. The second section of the questionnaire contained questions concerning occupational activity, i.e. the occupation performed, evaluation of the workplace, assessment of work in terms of its arduousness and possible health hazards, as well as the duration of employment in years. That latter part of the questionnaire mainly asked about the factors responsible for reduced male fertility, i.e. chemical agents, physical and emotional issues (mentioned in the literature on the subject).

The respondents evaluated their housing and material conditions according to a four-degree scale (4-1). The assessment criteria of housing conditions included: owning a house – 4pts, owning a self-contained apartment – 3pts, sharing an apartment with parents/parents-in-law – 2pts, renting an apartment or a room without access to facilities – 1pt. The evaluation of economic conditions was based upon monthly income per capita: over 1,500 PLN – 4pts., 750 – 1,500 PLN – 3pts., 350-749 PLN – pts, less than 350 PLN – 1pt.

While designing the questionnaire, general methodological guidelines were used, presented in the relevant literature, data from literature, as well as suggestions and comments of experts, including professors of gynaecology, reproductive medicine, sociology and psychology. The stage of preparation of the questionnaire was completed with performing a pilot study among 25 males; the results were eventually excluded from this report.

Before completing the questionnaire, the objective of the study was presented to each male as an undertaking leading to the improvement of care provided for partners seeking help in overcoming difficulties in procreation. The method of completing the questionnaire was explained, and the males were assured that all the information obtained will remain anonymous. The researchers ensured that the respondents were undisturbed when completing the questionnaire and had a sufficient time-limit; additional instructions were given as required (e.g. in the case of problems with understanding the questions).

During the period of diagnosing infertility, male semen tests were performed on each male at least twice, at monthly intervals. Before providing semen samples the males were advised to abstain from sex and alcohol for five days, and reduce the number of cigarettes smoked to a minimum. Semen samples were obtained by means of masturbation into a dry glass vessel. On the basis of initial laboratory testing of the semen density and the norms recommended by WHO [10], the respondents were divided into three groups. Group I consisted of males with semen density of 20×10^6 mln/ml or more; group II – below 20×10^6 mln/ml, and group III – only single spermatozoa or none.

The study results were subjected to descriptive and statistical analyses. The values of the analyzed parameters measured on a nominal scale, were presented by means of numbers and percentage, while on the ratio scale – presented by means of the median (*Me)*, lower and upper quartile *(Q_1, Q_3)*. To evaluate the significance of the differences or relationships between non-measurable parameters analyzed, cross-tabulation and chi-square χ^2 test for homogeneity or independence were applied. For small-size sub-groups (below 5) Yates' correction was used. To compare two dependent groups Wilcoxon signed-rank test was used.

A 5% inference error was assumed and the significance level set at $p<0.05$, indicating the presence of statistically significant differences or relationships [11]. Statistical analyses were performed using computer software STATISTICA v. 7.1 (StatSoft, Poland).

RESULTS

The males in the study were aged 22 - 49 (*Me 31; Q_1* 28; *Q_3 35)*, including 178 (79.4%) under 35 and 46 (20.6%) aged 35 and over.

The males examined represented various occupations. Considering all the jobs mentioned and workplace characteristics, the respondents were divided into two groups:

I. Males who performed occupations associated with an increased risk of occurrence of infertility problems (n=138; 61.6%), i.e. the occupation of a farmer, gardener, driver, locksmith, welder, vehicle varnisher, electronics engineer, electrician, wireman, IT specialist, central heating stoker, baker, fireman, miner, grinder, X-ray technician.

II. Males performing occupations which do not increase the risk of occurrence of fertility disorders (n=86; 38.4%), i.e. the occupation of a lawyer, medical doctor (internal disease specialist, paediatrician), customs officer, waiter, economist, teacher, tailor, constructor, architect, policeman, actor, merchant, labour inspector, office clerk, archivist, watchmaker.

83 (37.1%) males lived in rural areas and 141 (62.9%) were urban inhabitants.

The respondents evaluated their living conditions differently. The mean score values were, respectively – 2.2 (*Me 2; Q_1 2*; *Q_3 3*) and 2.5 (*Me 3; Q_1 2*; *Q_3 3*). The differences in the evaluation of housing conditions and material standard were statistically significant (Wilcoxon signed-rank test: $Z=5.67$; $p<0.000001$), in favour of housing conditions.

During the period of study, the semen parameters were evaluated from 2 - 4 times *(Me 2*; *Q_1* 2; *Q_3 3)*. Based on the laboratory results of semen density, over half of the respondents (121, 54.0%) qualified for group 2, 62 (27.7%) men qualified for group I, and 41 (18.3%) for group III.

Table 1 presents the relationship between age, group of occupation performed, place of residence, self-reported housing and material conditions, and sperm density values.

Age and group of occupation performed significantly differentiated the division of males according to their semen density – $p<0.0000001$; $p=0.02$, respectively. The place of residence and self-reported housing and material conditions were not statistically significant – $p=0.9$; $p=0.78$; $p=0.97$, respectively.

As many as 196 (87.5%) males were in permanent employment, and the remaining 28 (12.5%) had lost their jobs and lived on unemployment benefits (25; 11.2%) or health allowance (3; 1.3%).

While evaluating their workplace, the respondents used two terms: good (n=147; 71.0%) or poor (n=49; 29.0%). This evaluation was significantly related ($p=0.007$) to the division of the males into groups according to semen density.

When describing the type of occupation performed, 78 (39.8%) males reported that their occupations were: hazardous to health, arduous or detrimental and arduous. The occupations were hazardous to health due to constant contact with chemical agents (paint, solvents, varnish, plant protection products and/or fertilizers), indoor dustiness and/or smokiness, high temperature, electric or electromagnetic field, ionizing radiation, heavy metals (lead, magnesium), noise, vibrations and/or humidity. The occupations were arduous because of hard physical effort, exposure to stress, non-standard working hours, shift work, working at a height, working outdoors and/or considerable limitation of physical activity. The duration of employment in arduous or hazardous conditions varied (in this group) from 3 - 14 years (*Me 5; Q_1 3.4; Q_3 6.5)*. The remaining 118 males (60.2%) admitted that, in their opinions, the occupations performed were neither arduous nor hazardous to health.

Table 1. Age, occupation group, place of residence, self-reported housing and material conditions vs. semen density of respondents

Analysed characteristics		Male semen density					
		Group I n= 62; 27.7%		Group II n=121;54.0%		Group III n=41; 18.3%	
		n	%	n	%	n	%
Age	≤ 35 years n=178; 79.4%	47	75.8	112	92.6	19	46.3
	> 35 years n= 46; 20.6%	15	24.2	9	7.4	22	53.7
Statistical significance		χ^2=40.79; p<0.0000001					
Job	Group I n=138; 61.6%	29	46.8	81	66.9	28	68.3
	Group II n=86; 38.4%	33	53.2	40	33.1	13	31.7
Statistical significance		χ^2=8.0; p=0.02					
Place of residence	rural area n= 83; 37.1%	25	40.3	42	34.7	16	39.0
	urban area n=141; 62.9%	37	59.7	72	65.3	25	61.0
Statistical significance		χ^2=0.22; p=0.9					
Housing conditions (evaluation)	1-2 scores n=97; 43.3%	29	46.8	50	41.3	18	43.9
	3-4 pkt. n=127; 56.7%	33	56.2	71	58.7	23	56.1
Statistical significance		χ^2=0.5; p=0.78					
Material conditions (evaluation)	1-2 pkt. n=138; 61.6%	38	61.3	74	61.2	26	63.4
	3-4 pkt. n=86; 38.4%	24	38.7	47	38.8	15	36.6
Statistical significance		χ^2=0.07; p=0.97					

Table 2 presents the relationship between the evaluation of the occupation performed from the aspect of its arduousness and health risk, duration of employment in these conditions, and male semen density.

Evaluation of the occupations performed from the aspect of arduousness and health risk, as well as the adopted division of the respondents' duration of employment in such conditions, did not significantly differentiate the division of the males into groups according to their semen density - p=0.6; p=0.64, respectively.

DISCUSSION

To-date, several dozen physico-chemical agents have been identified which may impair male fertility. This list is still open, as the labour market is constantly changing, new jobs emerge, accompanied by new health hazards [12].

The relationship noted between the age of the males examined and their semen density appears rather obvious (fertility decreases with age) and confirms observations made by other authors [3, 6]. The lack of such a relationship with respect to the place of residence implies that both rural and urban inhabitants can be at risk of infertility.

The division of males according to the occupation performed was made based on literature reports directly or indirectly indicating the relation between a specified occupation and fertility disorders [3, 13-15]. However, the division as described in this article has not been found in available literature.

Table 2. Occupation evaluation with respect to arduousness, health hazards, and time of employment in such conditions vs. male semen density [x]

Analysed characteristics		Male semen density					
		Group I n= 24; 25.5%		Group II n=41; 53.6%		Group III n=13; 20.9%	
		n	%	n	%	n	%
Occupation	Hazardous to health n=34; 43.6%	9	37.5	16	39.0	9	69.2
	Arduous n=23; 29.5%	7	29.2	14	34.1	2	15.4
	Hazardous and arduous n=21; 26.9%	8	33.3	11	26.9	2	15.4
Statistical significance		χ^2=2.74; p=0.6.					
Duration of employment in evaluated conditions in years	≤ 5 years n=31; 39.7%	9	37.5	14	34.1	8	61.5
	6-10 years n=36; 46.2%	12	50.0	21	51.3	3	23.1
	> 10 years n=11; 14.1%	3	12.5	6	14.6	2	15.4
Statistical significance	χ^2=2.52; p=0.64						

[x] The data refer only to the 78 males who described their occupations as arduous and/or hazardous to health.

Nevertheless, it is noteworthy that the results obtained in this study correspond, in a sense, with the observations by other researchers. The literature review indicates that occupations which involve frequent contacts with heavy metals (lead, magnesium), pesticides, solvents and other substances which have estrogenic effect, can contribute to the decrease in male fertility [4, 16-22]. These agents may reduce sperm production, increase the number of defective spermatozoa and decrease androgen production. Exposure to ionizing radiation or high temperature has similar effects [5, 7]. Normal spermatogenesis occurs at a temperature which is 3-4°C lower than the body temperature, and a rise of 1°C in temperature reduces the number of spermatozoa by approximately 14%. Such risks are faced by men working in conditions of elevated temperature, e.g. bakers, welders, metallurgists, cooks, workers in the ceramic industry [7, 15].

Particular attention should be devoted to the group of farmers, whose work is associated with hard effort, non-standard working hours, exposure to changeable atmospheric conditions and agrochemicals [23]. The greatest risk to the fertility of rural males is posed by xenohormones [8]. These are substances with a chemical structure similar to hormones, and which imitate the action of hormones, or can block or oppose their effects. Pesticides are one of the most thoroughly examined xenohormones, and their detrimental effects can disturb all semen parameters. They penetrate into the body through the respiratory system, alimentary system and the skin. They bind with carrier proteins only to a small degree, tend to cumulate, which increases their toxic effect [24]. It is worth emphasizing that the farmers participating in this study ran their own small or medium-sized farms, often using old or even primitive equipment, which they admitted themselves. In such a situation, doubts can arise whether the farmers had adequate protection against chemical agents. This problem, however, lies beyond the scope of this study.

The authors hold differing views on the negative effects of working as a driver on male fertility. Some authors agree

that driving can impair male fertility, especially driving large vehicles, which also include agricultural vehicles and machinery [3]. Others maintain that driving creates risk for male fertility only to a small extent [21]. The representatives of that occupation constituted a considerable percentage of the studied group; however, this percentage was not sufficient to allow drawing conclusions concerning this issue.

Stress has long been considered an important factor conditioning human health, also reproductive health. Its influence on male fertility, however, has not yet been thoroughly investigated [25]. At present, it is accepted that stress is a consequence of procreation problems rather than their cause [26]. Moreover, it is known that stress that accompanies infertility treatment is a significant risk factor which can decrease semen quality [27]. There are reports presenting negative effects of psychological stress on semen density [28, 29].

The lack of significant relationship (in the analysed material) between the incidence of arduousness and health hazards, as well as the duration of employment in such conditions and male semen density, does not exclude the presence of such a relationship. This situation is probably due to the small size of the study group. Analysis of the collected material encourages a certain reflection – were all the examined males aware of the health hazards present at their workplaces? The answer appears to be negative. Such a conclusion is justified by entirely different evaluations of the work performed provided by the representatives of the same occupations, e.g. welders, farmers, electricians, electronic engineers or vehicle varnishers. For this reason, while searching for the causes of male infertility, it is always necessary to make a detailed analysis and evaluation of the working environment, it is not enough to ask only about the occupation performed or the occurrence of health hazards at the workplace. It is better to assume that not all males can evaluate this properly. It has been proved that exposure to the effects of specific physical and/or chemical agents at a workplace may be of considerable importance to, if not the direct cause, of reproductive dysfunctions [3,4].

The study results encourage continuation of the research and covering a larger group of males with reproductive problems.

CONCLUSIONS

1. Male semen density is significantly correlated with age, occupation performed, and subjective general evaluation of the workplace.
2. Living conditions, arduousness and occupational health hazards reported by the males, as well as the duration of employment in such conditions, are not significantly related to their semen density.
3. The results prompt continuation of studies and examining a larger group of men with reproduction problems.

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