"Measuring Quality of Life of Elderly People: A Fuzzy Approach"

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Abstract

Objective:

Uncertainty arises due to partial information about the problem or due to information which is not fully reliable. But the apparatus of probability theory cannot cover all kinds of vagueness; therefore the necessity of new approach was obvious. To fill up this gap a new approach has been developed.

Fuzzy logic deals with reasoning that is approximate rather than fixed and exact. The term "fuzzy logic" was introduced in conjunction with the proposal of fuzzy set theory by Lotfi A. Zadeh in the year 1965.Fuzzy logic has been applied to many fields. In this paper we have made an attempt to use the fuzzy approach to measure the quality of life.

Fuzzy set theory can improve various aspects of measurement with questionnaires. However, very little is known about how to use Fuzzy approach to measure quality of life(QOL). The main purpose of our study was to find an appropriate fuzzy measure for Quality of life(QOL) that, while demonstrating the advantages of Fuzzy approach, can also be compared with mainstream Quality of life measures, most of which use traditional Likert-type scales.

Methods:

Referring to the literature on fuzzy scoring methods, at first the measurement scale and scoring method of the traditional Older People's Quality of Life Questionnaire (OPQOL) which uses a five-point Likert-type scale are revised. Then, the psychometric relationships of the fuzzy measures and the traditional **OPQOL** are examined.

Results and conclusion:

The results show that a fuzzy-scales weighted-by-membership (FSWM) version of the OPQOL is comparable to the traditional OPQOL in that it accepts strong invariance and shows almost perfect agreement. It also demonstrates higher reliability and validity than the traditional OPQOL. From the results of the study the use of FSWM to measure QOL in future studies is recommended.

Keywords: *Fuzzy Approach, Likert-type scales ,Quality of life, Older People's Quality of Life Questionnaire etc.*

Introduction

The world population has been experiencing significant ageing- the process that results in rising proportions of elderly in the total population. Around the globe, the proportion of elderly people (age 60 years and above) is growing faster than any other age group. It is estimated that during the period 1970 and 2025, the growth of elderly people will be about 22.3% which accounts about 694 million people (World Health Organization, 2002). In 2025, there will be a total of about 1.2 billion people over the age of 60 and by 2050 there will be 2 billion with 80% of them living in developing countries. According to the United Nations (UN), "Population ageing is unprecedented, without parallel in human history and the twenty-first century will witness even more rapid ageing than did the century just past." India has also been experiencing rapid growth of elderly population. In India, the proportion of elderly population was about 7 per cent in 2009 (88 million) which is expected to increase to 20 per cent (315 million) by the year 2050. Ageing has profound consequences on a broad range of economic, political and social processes. Ageing also causes a higher probability of suffering from multiple health complaints. So living longer in most cases also means having more symptoms and diseases, most of which seem to cause distress in daily living (Campbell *et al.,* 1994). Moreover, at this time of life may include stressful events, retirements, decrease income, changes to socializing, physical functioning and death of love one. Thus despite the increase of life expectancy there is a vital question if they experience ill health, limited in physical functioning, uncomfortable situations; like loneliness, depression, social isolation or controversial quality of life. As a result of this, the most important priority is to promote the well-being of the growing number and proportion of older persons. Therefore, one of the greatest public health challenges of the present times is to increase the numbers of years of healthy and better quality life. To cope up with this challenge United Nations World Assembly on Ageing, held at Vienna in 1982, formulated a package of recommendations which gives high priority to research related to developmental and humanitarian aspects of ageing. In view of the increasing need for intervention in area of old age welfare, Ministry of Social Justice and Empowerment, Government of India adopted 'National Policy on Older Persons' in January, 1999. The policy provides broad guidelines to State Governments for taking action for welfare of older persons in a proactive manner by devising their own policies and plans of action. The issues related to the elderly population may be addressed with the multidimensional concept of quality of life and its measurement.

The concept of "quality of life" has already a research history of about 30 years; but it is only in recent years that it has become central in research both in medical field and in social policy decision making (Birren *et al.*, 1991). The World Health Organization defines quality of life as "individuals' perceptions of their position in life in the context of the culture and value systems in which they live and in relation to their goals, expectations, standards and concerns (The WHOQOL Group, 1994). The concept of quality of life is used as an umbrella term to cover different aspects of people's life and denotes the degree to which a person enjoys important possibilities of his/her life. These possibilities can be conceptualized in terms of the quality of physical environment, institutions, and welfare provisions in a country, on the one hand, and economic status, health status, psychological well being, social life, and spiritual needs of the people, on the other (Raphael, 1996). As a consequence of the multitude of approaches to Quality of life, a lot of different measures have been developed to serve the needs of research and decision making (Fayers & Machin, 2007). A number of quality of life measuring instruments particularly for elderly population have also been developed in recent time (Bergland & Wyller, 2006; Bowling, 2009; Brazier *et al.*, 1996; Fleck *et al.,* 2006). One of the most popular quality of life measuring instruments for elderly is Older People's Quality of Life Questionnaire (OPQOL-35) (Bowling *et al.*, 2011). It has been applied successfully in many parts of the world. The researchers attempt to develop a fuzzy version of OPQOL-35. OPQOL-35 uses the Likert scaling method for measuring Quality of life of older people residing in Assam.

Likert scale is used in quantities which intended to measure traits, attitudes, perceptions, opinion etc. the tendency of which runs from a low to high intensity. The questionnaires having likert scale are usually subjective in nature and ask the respondents to indicate their level of agreement with a declarative statement. Questionnaires having likert scale may be 5 point or 7 point likert scale. Usually 5-point likert scale are used to measure traits. The five point likert scale has five responses usually labeled as 1= strongly agree, 2= agree, 3=neither agree nor disagree, 4=disagree, 5=strongly disagree. Depending on what is being measured, the scale labels may be worked differently. Likert scale has been considered as the pillars of wide range of measuring instruments. Some of which worth mentioning are EORTC QLQ-C30 for measuring the quality of life of cancer patients and its site specific modules, OPQOL-30, Medical Outcomes Study (SF-36), Functional Assessment of Cancer (FACT-G), Quality of Life in Epilepsy (QOLIE-89) etc.

In spite of wide popularity of likert scale it is not free from debate. The main focus of debate is about the scale of measurement under which the labels of likert scale should consider. Likert (1932) its inventor claimed that the labels of responses under likert scale should assumed as interval scale. Edward (1957) also supported his view as they acquire through psychological scaling. They also supported the method of combining the scores of all the questions to measure the latent variable considering the scales are interval scale Measures like addition, subtraction, multiplication and calculating arithmetic mean and standard deviation is permissible in likert scale. Many researchers have contradictory view regarding this and they considered Likert scaling to be in the ordinal form (Hodge & 13 Gillespie, 2003; Pett, 1997). According to interval scale the differences between any two

consecutive values shows equal differences in the variable measured. It is not appropriate to conclude that the intensity of feeling between "strongly agree" and "agree" is equivalent to the intensity of feeling between other consecutive categories of a Likert scale (Cohen et al. (2000)). Thus it is inappropriate to use the above measures to data having Likert scale (Clegg, 1998). Due to this argument, the use of fuzzy Likert scale is considered to be more appropriate over the use of traditional Likert scale.

Test Instrument

The OPQOL- 35 (Bowling *et al*., 2011) is composed of eight constructs or scales carrying 35 questions or items. Each construct has different numbers of questions/items. The constructs are 'life over all', 'Health', 'Social relationship', 'Independence', 'Control over life', 'Freedom', 'Home and neighbor", 'Psychological and emotional well being', 'Financial circumstance' , 'Leisure activities' each carrying 4, 4, 5, 4, 4, 4, 4, and 6 questions respectively. Each question has five points response, i.e. strongly agree, agree, neither agree nor disagree, disagree and strongly disagree. Respondent has to respond any one of the above mention items base on his/her own perception. Structure of OPQOL-35; given in table 1.

Table 1: Structure form of OPQOL-35

Sl. No	Construct	Total questions	Item range
1	Life overall	4	4
2	Health	4	4
3	Social relationship	5	4
4	Independence, control over life	4	4
5	Home and neighborhood	4	4
6	Psychological and emotional well-being	4	4
7	Financial circumstances	4	4
8	Leisure and activities	6	4

Data collection :

The data collected in the present study through a cross sectional study design. Here in the present study a random sample of elderly persons (60 years and above) residing in Dibrugarh District of Assam are included. The sampling technique use in this study is a multistage cluster sampling method, as we do not have the sampling frame of elderly person living in the study area. At first, the Assamese version of the questionnaire was tried out with 100 elderly people to check its reliability and validity by using different statistical methods. The results of the reliability and validity analysis are presented through a paper to be publish Assam Statistical Review Vol. 32. Items having discrimination value less than 0.2 are dropped from the questionnaire in the context of older people

of Assam. As a result, out of 35 items 20 items retained which form the final questionnaire. The final questionnaire were administrated to a total of 200 older people residing in Dibrugarh district of Assam. After taking the consent, the OPQOL-20 questionnaire administrated to the older persons and asked them to fill-up the instrument. However, some older persons are unable to do this because of cognitive impairments, communication defects; severe distress caused by age or because of the quality of life measure is too burdensome physically or emotionally. Under these circumstances, a proxy has been used who may be a very close family member looking after the respondent as advocated by Addington (Addington *et al.*, 2001). The OPQOL-35 is a self-reporting instrument. So, before administrating it to study subjects, OPQOL-35, it was translated to Assamese language by using forward-backward method (Aaronson *et al.*, 1993).
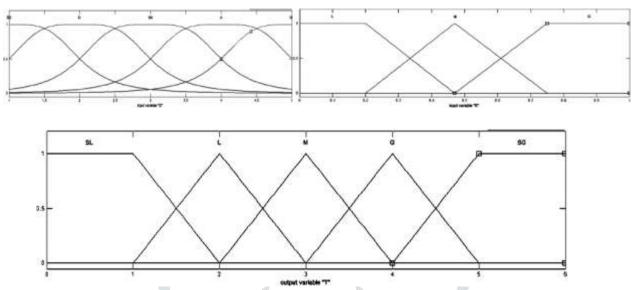
Fuzzy form of OPQOL-20 :

A fuzzy form of likert scale is proposed by Li, 2013. In this form of likert scale a respondent has to choose an agreement level on the scale which is same as the traditional method. In spite of this, the respondent has to assign a membership degree €[0,1] to the chosen agreement level. This membership degree indicates how strongly one complies with the level of agreement. For example, let us consider one question from OPQOL-35 i.e. "I enjoy my life overall" with five different options to answer, they are "Strongly agree", "Agree", "Neither agree nor disagree", "Disagree" and "Strongly disagree". One respondent might have an agreement level between "Disagree" and "Strongly disagree". For traditional likert scale he has to choose either "Disagree" and "Strongly disagree" which does not precisely reflect his exact agreement level. With the fuzzy form of the likert scale, a respondent is allowed to assign a partial membership degree to an agreement level which ranges from 0 to 1. If he tends "Strongly disagree" more than "Disagree", he may assign more membership degree to the agreement level "Strongly disagree" and less membership degree to the agreement level "Disagree". The following examples depicts the process,

Items of OPQOL-35						Likert Scale	Traditional Likert Scale
	SA	A	NN	D	SD		
I enjoy my life overall				0.3	0.7		
I am happy much of the time				0.8	0.2		
I look forward to things		0.2	.6	0.2			
Life gets me down	1						

Data were collected by using fuzzy likert scale as described above.

Fuzzyfication of Assamese version of OPQOL-20 : In the process of fuzzyfication, we first needs to develop the membership functions for further process of the collected data. The pictorial view of the membership functions

for responses, discrimination and suitability of answer are shown from figure 1 to figure fig. 3. Here, responses and discrimination are considered as the inputs and suitability of answer is considered as the output variable.

The fuzzy inference process is done by using Mamdani method which involve two steps (i) fuzzification and (ii) defuzzification. In the fuzzification process, we set up 18 numbers of if-then rules. For the if-then rule, there are two inputs viz., opinion of the respondents (O) and discrimination (R) of the item. The output is a suitable answer (T). The linguistic variable opinion (O) has the levels Strongly agree (SA), Agree (A), Neither agree nor disagree (NN), Disagree (D) and Strongly disagree (SD). The discrimination variable (R) has the levels least (SL), less (L), moderate (M), more (G) and most (SG). Answer suitability is measure by the levels less (L), moderate (M), more (G). A total of 18 if-then fuzzy rules were made some of which are given below.

Rule 1 : If (O is SA) and (R is SL) THEN (T is L)

Rule 2 : IF (O is SA) and (R is L) THEN (T is G)

Rule 3 : IF (O is SA) and (R is M) THEN (T is M)

.   .   ..   .

Rule 18 : Rule 3 : IF (O is SD) and (R is M) THEN (T is M)

Mamdani inference system is used to these If-then rules. The fuzzy values are not directly interpretable so they must be defuzzify. The defuzzification is done by using Centre-of-area (COG) method. Data collected by using the traditional likert scale and the fuzzy likert scale are compared by using mean, standard deviation. The fuzzification process is done by using MATLAB software. Different descriptive measures are calculated for data collected through traditional likert scale and fuzzy likert scale. The normality of the data collected by the two instruments is tested by using Kolmogorov-Smirnov test.

Analysis :

The responses for each of the 20 items of the fuzzy likert scale are modified in comparison to the traditional likert scale. The responses of the fuzzified OPQOL-20 is presented in table 2.

Table 2 : Responses of the fuzzy Likert scale

Items	Discrimination	Likert scale		Fuzzy Likert Scale		
		1	2	3	4	5
1	0.281	1.57	2.18	3.1	3.98	4.44
2	0.485	1.23	2.44	3.06	4.04	4.44
3	0.495	1.27	2.18	3.1	4.05	4.61
4	0.33	1.43	2.44	3.07	4.05	4.58
5	0.447	1.5	2.22	3.07	4.06	4.78
6	0.389	1.24	2.34	3.03	4.05	4.68
7	0.34	1.46	2.24	3.07	3.98	4.68
8	0.275	1.33	2.22	3.05	4.05	4.51
9	0.298	1.4	2.33	3.1	4.05	4.68
10	0.543	1.56	2.2	3.12	4.05	4.54
11	0.287	1.27	2.22	3.06	4.05	4.545
12	0.432	1.39	2.23	3.07	4.05	4.61
13	0.521	1.47	2.25	3.08	3.99	4.78
14	0.345	1.49	2.12	3.06	4.04	4.78
15	0.356	1.33	2.34	3.13	4.11	4.87
16	0.602	1.21	2.43	3.08	4.07	4.45
17	0.512	1.37	2.2	3.11	4.03	4.32
18	0.363	1.12	2.25	3.09	4.08	4.74
19	0.511	1.17	2.15	3.05	4.02	4.56
20	0.204	1.22	2.31	3.12	4.03	4.63

The mean and standard deviation for responses collected through traditional OPQOL-20 and the fuzzy OPQOL-20 are presented in table 3.

Table 3: Descriptive measures of likert and fuzzy likert scale

	Traditional Likert Scale		Fuzzy Likert Scale	
	Mean	S.D	Mean	S.D.
I enjoy life overall	3.61	0.88	3.76	0.76
I am Happy much of the time	3.34	0.89	3.45	0.73
I have lot of physical energy	3.07	1.11	3.14	0.98
Pain effects my well-being	2.67	1.11	2.80	0.88
My health restricts me	3.11	1.09	3.10	0.96
family, friends and neighbour help me	4.48	0.57	4.61	0.45
I would like more companionship	4.39	0.63	4.44	0.61
someone who gives me love and affcetion	4.38	0.74	4.38	0.63
more people to enjoy life with	4.22	0.86	4.26	0.69
I have children around	4.46	0.70	4.58	0.56
health enough to have independence	3.05	1.21	3.07	1.02
I feel safe	4.71	0.52	4.81	0.56
I get pleasure from home	4.62	0.56	4.70	0.41
I have enough momey for household bills	3.05	1.27	3.16	0.89
I have enough money for household repairs	2.99	1.23	3.06	0.99
I can buy what I want	2.90	1.16	3.04	1.03
I have social and other activities	4.03	0.74	4.02	0.68
I try to saty involve with things	3.80	0.91	3.93	0.82
Role in Life	3.45	1.03	3.50	0.79
Cultural and religious festivels	4.60	0.53	4.10	0.33

From the tables it can be observed that, the mean calculated for different questions of both the likert scale and the fuzzy likert scale are more or less same. Thus by using arithmetic mean it is not possible to compare the quality of data gather through the likert scale and fuzzy likert scale. The standard deviation of responses of all the 20

questions obtained through fuzzy likert scale are smaller than that of data obtained through traditional likert scale. From this we can infer that data collected through fuzzy likert scale are of improved quality.

Test of normality : The normality of data collected both the instruments are tested by using Kolmogorov-Smirnov test. The result of the test shows that, the responses of all the questions collected through the fuzzy likert scale are normally distributed. On the other hand, the responses of all the questions collected through traditional likert scale are not normally distributed. The results of the first five questions are presented in the table 4.

	Traditional Likert Scale		Fuzzy Likert Scale	
	Statistics	P-value	Statistics	P-value
I enjoy life overall	0.297	> 0.01	0.031	0.200
I am Happy much of the time	0.244	> 0.01	0.021	0.257
I have lot of physical energy	0.399	> 0.01	0.07	0.131
Pain effects my well-being	0.243	> 0.01	.132	0.03
My health restricts me	0.225	> 0.01	0.011	0.34

As the data collected through fuzzy likert scale is normally distributed so the measures like arithmetic mean, standard deviation can be used can be used to analyse them.

Conclusion : Researchers claimed that the responses of a likert scale follow ordinal scale. The newly developed fuzzy form of Assamese version of OPQOL-20 is an improvement over the traditional one in the sense that the responses of it are in the interval scale. It allows the use of arithmetic mean and standard deviation it etc. It is also found that the data obtained through the fuzzy likert scale follow normal distribution which indicate that proper parametric statistical test can be used to it. The measure of central tendency and dispersion calculated for data obtained through likert scale and fuzzy likert scale are not suitable for comparison the quality of the data. A low standard deviation indicates that the data points tend to be close to the mean. A high standard deviation indicates that the data are spread out over a large range of values. Further, it is more convenient to collect data through the traditional likert scale than that of fuzzy likert scale because in the latter we have to obtain some quantitative data from the respondents which are used to assign the membership value to their responses.

The future scope of research may be to study the quality of data obtained through the traditional liker scale and the fuzzy likert scale.

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