Comparative study of explanatory factor analysis for construction of Clinical Research education model

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Summary
Study of feature extraction from educational data with various analysis methods have been increased. Clinical research is the study to solve the question occurred in the clinical site. For high-quality clinical research following guidelines, different education model is required for the clinical training model. For construction of clinical research education model, in this paper, we had a comparative study by use of exploratory factor analysis with the clinical research education program student survey data composed of 5 variables. The comparative study was evaluated by changing of axial rotation and number of classifications.

Key words:
Factor Analysis, Clinical Research Education

1. Introduction

Clinical research skills to answer clinical questions arising daily clinical practice are necessary to improve the quality of medical care. For an avoidance of scientific misconduct and patient protection, since the ethical guidelines called "International Guidelines for Ethical Review of Epidemiological Studies" in 1991 [1], and "International Ethical Guidelines for Biomedical Research involving Human Subject" in 2002 [2] from CIOMS (Council for International Organizations of Medical Science) were published, several international organizations have issued ethical guidelines for clinical trials. These guidelines describe the importance of clinical research education. In order to carry out clinical research according to guidelines, professional knowledge and skills specific to clinical research is necessary. However, the clinical research area is almost not included in the undergraduate education program of medical school. Therefore, most medical staff strives for clinical research skills with medical work after graduation. In the field of medical education, clinical training model has already been defined by Kern [3], but as already mentioned, clinical research skills require unique knowledge and skills, so different models are needed. In spite, such models have not been proposed.

We have been managing clinical research education program for medical staff, consists of multiple courses for beginner, standard, and advanced level, that have received a high satisfaction and evaluation from program student and educational committee members [4]. As a next step, the program needs to be modeled for generalization in the clinical research education field. Toward to model generation, we tried to express our program by 5 variables defined in advance with reference to the ADDIE model [5] that is often referred for creation of the education program. The result showed that each factor has some characteristics, and it is worth clarifying these relationships [6].

In recent years, thanks to the improvement of computer performance, data analysis for finding some characteristics from vast quantities of data has been actively performing [7]. Also in the medical field, the study of feature extraction using medical data has been done [8] and the results from them are used for medical improvement. In this paper, we reported on the comparative study of several factor analysis results for construction of clinical research education model, with the clinical research education program student survey data.

2. Process of comparative study for construction of clinical research education model

In the field of data analysis, various methods are used for deriving unobserved variables, clarification of relationship between variables, and interpretation of a large-scale data. For example, multiple regression analysis formulates one variable with another observation variables, and factor analysis [9] reduces a number of given observed variables to a few factors. Specifically, as a procedure of factor analysis, based on the correlation between observation variables, latent variables that commonly exist behind and influence to them are extracted as common factors. We can determine the number of common factors based on the correlation between observed variables. Factor analysis can be divided into exploratory factor analysis to search common factors, and confirmatory factor analysis to verify the validation of some association already assumed. We can expect clinical research education model generalization by classifying observed variables from education program student survey data with factor analysis. In addition, at the stage of factor analysis, several calculating solutions between common factors and

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observation variables are defined as axis rotation. According to the characteristics of data, axis rotation can be defined as shown in Table1.

Table 1: Types of axis rotation

Axis rotation	Feature
Varimax	Simplifying factors
Promax	Correlating factors
Quartimax	Simplifying observed variables
Equamax	Combination of *varimax* and *quartimax*
Oblimin	Minimizing sum of covariance of factor load between factors. It suitable for analysis of complex structures

Since student survey data are thought to have high complexity, it is difficult to predict the relationship between common factors. So it is not easy to specify an axis rotation in advance. We considered that the comparison of the analysis results of each rotation method is appropriate. Furthermore, since no association is assumed for the data, application of exploratory factor analysis is needed. From the above, we had a comparative study for construction of clinical research education model, by the following procedure.

Step1 Prepare the scored 5 variables (*Ana*, *Des*, *Dev*, *Imp*, *Eva*) from student survey data

Step2 Generate correlation matrix and eigenvalue for each variable

Step3 Compare the results of exploratory factor analysis in the cases of applying the axis rotation shown in Table.1

3. Experimental Data

Program student report is an important material in the process of construction of clinical research education model. As described in chapter 1, we defined 5 variables such as *Analysis*, *Design*, *Development*, *Implement*, *Evaluation*, referring to the ADDIE model as an experimental data. Clinical research education program students scored each variable for the guidance contents received in the program so that the total value of them is 1.0. (N = 93)

4. Experimental result

Firstly, the correlation matrix in order to find the correlation between each of the 5 variables is shown in Table 2.

Table 2: Correlation matrix of 5 variables

	Ana	*Des*	*Dev*	*Imp*	*Eva*
Ana	1.000	**-0.450**	-0.158	-0.363	-0.006
Des		1.000	-0.132	-0.273	-0.245
Dev			1.000	-0.023	-0.180
Imp				1.000	-0.115
Eva					1.000

We can find that Ana (Analysis) and Des (Design) have some negative correlation and other combinations have no correlation in particular. Secondly, eigenvalues about Table 2 are shown in Fig. 1. The vertical axis shows the number of eigenvalues and the horizontal axis shows eigenvalues.

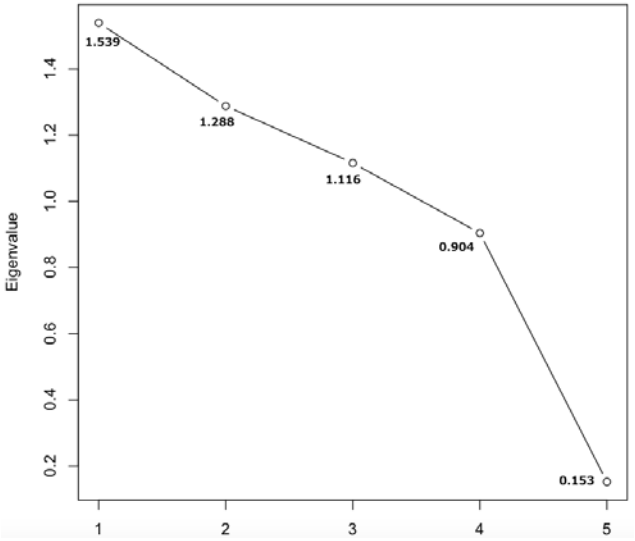

Fig. 1 Eigenvalue

Because the 3 eigenvalues take values greater than 1.0, the 5 variables were classified into 3 groups using exploratory factor analysis. We can obtain the results of factor analysis shown as Fig.2, composed of 4 evaluation values. Proportion Explained means the explanatory rate of common factor in experimental data. Factor loading means the correlation between common factor and each observed variables. Complexity means the degree of simple structure, so it can be said that the contribution to the simple structure is higher as its value is closer to 1.0. Uniqueness means the impact from common factor.

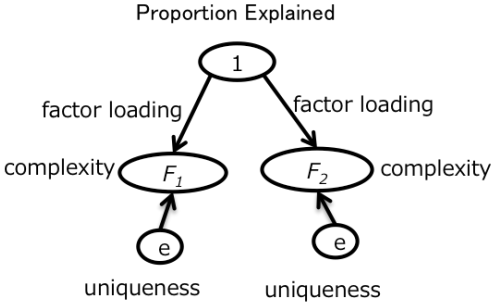

Fig. 2 Example of factor analysis result : Fi mean common factor

The results of factor analysis for all axis rotations are shown as Fig. 3 – Fig. 6.

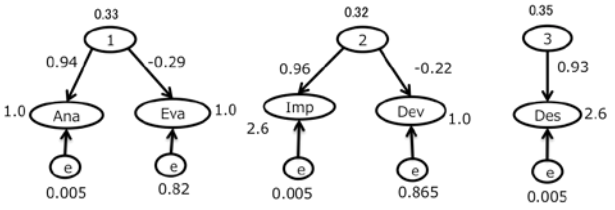

Fig. 3 Clinical Research Educational Model (oblimin)

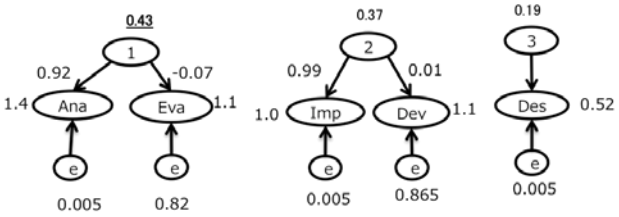

Fig. 4 Clinical Research Educational Model (varimax)

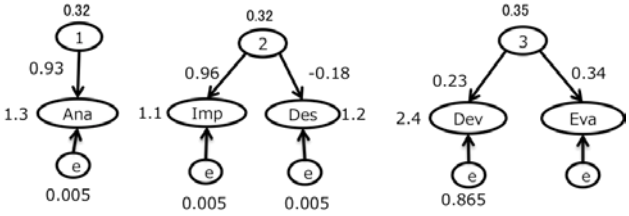

Fig. 5 Clinical Research Educational Model (equamax)

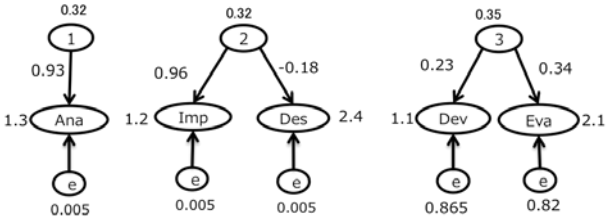

Fig. 6 Clinical Research Educational Model (quartimax)

The classification into 3 groups with promax rotation was impossible due to a small number of variables. Therefore, the result classified 2 groups with promax rotation are shown in Fig. 7.

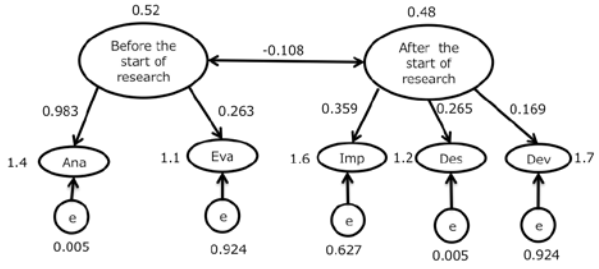

Fig. 7 Clinical Research Educational Model (promax)

We found that classification results depend on rotation method. According to the results of *oblimin* and *varimax* rotation, the combinations of *Ana*・*Eva* and *Imp*・*Dev* belong to the same group. On the other hand, the results of *equamax* and *quartimax* rotation, the combinations of *Imp*・*Des* and *Dev*・*Eva* belong to the same group. As a common point of all the results, *Ana* and *Imp* have high factor load, and they belong to different groups, therefore, we can say that these factors are almost surely classified as different common factors. Furthermore, both *complexity* of them are also close to 1.0, so it can be seen that they are simply classified. Similarly, *Eva* and *Dev* have low factor loads in other words, high uniqueness and both *complexity* of them deviates from 1.0 by comparison with the previous combination. The same result is also seen for the result with *promax* rotation. About Fig.6, we considered two common factors as before and after of the clinical research. We can say that as the flow of clinical research education, analysis of clinical question and design of clinical research belong to the step of before the start of clinical research, and implement and evaluation belong to the step of after start of them. Furthermore, since the correlation coefficient between common factors is low, it was also shown that each of them has high uniqueness.

5. Conclusion

In order to extract clinical research education model, we applied exploratory factor analysis to 5 variables such as *Analysis*, *Design*, *Development*, *Implement*, *Evaluate* scored by clinical research education program students. For the parameters of exploratory factor analysis, rotations of *promax, quartimax, equamax, oblimin, varimax* were applied. From a comparative experimental result, we found that when classified into 3 factors, the variables of *Analysis* and *Implement* belong to different common factors and have a stable structure. On the other hand, the variables of *Development* and *Evaluation* were shown to be highly complicated and difficult to belong to common factors. It was also found that when classified into 2 common factors, it can be distinguished before and after the start of clinical research. As a comprehensive discussion, stabilization and simplification of analysis result can be expected by the addition and deletion of variables used for classification.

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