Graph analysis of psychosocial factors correlations of patients with hypertension and neoplasm in Upper Silesia, Poland

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Abstract :- A graph representation to investigate correlations and dynamic of changes of different psychosocial factor of chronically ill patients is proposed. The rationale of the study was the theory of meaningfulness of suffering by V. E. Frankl. Participants were 181 patients with either arterial hypertension or neoplasms with bad prognosis, examined thrice: 0-10 days from the time of diagnosis (stage I), about 5 weeks from the diagnosis (stage II) and at a follow-up about 5 months since stage II (stage III). 75 factors were available for consideration: 17 in stage I, 28 in stage II, 27 in stage III and 4 sets of data that describe populations: age, gender, education, number of stages executed. For both diseases graph are built under assumption that factors are vertices and significant correlations are edges. The graphs are built for each gender and for each disease separately. Matching degree of graphs between diseases and gender is shown. Usefulness of this approach to analysis of difference between diseases and dynamic of factors is discussed.

Key-Words :- Graph methods, neoplasm, hypertension, psychosocial factors, biometrics

1 Introduction

Two so-called diseases of civilization were taken into account in this paper: arterial hypertension and neoplasm with bad prognosis ([6], [8]). These diseases were explored under ‘psychological’ point of view, i.e. such psychological properties like: hope, anxiety, meaning of life, coping with stress, different tests of self-esteem and other health cognitive-emotional processes were explored. Most of these factors describe emotional sphere of human life. Such kind of data are usually analyzed using different statistical tests that verify assumed hypothesis ([1], [2]). In the case explored in this paper data are special since they are unique in country-scale: over 70 psychosocial factors were determined for almost 200 patients suffering from serious diseases. Moreover the dynamic of these diseases were taken into account: the data collection has been divided into 3 stages.

A statistical analysis for particular factors from this set of data like hope, anxiety, meaning of life were explored earlier in our work [3]. In work [4] we introduced directed models that were very useful to illustrate cause-effect relations.

A motivation for this paper is to add to our consideration patients gender. Contribution of this paper is a proposition of graph representation for correlation exploration between illness and patients gender. As it is shown such model can describe differences and dynamic of cognitive-affective processes between diseases.

The paper is organized as follow. The data are more precisely explained, next the way of building graphs is described, next the graphs are analyzed. Finally, all is discussed and concluded.

2 Available data

The data were collected in Upper Silesia, Poland hospitals, including the Oncology Center - the M. Skłodowska-Curie Institute in Gliwice, and the Central Clinical Hospital of the Silesian Medical Academy in Katowice. We studied 181 patients: 108 with hypertension and 73 with neoplasm. The dynamics of the disease was taken into account in the research. The patients were examined thrice: stage I, 0-10 days from the time of diagnosis, was regarded as the period of shock due to the patient's learning about his/her severe chronic illness. Negative emotions (mostly anxiety) were expected at that stage, as well as an unfavorable self-rating of subjective health and a low sense of meaning in life. Stage II was carried out about five weeks after the first examination. In that period the patients could be expected to have adapted to their new life situation. They had enough time to undertake health-promoting activities that would improve not only their physical health, but also emotional state. The patients' improved affective condition and involvement in their own treatment should lead to their more favorable self-appraisal of health. Moreover, their perceived meaning in life should be higher than that in stage I. In stage III, about five months from the second examination, the patients could be expected to have markedly adapted to life with their chronic illness. However, various outcomes could be expected – from a significant deterioration of their functioning, through no change to a marked improvement – depending on the course of the disease and progress in its treatment.

Some classical psychological tools were used to transform data to psychosocial factors:

1) Perceived meaning in life was assessed using the Purpose in Life Test (PIL) by J.C. Crumbaugh and L.T. Maholick, in the Polish authorized translation by Z. Płużek. Only part A of the PIL was used, consisting of 20 items with a 7-point rating scale each, on which the respondent is asked to check his/her agreement with the item content (from 7 – fully agree to 1 – disagree). Items concerning death and suicide were excluded as too invasive in patients with a severe physical illness.
2) Two emotional states – hope and anxiety - were measured using The Gottschalk-Gleser Content Analysis Scales (GGCAS). This projective tool allows to measure emotions both at the conscious and unconscious level, taking into account also defense mechanisms. The respondent's current emotional state is assumed to influence his/her perception of the examination situation and his/her choice of the past events. According to the authors, this test yields an interval scale, and so parametric tests can be used in the statistical analysis of the obtained final scores (quoted after [5]). In this study inter-rater reliability calculated using Pearson's r was $r = 0.84$ for the Anxiety Scale, and $r = 0.85$ for the Hope Scale.
3) An interview was designed for the purposes of this study to measure the patient's self-appraisal of health. His/her subjective health was rated on a 5-point rating scale, from 5 (very good) to 1 (very bad). The intermediate ratings were: good, middling (average) and bad.

4) Miller Behavior Style Scale (MBSS) [10].
5) Medical estimation of health condition.

Finally, the factors are represented by 4 matrices: first two collects data for hypertension, second two collects data for neoplasm (men and women separately). Both consist of 75 column that correspond to factors. The number of rows corresponds to a number of patients: 108 for hypertension and 73 for neoplasm.

3 Graphs

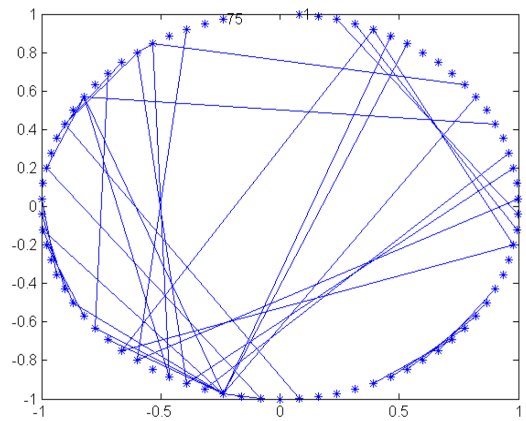
A graph is defined as G(V,E), were V is a set of vertices, and E is a set of edges that defines which vertices in a graph are connected [9]. It is assumed that a set V is the set that consists of all factors, i.e. graph for each disease consists of 75 vertices. Nodes from 3 to 19 are for stage I, 20 to 47 for stage II and 48 to 73 for stage III. First and last two describes population properties. It is also assumed that the edge exists when absolute value of Pearson's correlation coefficient between two vertices is greater that 0,6 and significance level is lower than 0,05:

$$r > 0{,}6;\ \ p < 0{,}05$$

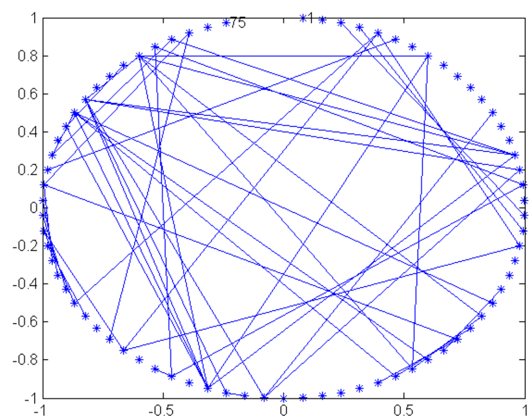
The border value of r is chosen arbitrary but is convenient for graph illustration (for lower values of r firstly low correlations are also considered as edges, secondly the number of edges fast increases and the graphs become difficult for presentation) and does not indicate weak correlations.

The absolute value is needed since the edge denotes only the strength and not the direction of correlation. Despite the data are of different kind (used scales are: interval and rating) only the correlation is calculated. This is justified since the correlation coefficients will be treated as weights of graphs edges.

The graph for a population of men for hypertension is shown in the Fig 1a, for neoplasm in the Fig 1b. The graph for a population of women for hypertension is shown in the Fig 2a, for neoplasm in the Fig 2b.



a) the graph for hypertension



b) the graph for neoplasm

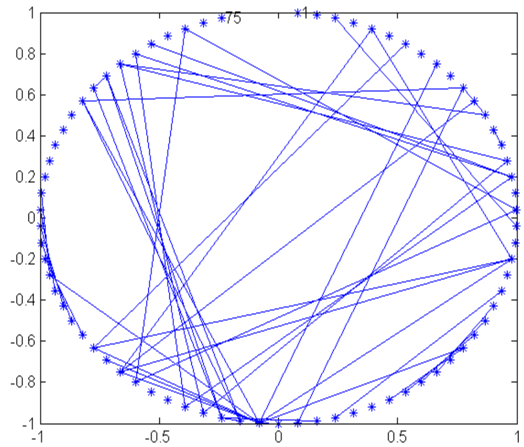
Figure 1. Graphs for hypertension and neoplasm for a population of men

The vertices of graphs are placed on a circle because our intension is to analyze also the dynamic of disease (see next section). Summarizing it can be stated that correlation between factors in different stages are modeled by undirected weighted graph.

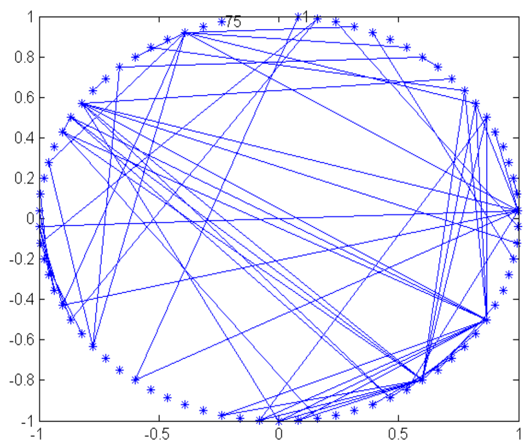
4 Graphs matching

Graphs were analyzed in the following way:
- a graph matching problem has been explored to show similarities between two diseases;

- a hypothetical graph model has been introduced to show differences in dynamic between two diseases.



a) the graph for hypertension



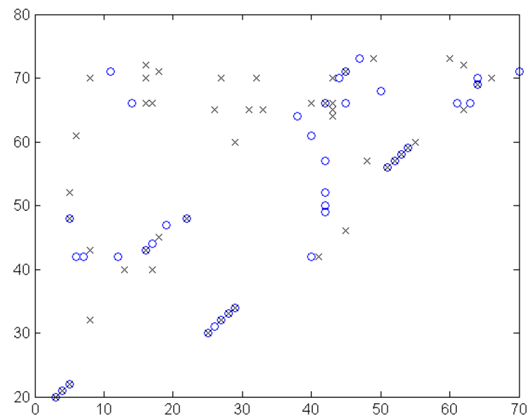
b) the graph for neoplasm

Figure 2. Graphs for hypertension and neoplasm for a population of women

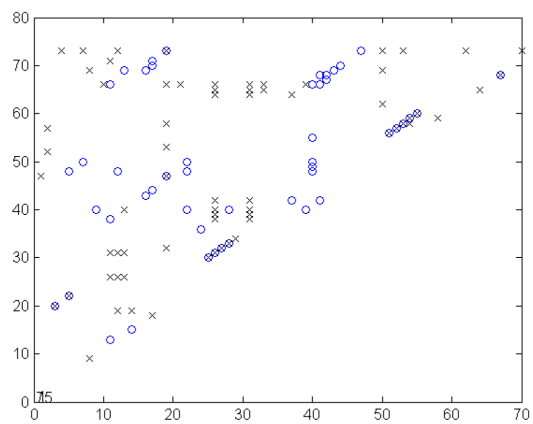
The graph matching problem is very well known and widely explored (e.g. [9]). It is known to be computationally difficult [7]. In the case presented here the matching problem reduces to matching only the edges since the vertices for both disease are the same (are matched). The edge matching for graphs from Fig.1 is presented in the Fig.3a and for graphs from Fig.2 is presented on Fig.3b.

Next figure (Fig.4) represents the matching of graphs for both diseases, i.e. in the Fig.4a the matching of hypertension graphs is presented (population of men vs population of women) and, similarly, in the Fig.4b – matching of neoplasm graphs.

In this figures (3 and 4) axis denotes vertex indices, i.e. point with coordinates X,Y denotes the edge between vertices (factors) X and Y.



a) men

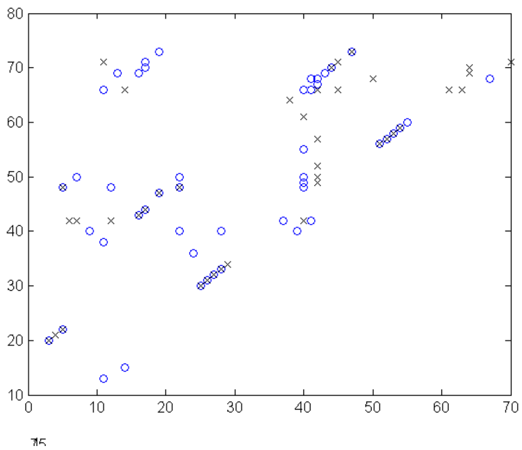


b) women

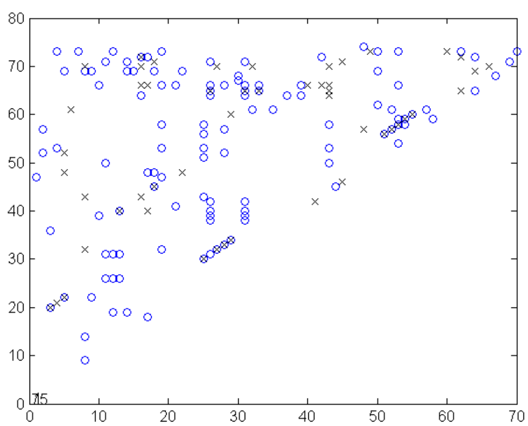
Figure 3. Illustration for graph matching problem between diseases

5 Discussion

To illustrate differences in dynamic between diseases a hypothetical model has been assumed: if there are no reasons to disturb factors in time (such reason is a disease), then the same factors measured in different time moments should be strongly correlated. For presented graphs if the same factor in 3 stages of research is correlated then characteristic triangles can be observed (fig.5). Here as an illustration 3 factors measured in 3 stages has been chosen: a meaning of life (vertices: 5, 22, 48), a hope (vertices: 6, 23, 49) and an anxiety (vertices: 7, 24, 50).



a) hypertension



b) neoplasm

Figure 4. Illustration for graph matching problem between gender

This model can be useful in analysis of graphs in figures 1 and 2.

A number of triangles are observed in figures 1b and 2a, whereas many disturbances can be observed in triangle regularities in figures 1a and 2b.

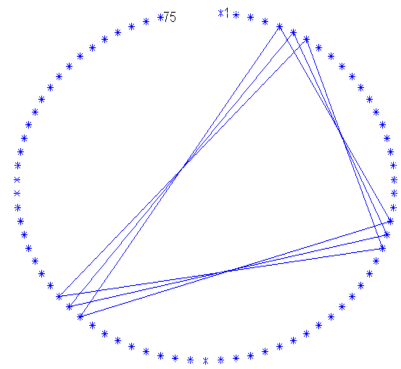


Figure 5. A graph model of analysis of the dynamic

One could introduce indices of similarity to describe these differences precisely.

Basing on results it is possible to show partly dependences in groups of psychosocial factors that are independent of a gender. They are presented in the Fig.6.

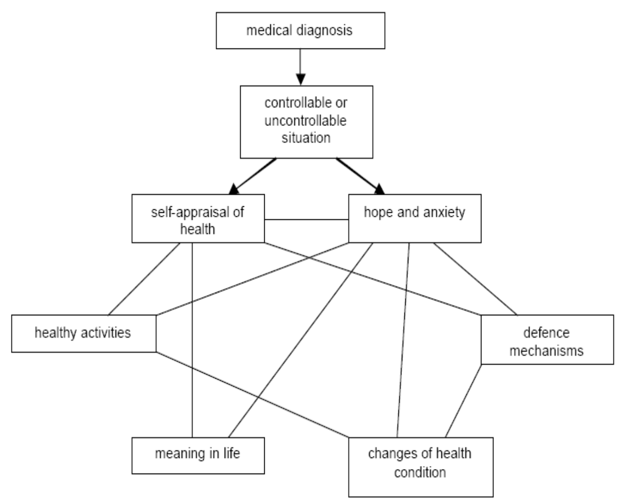


Figure 6. A graph model of partly dependences

6 Conclusion

In this paper a graph based approach is proposed to analysis a set of psycho-social factors. The graph analysis results in some conclusion. Firstly should be noted that diseases of different kind differently influences on cognitive, emotional and behavioral sphere of a man but there are also many similarities. The proposed hypothetical model illustrate how dramatic is the influence of serious disease (neoplasm) on psychosocial factors comparing to the second researched disease (hypertension) and illustrate the differences between population of men and women: the regularities in graphs are more disturbed in cases 1a and 2b.

The issue of psycho-social factors of patients with a chronic illness is of particular importance. Suffering associated with illness is destructive in itself. Finding meaning in suffering, and thus the meaning in his/her whole existence, helps the patient to adapt to new conditions, to gain a better quality of life, and to orient himself/herself towards supra-values.

In the future research more complex graph analysis methods to describe these psycho-social factors are planned to be applied.

To store and process patients data biometics techniques are planned to be used in the future. That is because biometrics refers to automatic identification of a person based on his or her physiological or behavioral characteristics. It provides a better solution for the increased security requirements of our information society than traditional identification methods such as passwords and PINs [11].

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References

1 Brzeziński J.: Metodologia badań psychologicznych, [Methodology of psychological research], Warsaw, PWN – Polish Scientific Publishers, 1997.
2 Ferguson G.A., Y.Takane: Statistical Analysis in Psychology and Education, New York, McGraw-Hill, Inc., 1989.
3 Gałuszka A.: Cognitive-Affective Correlates of Meaningfulness in Life in Chronic Somatic Disease, Polish Psychological Bulletin, 2005, in press.
4 Gałuszka Anita, Gałuszka Adam: Undirected and Directed Graph Model of Coping with Somatic Disease. [in]: Computational Intelligence: Methods and Applications. Ed. L.Rutkowski, R.Tadeusiewicz, L.A.Zadeh, J.Zurada. Academic Publishing House EXIT, Warsaw 2008
5 Heszen-Niejodek I.: Skale Analizy Treściowej Gottschalka i Gleser, [Content Analysis Scales by Gottschalk and Gleser], Przegląd Psychologiczny, 30, 1987, 987-1002.
6 Koszarowski T.: Onkologia kliniczna, [Clinical Oncology], Warsaw, PZWL, 1985.
7 Papadimitriou Ch.: Teoria złożoności obliczeniowej, [Theory of the Complexity], PWN, Warsaw, 2001.
8 Sheridan C.L., S.Radmacher: Health Psychology. Challenging the Biomedical Model, New York, John Wiley & Sons, 1992.
9 Wilson R.J.: Wprowadzenie do teorii grafów, [Introduction to the Graph Theory] , PWN, Warsaw, 1998.
10 Miller S.M.: Monitoring and Blunting. Validation of Questionnaire to Asses Styles of Information Seekeing under Threat, Journal of Personality and Social Psychology, 52, 1987, 345-353.
11 Jain A., L. Hong and S. Pankanti: Biometric identification. Communications of the ACM, Vol. 43, No. 2: 91—98, (2000)