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Research Article

Grey Relational Analysis on Elderly People' Life Quality and Sports

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Abstract: At present, China has gradually stepped into an aging society and the proportion of the aging population in total population has been increasing continuously. Improving the quality of life of elderly people is a common wish of the whole society. The author conducts surveys on the participation of sports of elderly people and their quality of life by means of questionnaire surveys and analyzes the internal relation between participation of sports and quality of life of elderly people by means of grey relational theory and relation analysis. The results indicate that taking an active part in sports plays an extremely important role in perspectives such as physical health, mental health, spiritual life and social activities etc for elderly people, which means that participating in sports is beneficial to improve quality of life of elderly people. Consequently, the study suggests that the elderly people should participate in sports more actively to improve their quality of life.

Keywords: Elderly people, grey relational analysis, life quality, sports

INTRODUCTION

Aging of population is another critical population problem in the wake of overpopulation in China. With the improvement of living standard and medical standard, the average life span prolongs constantly and the aging of population has drawn widespread attention in the whole society (Morag, 1995). It is a social problem which concerns many aspects such as national economy, social welfare, family life and individual development etc (Padoani *et al*., 1998). Therefore, the later life of elderly people is not merely a kind of family problem, but relates to social issues including social stability, ethics and morals.

Many scholars have conducted researches on improving quality of life of elderly people (Gunilla *et al*., 2005). Some studies have shown that Active participation in sports is contribute to improve physical and mental health of elderly people, resist senility and improve their quality of life (Didem *et al*., 2009). Some research had pointed out that participating in sports will promote blood circulation of the brain, promote metabolism, increase blood flow volume and oxygen uptake and also improve alimentation for elderly people, which will effectively postpone the senescence and promote physical and mental health for elderly people (Nathalie *et al*., 2008). They also had analyzed the current situation of aging of population from the viewpoint of sociology and discussed the characteristics, then put forwarded a series of measures which are beneficial to develop the elderly sports (David and Ann, 2004). For instance, enhance the training strength for professional guidance staff, promote the communalization, servitization and specialization for the elderly sports and also increase special fund to develop the elderly sports. Moreover, researches emphasized that systematization shall be attached importance to when the elderly people are participating in physical activities (Muszalik *et al*., 2011). In this way, it will not only attract more elderly people participating in sports but also make the elderly people to help each other. The elderly people's social circle will be enlarged while enhancing the effects of physical exercises.

It is not uncommon as for the researches on the elderly sports and many scholars have the opinions that participating in physical exercises in a systematization and specialization manner will have beneficial effects on many aspects such as physical health and mental health for elderly people (Bodner *et al*., 2011). However, most of the research results are theoretical analysis and laboratory researches from the perspective such as sociology, mass sport and public health etc, which is insufficient in informative data support such as questionnaire survey and data analysis (Osborne *et al*., 2003). I have to say that is a real defect. The author has selected four cities in eastern, central and western regions and conducted questionnaire survey on the elderly people living in each city. In addition, relational analysis and grey relational analytical method has been used to discuss the influence of sports on the quality of life of elderly people, in the hope that more and more elderly people could participate in sports to promote their physical and mental health, defer senility and improve quality of life.

GREY RELATIONAL ANALYSES

Brief introduction of grey relational analysis: Grey Relational Analysis, GRA is a kind of method for quantitative description of development, variation trend and comparison. The basic approach is that, first of all reference data column and multiple columns of data will be selected to determine the geometric similarity. Multiple data columns are often referred to as comparative data columns. The similarity of geometrical shape reflects the relational degree among the curves (Shih-Hsing *et al*., 2000).

Grey system theory is a kind of system science theory and was put forwarded firstly by Professor Deng Julong. The grey relational analysis is a kind of description and comparison method proposed according to grey system theory (Bor-Tyng *et al*., 2012). At first, it will draw up the variations of the curve for influencing factors and decide the relational degree of the factors by comparing the similarity of geometrical shape of each curve. In this way, the comparison of geometrical relationship of statistical data related to time series in the whole internal system has been realized by quantitative analysis of the development trend in the course of dynamic process, so as to calculate the grey relational degree among reference sequence and each comparative series respectively. The bigger the grey relational degree between reference sequence and comparison sequence is, the more similar these two variation curves will be. In addition, the closer its change direction moves towards the rate, the relationship between them will tie closer (Juchi, 2010).

The superiority of grey relational analytical method lies in the sample size. The regression prediction method, percentage increase method and so on can also be used in quantitative analysis; however, these methods have comparatively higher demands for data acquisition and are insufficient in processing capacity in case of the interference under special situations. While, by establishing analysis prediction model, grey relational analysis can solve the problem effectively such as difficulties in data acquisition and inconsistency of data that cannot be solved by conventional method. The amount of required sample size doesn't matter-the minimum amount could be 4, which is unimaginable in other methods. In the meantime, it also applies to irregular data and the quantitative analysis results are consistent with the qualitative analysis results. The key lies in the nondimensionalization treatment of influencing factors for evaluation, calculating relational coefficient and relational degree as well as sorting the influencing factors by size of relational degree. The grey relational analysis is widely used (Qinbao and Martin, 2011). In every field of social science and natural science, grey relational analysis will be used for description and analysis of the systematic development and variation. For example, evaluation of buildings, comprehensive assessment of crop variety and factor analysis of household consumption and so on.

It shall be pointed out that relational degree is divided into absolute relational degree and relative relational degree. Comparatively speaking, relational degree is applied more widely. In case of big difference in the concentration factors to be analyzed and inconsistent dimensions among the factors, the final analysis results will be influenced or even lead to the wrong conclusion. On the contrary, relative relational degree will correct the defect of absolute relational degree (Jihong *et al*., 2011). It conducts grey relational analysis by use of relative quantities and the final result has nothing to do with specific size but relates only to the change rate of each variation factors with respect to initial values.

General steps of grey relational analysis: Let us have a look at the general steps of grey relational analysis specifically.

The processing steps of grey relational technique can be divided into three steps: at first, determine the optimal evaluation object factor sets and conduct normative approach on the indicators and finally calculate the comprehensive evaluation results and sort these indicators (Duolin, 2011). The concrete steps as follows:

- **Determine the analysis sequence:** Determine the reference sequence-reflect the systematic behavior characteristics and determine comparative sequence-influence systematic behavior.

Let's suppose the reference sequence is Y = {Y (k) | k = 1, 2, Λ, n} and the comparative sequence is Xi = {Xi(k) | k = 1, 2, Λ, n}, i = 1, 2, Λ, m. The reference sequence is also known as the mother sequence and comparative sequence is also known as sub-sequence.

- **Nondimensionalization of the variables:** There may be some different dimensions of the data in the mother sequence and sub-sequence of the system, which means that it is hard to get the correct conclusion or lead to inconvenient comparison at the time of making comparison for the data in different sequences. Therefore, the second step of grey relational analysis is nondimensionalization treatment of the data in different sequences:

$$X_i' = \frac{X_i}{x_i(1)} = \left(\frac{x_i(1)}{x_i(1)}, \frac{x_i(2)}{x_i(1)}, \ldots, \frac{x_i(n)}{x_i(1)}\right) \quad (1)$$

where,
$x_i(1)$ = The value of the reference sequence

- **Calculate the relational coefficient:** The relational coefficient between $x_0(k)$ and $x_i(k)$

$$\xi_i(k) = \frac{\min_i \min_k |y(k) - x_i(k)| + \rho \max_i \max_k |y(k) - x_i(k)|}{|y(k) - x_i(k)| + \rho \max_i \max_k |y(k) - x_i(k)|} \quad (2)$$

Let $\Delta_i(k) = y(k) - x_i(k)$, thus

$$\xi_i(k) = \frac{\min_i \min_k \Delta_i(k) | + \rho \max_i \max_k \Delta_i(k)}{\Delta_i(k) + \rho \max_i \max_k \Delta_i(k) |} \quad (3)$$

where, $\rho \in (\theta, \infty)$ is referred to as the resolution ratio. The smaller the ρ is, the bigger resolving power will be. Normally, the range of ρ is (0, 1) and the specific value depends on the given circumstances. The resolving power is the optimal in case $\rho \leq 0.5463$ and normally = 0.5.

Calculate the relational degree: In grey relational analysis, the relational coefficient of the comparative sequence and reference sequence at every moment (i.e., all the points in the curve) will be calculated respectively. Therefore, there are more than one relational degree values achieved. In view of too much data and inconvenience for overall comparison due to distributed information, the average value can be used as the quantitative representation of the relational degree between comparative sequence and reference sequence. In this way, each point in the variation curve of the mother sequence and subsequence the relational coefficient representing each time point in the curve will be centralized as one value and it will be easier and faster in the course of analytic comparison.

After the relational coefficient of sequence $x_i(k)$ and sequence $y(k)$ have been calculated, then the average value of various relational coefficient will be calculated and the average value r_i is referred to as the relational degree between $y(k)$ and $x_i(k)$. The calculation formula of relational degree r_i as follows:

$$r_i = \frac{1}{n}\sum_{k=1}^{n} \xi_i(k), k = 1, 2, \Lambda, n \quad (4)$$

Sort the relational degree: The third step of grey relational analysis is sorting the relational degree by size and the smaller the relational degree of one sub-sequence is, the more similar the sub-sequence and mother sequence will be and the influencing factors represented by the sub-sequence will have more impact on the systematic behavior characteristics.

RESEARCH METHODS

Literature research: The author has looked up and read over numerous academic monograph and materials in terms of the health of the aged, sports, physical health and mental health as well as searched for statistics and relevant documents related to elderly people's participating in sports from Ministry of Health and the State Sports General Administration, in order to learn the situation of elderly people's participating in sports in China and also the influence of sports on their quality of life.

Table 1: The composition of experts

Category	Title	Number of people
Expert of physical education theory	Professor	4
Expert of public health	Associate professor	3
Psychologist	Professor	4
Expert of presbyatrics	Associate professor	4

Personal interviews:

Interviewing professors in universities and experts: In allusion to the research topic, there were totally 15 people (including experts of physical education theory, experts of public health, psychologists and experts of presbyatrics) selected and interviewed to discuss the relation between elderly people's participating in sports with their quality of life. The composition of experts is as shown in Table 1.

Interviewing some elderly people: For the purpose of research, 30 elderly people in Xiangtan City were selected and interviewed to learn the status of their participating in sports in detail and discussed the influence of sports on their quality of life.

Questionnaire survey:

Questionnaire design: One questionnaire was designed according to the research subject, as shown in appendix 1. After communicating with 15 experts, the questions were designed from four aspects of quality of life--physical health, mental health, spiritual life and social activities to conduct a survey research and also measure the quality of life of elderly people comprehensively.

Validity determination for the questionnaire: To ensure the correctness and rationality of the questionnaire, Delphi method was adopted to determine the validity of the questionnaire. The main content of Delphi method involves weaving the predicted problems and background information into an objective and scientific questionnaire, sending the experts by means of door-to-door delivery and mailing, making predictions by use of experts' experience and knowledge, making the opinions to be stayed on the similar side after composition, induction and feedback for several times in order to improve the accuracy of the prediction.

There are totally three rounds of expert consultation and the collection statistics of the survey is as shown in Table 2.

The evaluation results of questionnaire for 20 experts as shown in Table 3.

It can be seen from the findings in Table 3 that, the questionnaire is basically effective to the experts'

Table 2: Collection of the survey and statistics on experts

Round	Number of experts in consultation	Collected questionnaire	Collection rate (%)
1	20	16	80
2	20	16	80
3	20	18	80

Table 3: Collection of the evaluation results of the questionnaires made by experts

	Highly effective	Effective	Basically effective	Completely ineffective	Total
Number of people	4	14	2	0	20
Percentage	20%	70%	10%	0%	100%

Table 4: The status of questionnaires issuing and collection for reliability inspection

	Issued	Effectively collected
First round	50	44
Second round	50	46

Table 5: The situation of questionnaires issuing and collecting

City	Questionnaires issued	Questionnaire collected	Collection rate of questionnaire (%)
XXX1	100	98	98
XXX2	100	96	96
XXX3	100	96	96
XXX4	100	92	92
Total	400	382	95.5

Table 6: Validity of questionnaire collection

School	Questionnaires collected	Valid questionnaires	Validity (%)
XXX1	98	88	89.8
XXX2	96	85	88.5
XXX3	96	92	95.8
XXX4	92	85	92.4
Total	382	350	91.6

Table 7: Personal information statistics for surveyed elderly people living in four cities

City	Economic income(Yuan/month)	Length of sleep (hours/day)	Length of sports(hours/day)
XXX1	2600	7.7	0.8
XXX2	2200	7.5	0.6
XXX3	1800	7.2	0.5
XXX4	3400	8.0	1.0

Table 8: Survey and statistics of physical health of elderly people living in different cities

City	Number of people	Lowest score	Highest score	Average score	S.D.
XXX1	88	21.5	23.4	22.8	1.1
XXX2	85	22.3	24.2	22.7	0.9
XXX3	92	21.9	22.5	22.2	1.0
XXX4	85	22.0	23.6	23.0	0.8

opinion and can be used for researches on nursing staff in terms of values, working mood and quality of post-disaster nursing care.

Questionnaire inspection: Reliability inspection of the questionnaire is conducted by adopting retesting method. This method requires twice surveys: randomly select 30 elderly people in community XXX1 for questionnaire survey. After 21 days' interval, randomly select 30 elderly people once again in the community XXX1 for questionnaire survey. The status of the questionnaires issuing and collection is as shown in Table 4.

Let X as the statistical score of questionnaire survey in the first round, Y as the statistical score of the questionnaire survey in the second round, N = 50 as the people surveyed, thus the calculation formula of reliability (the relational coefficient of the statistical results twice) is:

$$r=\frac{N\sum XY-\sum X\sum Y}{\sqrt{\left[N\sum X^2-(\sum X^2)\right]}\sqrt{\left[N\sum Y^2-(\sum Y)^2\right]}} \quad (5)$$

After calculation and we get to know the reliability (relational coefficient between them) r = 0.88, which indicates a favorable reliability for the questionnaire designed.

Questionnaire issuing and collection: The author had conducted a survey on elderly people living in major and medium-sized cities of eastern, central and western regions by means of random sampling. The survey on the elderly people living in four cities XXX1, XXX2, XXX3 and XXX4 was conducted between April 2012 and June 2012. There were 400 questionnaires issued and 382 collected, which means that the collection rate of the questionnaire is 95.5%. There were 32 questionnaires removed which were filled halfheartedly, unscrupulously and incompletely and there were 350 valid questionnaires, indicating that the valid rate of the questionnaire is 87.5%. The questionnaire is shown in appendix 1. The result of questionnaire issuing and collecting is as shown in Table 5.

Among the questionnaires collected, there were 350 valid questionnaires and the situation of questionnaire collection is as shown in Table 6.

Relation analysis: The personal information of the surveyed elderly people living in four cities is as shown in Table 7.

By utilizing the software SPSS, after the findings of the questionnaire survey have been treated with statistical process in the form of the five-grade marking system, the scores in terms of physical health, mental health, spiritual life and social activities of elderly people living in different cities as well as the total points for the quality of life of elderly people are shown in Table 8 to 12.

Relation analysis is conducted on personal information of elderly people (economic income, length of sleep and sports) and quality of life (physical health, mental health, spiritual life and social activities) by use of the data in the above table. The analysis results are as shown in Table 13.

Table 9: Survey and statistics of mental health of elderly people living in different cities

City	Number of people	Lowest score	Highest score	Average score	S.D.
XXX1	88	22.1	23.2	22.9	0.8
XXX2	85	21.7	23.1	22.6	1.2
XXX3	92	21.5	22.4	22.1	0.6
XXX4	85	21.9	23.5	23.3	1.3

Table 10: Survey and statistics of spiritual life of elderly people living in different cities

City	Number of people	Lowest score	Highest score	Average score	S.D.
XXX1	88	21.4	22.3	22.3	0.6
XXX2	85	21.3	23.5	22.0	0.9
XXX3	92	20.8	21.9	21.7	1.0
XXX4	85	21.7	23.7	23.4	1.4

Table 11: Survey and statistics of social activities of elderly people living in different cities

City	Number of people	Lowest score	Highest score	Average score	S.D.
XXX1	88	22.0	23.6	23.2	1.2
XXX2	85	22.1	23.2	22.3	0.9
XXX3	92	21.8	22.6	22.2	1.0
XXX4	85	22.2	23.7	22.8	1.1

Table 12: Survey and statistics of quality of life of elderly people living in four cities

City	Number of people	Lowest score	Highest score	Average score	S.D.
XXX1	88	88.3	93.1	91.2	3.7
XXX2	85	84.2	94.4	89.6	4.1
XXX3	92	87.5	91.2	88.2	3.3
XXX4	85	87.3	95.6	92.5	4.0

Table 13: Relation analysis on economic income, length of sleep, length of sports and quality of life of elderly people

Aspects	Overall quality of life	Physical health	Mental health	Spiritual life	Social activities
Economic income	0.21**	0.25**	0.17**	0.22**	0.18**
Length of sleep	0.15**	0.20**	0.18**	0.16**	0.02
Length of sports	0.19**	0.23**	0.20**	0.15**	0.14**

The relational coefficient of both corresponding aspects *p<0.05, **p<0.01

After analyzing the data in the above table, the conclusion can be made as follows:

- The economic income, length of sleep and length of sports have positive relation with physical health, mental health, spiritual life, social activities and quality of life. In addition, the economic income has the biggest relativity with respect to overall quality of life (the relational coefficient r = 0.21**, p<0.01). The relation between length of sports and quality of life takes second place (relational coefficient r = 0.18**, p<0.01). The relation between length of sleep and quality of life is the smallest (the relational coefficient r = 0.15**, p<0.01）. It shows that the economic income has the greatest influence on quality of life, while the length of sports time takes second place and length of sleep is on the lower side.
- We can find out after comparison that the economic income, length of sleep, length of sports have comparatively larger relation with respect to physical health. Therefore, the rise of economic income, increase of length of sleep and increase of length of sports time will effectively improve the physical health and promote the quality of life.

Grey relational analysis: In accordance with grey relational theory, the influence of elderly people's participating in sports on their quality of life has been analyzed from another perspective by utilizing grey relational analytical method.

Table 14: Data sheet for total points of quality of life of elderly people and influencing factors

City	$X_1(k)$	$X_2(k)$	$X_3(k)$	$X_4(k)$
XXX1	91.2	2600	7.7	0.8
XXX2	89.6	2200	7.5	0.6
XXX3	88.2	1800	7.2	0.5
XXX4	92.5	3400	8.0	1.0

Based on the statistical results, set the average value of the scores for quality of life of elderly people living in four cities as the mother sequence and set the indicators of economic income, length of sleep per day and length of sports per day as the sub-sequence to analyze the influence of three sub-sequences on mother sequence by use of grey relational analytical method, so as to come up with the connection between sports and quality of life.

At first, set the average value of the scores for quality of life of elderly people living in four cities as the generating function sequence and then set economic income $X_2(k)$, length of sleep per day $X_3(k)$, and length of sports per day $X_4(k)$, as the sub-function sequence. The specific data are as shown in Table 14.

The data in Table 4 have been processed with non-dimensionalize by use of formula (1) and the data after nondimensionalization refer to Table 15.

Calculate the difference between each column and then find out the maximum absolute difference and

Table 15: The data sheet of nondimensionalization

School	$X_0(k)$	$X_1(k)$	$X_2(k)$	$X_3(k)$
XXX1	1	28.55	0.0844	0.00877
XXX2	1	24.55	0.0837	0.00669
XXX3	1	20.41	0.0816	0.00567
XXX4	1	36.76	0.0865	0.01081

Table 16: Nondimensionalization difference sequence

	$\|x_1(k)-x_2(k)\|$	$\|x_1(k)-x_3(k)\|$	$\|x_1(k)-x_4(k)\|$	
1	27.55	0.9156	0.99123	$\min_i \min_k$ =
2	23.55	0.9163	0.99331	0.9135
3	19.41	0.9184	0.99433	$\max_i \max_k$
4	25.76	0.9135	0.98919	= 27.55

Table 17: Relational coefficients and relational degree in the research

	$\xi_1(k)$	$\xi_2(k)$	$\xi_3(k)$
1	0.355438	0.999857	0.994735
2	0.393529	0.999809	0.994595
3	0.442624	0.999666	0.9945271
4	0.371531	1	0.994873
r_i	0.390781	0.999833	0.994683

minimum absolute difference of each column. Among them, the maximum difference is $\max_i \max_k$ = 27.55 and the minimum difference is $\min_i \min_k$ = 0.9135, as shown in Table 16.

Calculate the relational coefficient by use of formula (2) and formula (3), set ρ 0.5. The relational degree of each sub-sequence can be calculated by use of formula (4). The relational coefficients and relational degree refer to Table 17.

By comparison of the relational degree of each sub-sequence, we will get: $r_1 < r_3 < r_2$.

We can learn from the grey relational analysis theory that the economic income has the greatest influence on quality of life of elderly people. The more economic income, the higher quality of life will be. The economic income of the elderly people living in XXX4 city is the highest and their quality of life is also the highest; the economic income of the elderly people living in XXX3 city is the lowest and their quality of life is also the lowest. It literally has the rationality in this regard. The economic income is the assurance for quality of life and well-off living environment will lead to relatively superior later life of elderly people. It can ensure abundant nutrition for the elderly people and ensure physical health; it could also make elderly people to keep in a cheerful mood without worrying about bread-and-butter issues; it would enable the elderly people to buy books, participate in concert and have colorful activities to keep life joyful. Economic income can ensure the quality of life of elderly people to keep them at a high level in many ways consistently.

The length of sports time per day ranks only second to economic income and ranks the second in the relevant sequence, which suggests that the length of sports time is also an important indicator that influences the quality of life. The longer the length of sports time, the higher total points of quality of life of elderly people will be. Participating in sports will make the elderly people to do physical exercises effectively to improve their physical function, strengthen physique, prevent disease and promote physical health. Participating in sports will broaden the mind and relieve the tension, which plays an important role in keeping the elderly people in optimistic and positive attitude. Moreover, sports is a kind of socializing way for making friends and social communication, which also plays a significant role in improving the quality of life of elderly people.

The length of sleep ranks the third in relevant sequence, which shows that the influence of length of sleep on the quality of life of elderly people is on the small side in comparison with economic income and length of participating in sports. However, it cannot be ignored similarly. Sufficient sleeping is beneficial to metabolism to ensure adequate energetic power in the daytime. Long-term deficiency of sleeping will lead to sluggish, dull reaction and degradation of physical fitness, which will greatly affect the physical and mental health. It can be seen from the table that the quality of life of elderly people living in XXX4 city is the highest and their length of sleep is also the highest, while the length of sleep of the elderly people living in XXX3 city is short. We can find out by comparison that the degree of correlation between length of sleep and length of sports time is extremely close, indicating their similar influences.

CONCLUSION

At present, aging of population is another population problem that has to be faced by China. Similarly, the quality of life of elderly people during the course of their later life is a major concern in our society. The study adopts grey relational theory and relational analysis method to conduct questionnaire survey on elderly people living in four cities from the perspective of sports and also discusses the issues of improving quality of life of elderly people. It turned out that Active participation in sports will improve the physical fitness of the elderly people and play an extremely important role in terms of keeping optimistic and positive attitude, enriching the spiritual life, promoting social communication and enlarging social circle and so on. Active participation in sports will greatly improve the quality of life of elderly people.

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