

MODEL FOR DETECTION OF ANXIETY AND DEPRESSION WITHIN COPD PATIENTS

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Summary. Researchers suggest that insomnia, anxiety and depression have negative effect on respiratory symptomatology and that early detection of symptoms helps the quality of life of patients.

Aim: Examine the correlation of anxiety and depression, determined by the questionnaire "Anxiety and Depression Scale" (HAD), using the "SF-36" general health questionnaire and the questionnaire of quality of life of patients with chronic obstructive pulmonary disease (COPD) and asthma, with lung function parameters. Define a mathematical model for more efficient detection of symptoms, using statistical methods.

Method: 76 patients were included, aged, on average, 40.1 ± 11.6 and 46% were women. All subjects answered the questionnaire and pulmonary function testing was conducted for them. A model that mathematically describes the relationship between the questionnaire score and lung function parameters was defined using multifactor, nonlinear regression.

Result: The average level of anxiety and depression was 26.3 ± 5.3 . The result (score) of the questionnaire was used as a predictor of anxiety, depression, general health status and specificity and individuality of patients. The mean score was 46 ± 4.5 (moderately weighted quality of life). The total score was in negative correlation with lung function parameters.

Conclusion: Anxiety and depression correlate with the lung function parameters. Usage of the questionnaire provides insight into the current condition of patients. Using the mathematical model it is possible to obtain the total score of the questionnaire based on lung function parameters, and therefore the rapid assessment of the condition of patients.

1. INTRODUCTION

Chronic obstructive pulmonary disease (COPD) is a progressive and irreversible loss of lung function with the decline in Forced Expiratory Volume (FEV1) of 7-33ml per year, loss of breath, chronic cough and sputum production¹³. The diagnosis of asthma is often made in first years of life, with the occurrence of bronchial hyperactivity and loss of breath².

Successful treatment of obstructive pulmonary disease requires the cooperation of psyche and body. It is achieved through the neurovegetative and endocrine-immune system^{3,8}.

During the examination of patients with COPD and asthma, psychiatrists and clinical psychologists should consider the following: possible psychiatric source for lung problems, existing psychiatric problem due to therapy of these patients, increased emotional instability with worsening of lung function, psychiatric problem (e.g. delirium) due to treatment of primary disease^{6,11}.

Psychosomatic imbalance connects psychiatry with other branches of medicine. It is believed that the psychiatric deterioration causes asthma attack by: increasing resistance in airways, constricting airways, joint occurrence with panic and depression¹¹. Insomnia reduces the patient's proprioceptive capacities of airways and changes day-night rhythm of airways resistance. Parasympathetic activation enhances respiratory reactivity and constriction¹¹.

In this research, we examined the connection between insomnia, anxiety and depression in patients with COPD and asthma with specific lung function parameters. As the primary instrument for carrying out the experiment we used the questionnaire "Level of Hospital Anxiety and Depression" (HAD). We also applied the general questionnaire "SF-36", as well as a specific quality of life questionnaire "Saint George" (SGRQ), with chronic obstructive pulmonary disease, in order to achieve greater precision and reliability in the assessment of correlation of general subjective condition of patient with lung function parameters.

2. AIM OF RESEARCH

- Prove the correlation of insomnia, depression and anxiety on the occurrence of dyspnea and obstruction of upper airways.
- Demonstrate mutual correlation of lung function parameters and subjective condition of patient and show the same by mathematical equation (model).

3. METHOD

The study included 76 subjects with COPD and asthma. While carrying out the necessary examinations (spirometry, chest radiography, blood gas analysis), the patients were filling in questionnaires:

- 1) SF-36 short form, containing 36 questions, showing the general condition of patient through: physical condition, general health, vitality, social functioning, emotions, mental health, activity and pain.
- 2) SGRQ questionnaire, containing 76 items in three domains (symptoms, activity, impact) and showing the level of quality of life of patients. Its results are given in range from 0 (entirely satisfactory quality of life) to 100 (maximally reduced quality of life).
- 3) HAD questionnaire shows the emotional state of patient, the degree of anxiety and depression. It contains 10 items for which the subject states the extent to which the items refer to him/her. Mild (0 - 10), moderate (10 - 25) and severe (25 - 40) degree of anxiety and depression are determined based on the total result.

Considering that some questions from these three questionnaires were repeated, and that some questions were adjusted to the socio-demographic structure of patients who live in the central region of Montenegro, a modified questionnaire, adapted to this research, was made.

Tests of lung function, using the examination method of curve "flow-volume", were carried out at the Center for Pulmonary Disease, Podgorica. A device, type FLOWSCREEN VERSION 2.10d, was used, where the patients were in a sitting position in order to achieve the correct position of diaphragm. During testing, the following lung function parameters were determined:

- 1) Vital Capacity (VC) expressed in liters and in percentage;
- 2) Forced Expiratory Volume in one second (FEV1), expressed in percentages;
- 3) Peak Expiratory Flow (PEF), expressed in percentages.

Statistic software DATA FIT 9-version 2008 was used for statistical data analysis, with which the significance test of correlation of lung function parameters and recently modified questionnaire, as well as the degree of correlation of SGRQ scale with SF 36 and HAD scale, was done. Multifactor nonlinear regression analysis was done to define the model that would mathematically express general physical condition, quality of life and emotional state of patients with COPD based on lung function parameters.

4. RESULTS

Age of subjects was, on average, 40.1 ± 11.6 years. The percentage of women was 46.7%. Of the total number of subjects, 34.6% stated that they had contact with a psychiatrist, and even 71,3% stated that they had used psychotropic drugs.

Psychiatric heredity was positive in 15.2% of patients. On anxiety and depression scale, the average intensity among patients was severe (26.3 ± 5.3). The most significant predictor of insomnia, anxiety, depression, general health status and specificity of patients was the total result (score) of all three questionnaires. Its mean value for all subjects was 46 ± 4.5 , therefore the moderately weighted quality of life.

The correlation of the aggregate value of the modified questionnaire and lung function parameters was separately: a) -0.75 (SCORE - PEF) b) -0.83 (SCORE - FEV1) c) -0.63 (SCORE - VC).

Correlation ratio between PEF and FEV1 was 0.77, while the ratio between PEF and VC was 0.87. Correlation ratio between parameters FEV1 and VC was 0.68.

The results of multifactor nonlinear regression analysis gave the model defined by the following:

$$\text{Model Definition: } Y = \text{EXP}(AX_1 + BX_2 + CX_3 + D) \quad (1)$$

Number of observations = 76

Number of missing observations = 0

Solver type: Nonlinear

Nonlinear iteration limit = 250

Diverging nonlinear iteration limit = 10

Number of nonlinear iterations performed = 3

Residual tolerance = 0,0000000001

Sum of Residuals = 0,215784802831983

Average Residual = 2,83927372147346E-03

Residual Sum of Squares (Absolute) = 302,726266867174

Standard Error of the Estimate = 2,05049542410275

Coefficient of Multiple Determination (R^2) = 0,8862997969

Proportion of Variance Explained = 88,62997969%

FEV 1	PEF	VC	SCORE	CALCUL.	RESIDUAL	%ERROR	ABS RESID.
6,44	4,75	10,03	35,1	35,2135	-0,1135	-0,32335	0,113497164
6,92	5,39	11,29	36,1	33,36316	2,736844	7,581284	2,736843699
5,23	3,78	6,71	47	43,47651	3,523492	7,496791	3,523491693
3,78	3,26	5,26	50,7	52,16347	-1,46347	-2,88652	1,463466826
4,6	3,34	7,74	41,7	42,05528	-0,35528	-0,85199	0,35527871
4,03	2,95	6,15	46,9	46,83636	0,063637	0,135686	0,063636779
3,75	2,82	5,76	49	48,65379	0,346207	0,706544	0,346206508
5,05	3,41	6,84	41,2	42,36118	-1,16118	-2,8184	1,161179945
3,95	3,44	7,27	45	46,78309	-1,78309	-3,96242	1,783090607
4,32	3,64	7,05	45,1	46,43574	-1,33574	-2,96173	1,33574165
4,89	4,01	7,55	44	44,14526	-0,14526	-0,33013	0,145257419
3,63	2,8	6,45	47,2	47,38141	-0,18141	-0,38433	0,181405045
6,21	4,67	8,9	37,7	38,07049	-0,37049	-0,98273	0,37049093
4,9	3,17	7,98	40,8	39,47544	1,32456	3,24647	1,32455995
4	1,27	4,11	44,2	44,07564	0,12436	0,281356	0,124359554
3,8	2,56	5,01	49,6	49,05619	0,543813	1,096397	0,54381271
2,91	3,18	6,55	52,9	53,01395	-0,11395	-0,2154	0,113946085
3,13	0,84	1,58	52	53,14607	-1,14607	-2,20397	1,146066095
3,94	1,41	7,03	39,6	38,41602	1,183976	2,989838	1,183975778
2,25	0,74	2,03	59,4	56,4764	2,923604	4,921892	2,923603913
2,74	1,61	4,27	48,7	51,90857	-3,20857	-6,58843	3,208565645
2,86	1,86	2,86	56,8	56,76922	0,030782	0,054193	0,030781602

3,63	2,38	7,11	43,9	43,75967	0,140333	0,319666	0,140333227
3,92	2,2	4,56	47,8	47,79446	0,005538	0,011586	0,005538021
3,84	2,24	4,31	48,3	49,07422	-0,77422	-1,60293	0,774217581
3,32	2,6	5,66	49,7	50,09855	-0,39855	-0,8019	0,39854599
4,8	2,72	4,83	42,1	45,1836	-3,0836	-7,32445	3,083595411
4,53	3,31	6,68	47,6	44,74647	2,853535	5,994821	2,853534989
3,46	2,31	5,98	48,1	47,05156	1,048444	2,179716	1,048443552
3,54	3,09	8,47	42,7	44,19081	-1,49081	-3,49137	1,490814248
3,26	1,93	5,36	47,9	47,80368	0,096321	0,201089	0,096321408
5,96	4,08	8,17	37,61	38,27732	-0,66732	-1,77431	0,667319012
3,08	3,04	5,95	50,1	52,98949	-2,88949	-5,76744	2,889487742
4,74	3,62	7,32	43,7	43,62804	0,071956	0,164659	0,071955784
5,6	4,28	8,66	38,4	39,57409	-1,17409	-3,05752	1,174089409
5,72	3,92	5,84	44,1	43,85002	0,249978	0,566844	0,249978026
3,12	1,2	2,2	51,4	53,40588	-2,00588	-3,90249	2,00588205
4,28	3,39	8,48	41,5	42,04673	-0,54673	-1,31741	0,546727183
4,01	3,6	7,12	50,6	47,64555	2,954452	5,838838	2,954452148
3,2	1,4	2,87	50,9	52,1259	-1,2259	-2,40844	1,225895141
3,56	2,32	6,46	42,1	45,3932	-3,2932	-7,82233	3,293199671
4,34	3,28	6,81	44,7	45,2172	-0,5172	-1,15705	0,517202807
2,23	1,57	2,24	61,3	61,00361	0,296394	0,483514	0,296394191
2,93	1,57	4,06	50,2	51,21744	-1,01744	-2,02677	1,017438035
6,43	4,81	7,61	39,7	40,45251	-0,75251	-1,89548	0,752507204
3,39	3,39	5,65	53,3	54,00658	-0,70658	-1,32567	0,706584596
3,35	1,69	2,7	58,4	53,34389	5,056112	8,657726	5,056112032
4,15	2,85	6,48	42	44,93899	-2,93899	-6,99761	2,938994225

4,18	2,32	4,87	48,1	46,26175	1,83825	3,821726	1,838250408
5,1	3,69	7,71	40,1	41,37585	-1,27585	-3,18166	1,275845372
4,73	3,26	6,08	49	44,99959	4,000407	8,164096	4,000406993
4,98	1,94	3,45	46	44,03372	1,966279	4,274521	1,966279473
2,94	1,41	2,47	54,8	54,85342	-0,05342	-0,09748	0,053421741
4,35	1,88	2,96	44	48,12309	-4,12309	-9,37066	4,123088762
5,72	3,62	8,16	36,1	37,4732	-1,3732	-3,80389	1,373203347
5,11	3,82	8,64	40,7	39,83109	0,86891	2,134913	0,868909599
3,23	2,92	6,22	50,2	50,73707	-0,53707	-1,06987	0,537072705
3,28	2,29	3,74	52,7	54,07219	-1,37219	-2,60378	1,372190449
2,89	1,5	2,57	54,8	55,36957	-0,56957	-1,03937	0,569572844
3,88	2,32	3,78	50,2	50,70786	-0,50786	-1,01168	0,507864389
3,9	2,35	3,81	49,3	50,67335	-1,37335	-2,7857	1,373349769
4,97	3,37	7,64	40,3	40,74506	-0,44506	-1,10438	0,445064781
4,84	2	4,75	41,8	41,92306	-0,12306	-0,29441	0,123062728
3,58	2	3,62	56,9	51,1148	5,785195	10,1673	5,785195294
4,8	3,57	7,82	47,8	41,96506	5,834937	12,20698	5,834937035
3,89	2,8	6,7	45,9	45,44079	0,459208	1,000453	0,459207975
2,07	1,36	3,19	62	57,67943	4,320566	6,968654	4,320565572
3,08	2,42	5,66	52	50,4682	1,531796	2,945761	1,531795649
4,7	2,13	5,25	40,92	41,98979	-1,06979	-2,61435	1,069790979
4,18	2,37	5,07	42,1	46,00083	-3,90083	-9,26562	3,900826845
4,28	2,59	4,97	46,92	46,81051	0,109487	0,233348	0,109486825
4,6	2,26	4,57	44,3	44,64437	-0,34437	-0,77736	0,344370183
4,41	2,51	5,24	46	45,10553	0,894468	1,944496	0,894467963
4,28	2,35	4,19	47,8	47,63109	0,16891	0,353369	0,168910204

5,2	2,46	4,3	42,9	43,33676	-0,43676	-1,0181	0,436763717
2,83	1,99	3,43	55,2	55,97099	-0,77099	-1,39672	0,770988712

Table 1: Input data, calculation values, residuals of regression model

Varia.	Value	99% (+/-)	Lower Limit	Upper Limit
A	-0,1086469896	2,056808067E-02	-0,12921507037353	-8,80789090150056E-02
B	0,1040207881	3,448893445E-02	6,95318536532961E-02	0,138509722564796
C	-5,428572559	0,0143372292	-6,86229555395815E-02	-3,99484956433375E-02
D	4,3115031490	5,490281724E-02	4,25660033181597	4,36640596630527

Table 2 : Regression variable coefficients for the 99% confidence intervals

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob(F)
Regression	3	2359,76912655388	786,589708851292	187,0814172	0
Error	72	302,726266867174	4,20453148426631		
Total	75	2662,49539342105			

Table 3: Variance analysis

Final model view:

$$\text{SCORE} = \text{EXP} (-0.10865\text{FEV1} + 1.10402\text{PEF} - 5.42857\text{VC} + 4.31150) \quad (2)$$

SCORE - total results of questionnaires

VC, PEF, FEV1 - lung function parameters

5. DISCUSSION

Mean value of insomnia, anxiety and depression in the observed sample of patients with COPD and asthma is higher than for average population. The level of anxiety and depression has been moderate to severe, which is in accordance with previous studies¹².

Suggestions of scientists that depression has a negative impact on respiratory symptomatology have been confirmed by this study.

Shame and insecurity, insomnia, the most common symptoms of depression, are a risk factor for deterioration of primary disease¹¹. Increased values of the modified questionnaire indicate deterioration of primary disease. Improved values of lung function parameters (PEF, FEV1 and VC) are followed by the decrease of the total score of the questionnaire or subjective general condition of patient.

The literature states that more than 30% of people with asthma have panic attacks and agoraphobia. Rapid breathing, a common symptom of anxiety and panic fear, is the trigger for the deterioration of lung disease. The occurrence mechanism is related to the increased activity of brain cells that respond to the level of arterial carbon dioxide (CO₂)¹¹. Approximately 17% of patients are not able to detect changes in airway resistance. However, measurements of individual patients, with frequent loss of breath, show a decline in FEV1. Patients with variable FEV1 (more than 54% have variability in FEV1 on a daily basis) have a particularly limited perception of the increase of respiratory resistance.

Usage of statistical methods can simplify and facilitate the work in the part regarding conclusions on the existence of anxiety and depression of COPD and asthma patients, based on measured lung function parameters. The developed mathematical model in this research corresponds to the reliability of 99%, which is more than enough to conclude whether it is necessary to engage a psychiatrist or clinical psychologist. Development of mathematical model based on a large number of samples, with regard to socio demographic characteristics, would contribute to more efficient detection of anxiety and depression.

6. CONCLUSION

- Usage of the modified questionnaire in clinical practice provides an easier access to the current condition of patients with COPD and asthma. Namely, increased values of questionnaire scores (approximately 46) show a reasonable suspicion of anxiety, depression of a certain intensity and decline in values of PEF, FEV1 and VC. It is necessary to integrate measures to detect anxiety and depression in the assessment of patients, either by questionnaire or by applying a mathematical model, developed based on a larger sample, with adequately defined socio-demographic characteristics.
- We propose cooperation and teamwork of the chosen doctor, specialist psychiatrist, clinical psychologist and pulmonary disease specialist to achieving better diagnostic and therapeutic regime of patients.

7. LITERATURE

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