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# The Role of Air Quality in Perception of Health of the Local Population

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## ABSTRACT

*The research aim was to investigate and establish the perception of health among population groups with different number of industrial polluters in their living environment. Namely, the Kostrena living area (3250 inhabitants) is situated near big industrial pollutant producers: INA oil refinery Urinj, thermo power plant Rijeka, shipyard »Viktor Lenac«, while in Crikvenica living area such pollutant producers do not exist. In this research 146 subjects from Kostrena participated (74 men and 72 women with age average 40.8, SD 9.2 years), and 157 subjects from Crikvenica area (79 men and 78 women with age average 39.4, SD 10.1 years). The perception of health was measured by the means of SF-36 questionnaire variables. Lung function (FEV1, FVC, FEV 25/75, PEF), cardiovascular function (systolic and diastolic arterial blood pressure, heart rate were also measured, including body proporton measures by the means of waste and hip circumference and silhouette test, in order to establish the eventual objective physical health parametar difference among examined population groups. Subjects from Kostrena perceived their general health, mental health, and vitality worse than subjects from Crikvenica. Group from Kostrena felt themself more limited in their roles due to emotional problems, perceiving more pain than group from Crikvenica. On the opposite site, social functioning of subjects from Kostrena was better in comparison to Crikvenica group. No signifficant differences between groups were found in physical functioning and in role limitation due to physical problems. In addition, there were no signifficant differences between groups in objective physical health parameters, such as pulmonary function, arterial blood pressure, pulse, and waist to hip ratio. Subjects using sensoric systems and the mental cognition about harmful environmental factors, percieve their health worse if there are present industrial resources in their environment, even when concentration of the pollutants are within legal ranges.*

**Key words:** air quality, perception of health, pulmonary and cardiovascular function, SF-36 Questionnaire

## Introduction

From the beginning of industrial revolution and in last hundred years especially, industrial pollutant producers influence the human environment in negative way, changing the quality of air, soil and water. Significant air pollution exists as seen by many research data with genesis or deterioration of the diseases of respiratory and cardiovascular system<sup>1-4</sup>. World Health Organization printed the edition 1987 Guidelines of Air Quality for Europe<sup>5</sup>. Republic of Croatia restricted the air pollution by the Law for protection of air quality and Articles about recommended and limited air quality limits<sup>6,7</sup>.

Air pollutant concentration within limited values, which do not yet produce illnesses, can influence the perception of individual health. Public perception of air quality deterioration is very negative. It is aroused by detected sights of fume and steam, as well as by the smell of aromatic carbohydrates including sneezing and coughing that warn public on the presence of irritant particles in the air.

In other way, when objective relevant air pollutants concentration has not been effectively registrated with

own human senses, there is the great influence of subjective personal perception of air pollution and the physical presence of industrial resources in environment. Thomas and colleagues put the stress on air quality as the precipitated trigger for asthma attack<sup>8</sup>, while Day shows the connection between living place and perception of air quality<sup>9</sup>. Howel and colleagues emphasize the public opinion influence on air pollution with perception of personal health<sup>10</sup>.

In this research the main intention was to detect the differences in the perception of health of the population that lives in the vicinity of industrial pollutants plants and the other, living in area without industrial polluters. In Kostrena area, big industrial pollutant plants are situated, such as INA oil refinery, thermo power plant Rijeka and shipyard »Viktor Lenac«. On the contrary, in Crikvenica such polluters do not exist.

#### Participants and Methods

Participants of this research were randomized from the list of inhabitants of Kostrena area (3250, experimental group) and town of Crikvenica (6540, control group) – 200 subjects from each list. The criteria forming, the investigated cohorts were consisted of the following criteria: permanent residence in Kostrena or Crikvenica in period not less than 10 years, personal and family non-smoking history, the absence of professional pollutant exposure in working place. During the preliminary phase, 54 Kostrena and 43 Crikvenica examinees were excluded from further investigation, due to unsatisfactory criteria conditions. The final population sample consisted of 146 subjects from Kostrena (74 male and 72 female) and 157 subjects from Crikvenica (79 male and 78 female). Age average of Kostrena group was 40.8 years (SD 9.2) and of Crikvenica group 39.4 years (SD 10.1). The average age difference between the groups was not statistically significant ( $p > 0.05$ ) and the age span was between 17 and 72 years.

As for the Industrial pollutants plants in Kostrena area, INA oil refinery, thermoelectric power plant and shipyard Viktor Lenac are situated. Air Quality is defined by the concentration of ambient air pollutants (particles, cadmium, lead, benzen, SO<sub>2</sub>, NO<sub>2</sub>) and measured by standard and automatic devices for air quality measurement. Air quality measurements were performed by Teaching Institute of Public Health, Primorsko-Goranska county and the results were made visible to the public on daily base through the web portal, and also edited in Primorsko-Goranska county annual reports<sup>11,12</sup>.

Health perception was measured by the means of SF-36 Questionnaire, of American authors, that was modified according the Croatian conditions<sup>13</sup>. Questionnaire consists of 36 items, that form eight scales (dimensions) of health: 1. PF – physical functioning, consists of 10 items; 2. RP – role limitation due to physical problems, consists of 4 items; 3. RE – role limitation due to emotional problems, consists of 3 items; 4. SF – social functioning, consists of 2 items; 5. MH – mental health, consists of 5 items; 6. VE – vitality and energy, consists of 4 items; 7. BP – bodily pain, consists of 2 items; 8. GH –

general health perception, consists of 5 items. The raw results were transformed and presented on the 0–100 scale, in order that different profiles of health perception dimensions could be compared. SF-36 questionnaire has acceptable metric characteristics and is widely used in health perception researches<sup>14,15</sup>.

The following pulmonary function tests were performed by the means of digital spirometric device Schiller: forced expiratory volume in first second (FEV<sub>1</sub>), forced vital capacity (FVC), forced expiratory air flow between 25% and 75% FVC (FEV<sub>25/75</sub>) and personal expiratory air flow (PEF). In the research procedure, data for systolic and diastolic arterial blood pressure (mm Hg), measured by sphygmomanometer Spiedel+Keller with arm bracelet of 29–42 cm dimensions and pulse (heart beat/minute) were measured. Sorensen silhouette test<sup>16</sup> was used with the evaluation range of 1–9, as well as waste and hip circumference and waist to hip ratio<sup>17,18</sup>.

The research procedure was performed in the period from beginning of March until the end of May 2008. Examinees were instructed to first fill in the SF-36 questionnaire form on health perception. Following to that, the spirometric testing, measurement of systolic and diastolic arterial blood pressure, pulse, and waste and hip circumference, were done in standard conditions.

Descriptive and inferential statistic methods were used and performed by computer program SPSS 13, SPSS Inc. Chicago, Illinois, USA. The level of statistical significance was defined by  $p < 0.05$ . Normal distribution ( $p < 0.05$ ) of SF-36 questionnaire results, pulmonary, anthropometric and cardiovascular measurements was checked by Kolmogorov-Smirnov test. Statistical evaluation of results was done using parametric double direction test (2X2, group X sex) of variance analysis (ANOVA).

## Results

Arithmetic average and standard deviation of health perception results for examinees from Kostrena and Crikvenica were shown on Figure 1. The results were obtained by the means of SF-36 questionnaire. Results showed on Figure 1, were examined by analysis of variance (ANOVA) 2 X 2 (group X gender). Kostrena group perceived their general health status worse than Crikvenica group ( $p < 0.01$ ). In addition they also perceived their mental health worse ( $p < 0.03$ ) and felt less vital ( $p < 0.02$ ). In addition, their emotional problems limited them more in everyday activities ( $p < 0.03$ ) and perceived more bodily pain ( $p < 0.3$ ) in comparison to Crikvenica subjects. On the contrary, Kostrena group performed social functioning better than Crikvenica group ( $p < 0.01$ ).

Subjects from both groups did not significantly differ in physical functioning ( $p = 0.09$ ) and in limits of everyday activities due to physical problems ( $p = 0.19$ ). Women in both groups perform social functioning better than men ( $p = 0.04$ ). Interactions between group and gender for all the scales of SF-36 questionnaire are not statistically significant ( $p > 0.05$ ). Two way ANOVA (group x gender) was used to compare the results of lung and cardio-

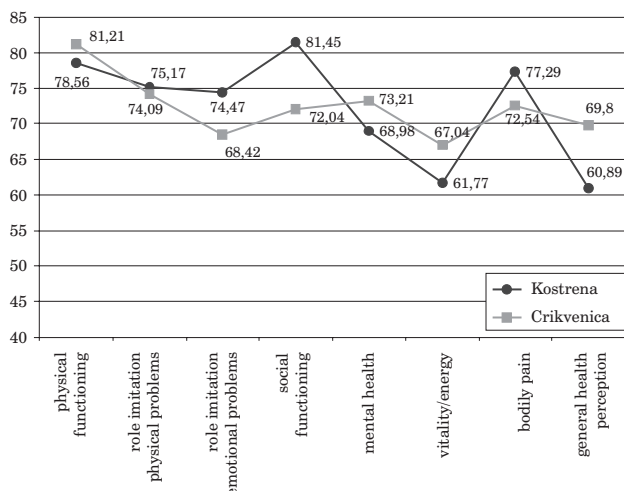


Fig. 1. Arithmetic means and standard deviations  $M(SD)$  of health perception results transformed on unique SF-36 questionnaire scale for Kostrena ( $n=146$ ) and Crikvenica ( $n=157$ ) subjects.

vascular functions together with body measures of Kostrena and Crikvenica examinees (Table 1). Results in Table 1 show that Kostrena and Crikvenica examinees did not significantly differ ( $p>0.05$ ) in measurements of their lung function testing (FEV1, FVC, FEV 25/75), as well as in results of measured systolic and diastolic arterial blood pressure, pulse and waist to hip ratio. Crikvenica group had statistically significant ( $p<0.05$ ) wider waist and hip circumference and wider silhouette in comparison to Kostrena group.

In addition, results of waist to hip ratio and lung functions differed according to gender only. Men of both

groups had statistically significant ( $p<0.05$ ) higher results of FEV1 and FVC, wider waist circumference, while women of both groups showed larger hip circumference ( $p<0.05$ ). Men showed statistically significant higher ( $p<0.05$ ) waist to hip ratio.

## Discussion

Although, air pollutants concentration in Kostrena were within legal ranges in observed period of time, examined subjects from Kostrena perceived their general and mental health, together with vitality worse than those from Crikvenica. Group from Kostrena felt themselves more limited in their roles due to emotional problems, perceiving more pain than group from Crikvenica. On the other hand, no significant differences between groups were found in pulmonary function, arterial blood pressure and waist to hip ratio. This could be explained with evolutionary significance of human sensoric systems, which can detect the presence of most pollutants in the environment, even in concentration that could not be harmful for respiratory and cardiovascular function. Our visual system could detect industrial plants, smoke and vapour in our environment, auditory system detects noise, and the olfactory system detects smells and odours in our environment. Cognition, beliefs and knowledge of harmful environmental factors and environment-born diseases, on the other side, are very important factors for developing consciousness of the relationship between health and environment<sup>19</sup>.

Subjects from Kostrena could detect three industrial facilities: oil refinery, thermo power plant, and the shipyard, in their environment, while subjects from Crik-

TABLE 1  
COMPARISON OF LUNG AND CARDIOVASCULAR FUNCTIONS, AND BODY MEASURES OF KOSTRENA AND CRIKVENICA GROUP – TWO WAY ANOVA (GROUP X GENDER)

Lung and cardiovascular function Body measures	Kostrena		Crikvenica		Main effect of group		Main effect of sex		Interaction group/sex	
	M	SD	M	SD	F	p	F	p	F	p
FEV1 (lit/s)	3.32	0.71	3.44	0.73	0.18	0.68	5.22	0.02 m>f	2.66	0.10
FVC (lit)	3.76	1.01	3.85	0.97	0.14	0.71	13.43	<0.001 m>f	0.89	0.35
FEV 25/75	3.64	0.98	3.60	0.99	0.13	0.72	0.43	0.51	2.40	0.12
PEF	5.31	1.46	5.34	1.45	0.01	0.92	1.85	0.17	1.65	0.20
RR systolic	123.94	6.36	124.90	3.62	0.02	0.89	0.08	0.77	1.49	0.22
RR diastolic	72.85	4.81	73.65	3.20	0.16	0.69	0.12	0.73	0.32	0.58
Pulse	73.00	3.03	71.98	3.56	0.92	0.34	2.15	0.15	0.01	0.97
Waist circumference	94.55	9.94	99.92	10.46	6.85	0.01	4.89	0.03 m>f	2.49	0.12
Hip circumference	105.57	10.30	110.61	11.23	4.25	0.04	7.71	<0.01 f>m	3.06	0.10
Waist to hip ratio	0.91	0.02	0.90	0.02	0.87	0.35	10.44	<0.001 m>f	0.36	0.55
Silhouette	3.32	1.66	3.74	1.06	5.25	0.02	0.20	0.66	0.29	0.26

venica could not detect any of them. This, together with cognitions and beliefs about harmful environmental factors, as industrial pollutants, could easily explain why the subjects from Kostrena perceive their health worse than subjects from Crikvenica, although air concentration of pollutants is within legal range in both places. Ferrer – Carbonell and Gowdy, using data from the British Household Panel Survey found a negative correlation between concern about ozone pollution and individual's well-being, while concern about species extinction was positive correlated with the well-being<sup>20</sup>. The concept of therapeutic landscapes emphasises connection between individual's health and environment. Therapeutic landscapes are places, settings and situations that make physical and psychological environments associated with treatment or healing, and the maintenance of health and well-being<sup>21</sup>. Emotional geography is based on the relationship between emotions and places and is playing an important role in shaping and maintaining therapeutic landscapes that can improve individual's health perception<sup>22</sup>.

Nobody can deny that living in the detected polluted environment, in which concentration of the pollutants are above legal ranges, is an independent factor in ethiology of many acute and chronic diseases<sup>23,24</sup>. Long-term exposure to the fine particles of air pollution is linked especially to the lung cancer, and cardiopulmonary mortality<sup>25,26</sup>. When concentration of the pollutants are still

within legal ranges, just presentation of the industrial facilities, with specific smells, smokes and vapours could »pollute« emotional environment of the individual, producing higher level of psychological stress, that strongly affect own health perception.

## Conclusion

Subjects from Kostrena perceived their general health, mental health, and vitality worse than subjects from Crikvenica. Group from Kostrena felt themselves more limited in their roles due to emotional problems, perceiving more pain than group from Crikvenica. On the opposite site, social functioning of subjects from Kostrena was better in comparison to Crikvenica group. No significant differences between groups were found in physical functioning and in role limitation due to physical problems.

In addition, there were no significant differences between groups in pulmonary function, arterial blood pressure, pulse, and waist to hip ratio.

Subjects using sensoric systems and the mental cognition about harmful environmental factors, perceive their health worse if there are present industrial resources in their environment, even when concentration of the pollutants are within legal ranges.

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## UTJECAJ KVALITETE ZRAKA NA SAMOPROCJENU ZDRAVLJA KOD LOKALNOG STANOVNIŠTVA

### SAŽETAK

Svrha ovog istraživanja sastoji se u proučavanju i utvrđivanju samoprocjene zdravlja između dviju grupa populacije stanovništva, s različitim brojem industrijskih zagađivača u njihovoj životnoj sredini. Ispitivano naseljeno područje Kostrene (3250 stanovnika) smješteno je blizu velikih industrijskih zagađivača: INA rafinerija u Urinju, Termocentrala Rijeka, Remontno brodogradilište »Viktor Lenac«, dok istovremeno u naseljenom području Crikvenice takvi zagađivači ne postoje. U ovom je istraživanju sudjelovalo 146 ispitanika iz područja Kostrene (74 muške osobe i 72 žene s srednjom dobnom vrijednosti 40,8 godina i SD od 9,2 godine) i 157 ispitanika iz naseljenog područja Crikvenice (79 muških i 78 ženskih osoba s srednjom dobnom vrijednosti 39,4 godina i SD od 10,1 godine). Samoprocjena zdravlja ispitanika bila je mjerena prema standardnim postavkama i varijablama SF-36 anketnog upitnika. Funkcije pluća (FEV1, FVC, FEV25/75, PEF), kardiovaskularne funkcije (sistolčki i dijastolički arterijski tlak, puls i srčana akcija) također su mjereni, uključujući mjerenje standardnih tjelesnih proporcija: opseg struka, opseg bokova i test siluete ispitanika, u namjeri utvrđivanja eventualnih objektivnih razlika u fizičkim zdravstvenim parametrima među ispitivanim populacijskim grupama. Ispitanici iz populacije Kostrena procijenili su svoje opće zdravstveno stanje, psihičko stanje zdravlja i opću vitalnost slabije nego ispitanici iz populacije Crikvenica. Grupa iz Kostrene osjećala je veću ograničenost utjecanja na njihove emocionalne probleme, s uočavanjem većih smetnji od grupe iz Crikvenice. Nasuprot tome, uočeno je da je socijalno funkcioniranje ispitanika iz Kostrene bilo bolje od ispitanika iz Crikvenice. Nije bilo značajnih razlika među grupama u fizičkom funkcioniranju, niti ograničenja utjecaja na fizičke napore i probleme. Dodatno, nije bilo nekih značajnih razlika među grupama u objektivnim fizičkim parametrima, kao što su funkcije pluća, krvni tlak, puls i srčana akcija, te odnos opsega pojasa i bokova. Ispitanici u korištenju svojih senzoričkih osjetila i misaonim prepoznavanjem i zaključivanjem o štetnosti čimbenika zagađenja okoliša, procjenjuju da im je zdravlje ugroženo i lošije, ako su u njihovoj okolini prisutni industrijski izvori, čak i u slučaju da je koncentracija štetnih tvari unutar zakonom dozvoljenih granica.