THE USE OF ANALYTIC HIERARCHY PROCESS FOR THE PRIORITIZATION OF FACTORS AFFECTING WELLBEING IN ELDERLY

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ABSTRACT

The definition of well-being is complex and well-being may be affected by a wide variety of factors. Among older people well-being is even more complex, because it may vary depending on different individuals' backgrounds and experiences. Nonetheless, it is important to understand what the concept of well-being means to older people and which factors affect well-being, because of the growing importance of cost-utility studies in medicine and health services research. Such studies aim to measure the quality of life in participants before and after a medical/surgical intervention. However, the scales used to measure quality of life are based on expert opinion, and could be improved by being more focused on what the concept of well-being means to older people themselves.
In this study, based on scientific literature, we defined a hierarchy of 45 factors, organized into 15 sub-categories, which were grouped into 5 main categories. A questionnaire was submitted to 23 older people who participated in a focus group on well-being. Based on their responses, we used the Analytic

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Hierarchy Process to develop a hierarchy of factors that contribute to well-being in later life. Our experience leaded us to believe that AHP could contribute to qualitative research, assessing the priority of factors influencing the wellbeing in older people.

Keywords: AHP, Well-being, older people, utility.

1. Introduction

In the last decades the rising of EBM reinforced the idea on hierarchy of evidence, which judge specific types of knowledge to be more valuable than others. Particularly significant in healthcare are considered the clinical trials, which does not make it easy for qualitative researchers to contribute to the health care debate, while there is a high potential contribution of qualitative methods and qualitative research in medicine and healthcare [Popo 2001]. Nonetheless, ddespite of hierarchy of evidence the complexities of health problems continue requiring data from a spectrum of qualitative and quantitative knowledge and, as reported by Leys et al. [Leys 2003] "qualitative evidence could be put higher in the hierarchy of 'evidence generating research' in health care in so far that methodological prerequisites of the methods used are respected and clarified".

The Analytic Hierarchy Process (AHP) is a method particularly effective in quantifying qualitative knowledge by measuring intangible dimensions. This is important because intangible dimension, which can be measured only with qualitative research, cannot be direct measured using absolute scale [Saaty 2009], and so far via clinical multicentre trials. AHP bases on the idea that judging the *relative* importance of elements, i.e., comparing pairs of them in a hierarchic structure, is more reliable than judging their absolute importance. AHP is an analytic aims to solve multifactor and multidimensional fuzzy problems [Johnson 2001]. Several studies assessed its effectiveness for medical and healthcare decision making [Liberatore 2008]. The AHP has been suggested and applied for use in medical diagnosis [Dolang 1990], and in many study in order to include patients in designing and choosing the healthcare programs to undergo [Dolang 1993, Dolang 2000, Dolang 2003, Liberatore 2003].
In this paper we apply AHP to a group of health elderly to prioritize factors contributing to their wellbeing. The aim of this paper is to provide further insight in how elderly balance factors affecting wellbeing and to investigate if AHP can contribute in this task.

2. Methods e materials

The method we used consist of six steps as represented in the Figure 1. Each step is further described.

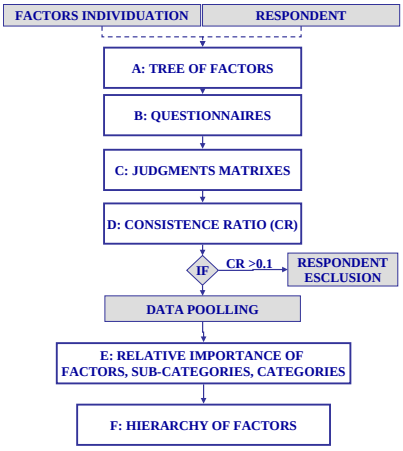

Figure 1. algorithm of AHP.

A. Tree of factors.

From previous studies, we first identified a range of factors, which concur to wellbeing in elderly. We then grouped them into meaningful categories, inspired to pyramid of needs of Maslow [Maslow 1943]. Each category was further organized in three subcategories. Successively, we designed an oriented graph, a tree, in which the vertexes are defined as following: each factor is a leaf; each sub-category is a root; each category is a hyper-root.

B. Questionnaires.

For each pair of factors (*i*,*j*) of each category, respondents were asked the following question: "in your opinion is *i*, compared to *j*: much less, less, equally, more, or much more important?" Respondent was required to choose one option. Similar questions were posed to compare categories of needs. In accordance with the scale of Saaty, a numerical value was given to each judgment as shown in Table 1.

Table1 Saaty Fundamental Scale.

Judgments	Score
much more important	5
more important	3
equally important	1
less important	1/3
much less important	1/5

C. Judgments matrixes.

From responders answer, using scores defined in table 1, for each sub-category of factors we constructed a judgment matrix A_{nxn}, where "n" is the number of factors in this sub-category. This matrix has as the generic element (a_{ij}), the ratio between the relative importance of the factor "*i*" (F_i) and the relative importance of the factor "*j*" (F_j). Assuming the reciprocity of judgment, the element a_{ji} is the reciprocal of a_{ij}, becouse if F_i is 3 times more than F_j, then F_j should be 1/3 that of F_i. Moreover, the diagonal elements a_{ii} are equal to one, because F_i is equally to it self. Finally, A is assumed to be a transitive matrix, which means that "$\forall\, i, j, k \in (1;n),\ a_{ij} = a_{ik} * a_{kj}$". This property comes from the definition of a_{ij}, as reported in the following equation:

1) $$a_{ij} = \frac{F_i}{F_j} = \frac{F_i}{F_k} * \frac{F_k}{F_j} = a_{ik} * a_{kj}$$

This is called transitivity propriety and reflects the idea that if $F_i = a_{ij} * F_j$ and $F_j = a_{jk} * F_k$ then $F_i = (a_{ij} * a_{jk}) * F_k$. It has been proved [Saaty 1997] that, if the judgments are consistent in respect of the transitivity propriety, this matrix will have each column proportional to the other and so far only one eigenvalue (λ), which will be equal to "n". The corresponding eigenvector is again proportional to each column and its components, normalized, represent the relative importance of each factor within its category. This step was iterated for each sub-category of risk factor. Finally, by applying the same algorithm to the questionnaire on the relative importance of sub-categories it was possible to evaluate their relative importance into their categories. The same was done to assess the relative importance of categories of factors for wellbeing. The outcome of this step is, for each respondent, a set of judgment matrices: for each respondent one matrix per each sub-category, containing relative judgments on factors within the sub-category: for each respondent one matrix each category, containing relative judgments on sub-categories within the category: for each respondent one matrix containing judgments on categories.

D. Inconsistency

In case the judgments are not fully consistent, the column of the matrix are not proportional, so the matrix has more eigenvectors and none proportional the all the column. For this reason none is anymore representative of relative importance of each factor. The strategy adopted in this case was to chose as main eigenvector, the one corresponding to the major eigenvalues (λ_{max}), and chose its normalized components to represent the relative importance of each factor, as described in paragraph C. This will generate an inconsistency, which can be estimated by posing some redundant questions. Considering three factors *i*,*j*, and *k*, the respondent is asked to perform the pair comparisons *i*-*j* and *j*-*k*, and then the redundant comparison *i*-*k*. The answer to the redundant question is compared with the one deduced from the first two, assuming the transitivity of judgment, applying the equation 1. The difference between the real answer and the transitive one represents the degree of inconsistency. Mathematically, the coherence of each response is modelled as an error: $error_{ij} = a_{ij} - a_{ik} * a_{kj}$. The global effect of these errors, which reflects the global inconsistence of the respondent, can be estimated measuring the difference of the major eigenvalue λ_{max} from "n". The error is zero when the framework is completely consistent. This error can be seen as a precision error and could be in part due to the scale adopted, which has only natural numbers. For this reason, an error less than 0.1, is usually accepted [Saaty 1996], as it is the 10% of the minimum step of the judgment scale. Typically, the

threshold inconsistency is assumed as 0.1. An error over this threshold is considered too high for reliable decisions. The outcome of this stem is an index, which state, for each respondent, which matrices is consistent.

E. Data Polling

Following a well assessed group decisions support techniques, we integrated individuals' opinions, by applying the geometric mean [Kim 2001, Ramanathan 1994] among respondents, to each consistent judgments matrixes. After this averaging process, for each sub-category and category, there is just one matrix, which reflects the average opinion of all the respondents. Each of these matrixes is consistent, because the geometric mean preserves transitivity by definition, as briefly reported in equation 2:

2) $$\bar{a}_{ij} = \sqrt[m]{\prod_{z=1}^{m} a_{ij}^{z}} = \sqrt[m]{\prod_{z=1}^{m} a_{ik}^{z} * a_{kj}^{z}} = \sqrt[m]{\prod_{Z=1}^{m} a_{ik}^{z}} * \sqrt[m]{\prod_{z=1}^{m} a_{kj}^{z}} = \bar{a}_{ik} * \bar{a}_{kj}$$

$\bar{a}_{ij}$, $\bar{a}_{ik}$, $\bar{a}_{kj}$, are the averaged ratios between F_i, F_j, F_k; "m" number of consistent responders.

The outcome of this step is a set of averaged consistent judgment matrices ($\bar{A}$): one per all consistent respondents per each sub-category, containing averaged relative judgments on factors within the sub-category: one per all consistent respondents per each category, containing averaged relative judgments on sub-categories within the category: one per all consistent respondents containing averaged judgments on categories.

F. Relative importance of factors, sub-categories and categories.

From each averaged matrix $\bar{A}$, we calculated the main eigenvector and its normalized components represent the relative importance of each judged element. Iterating this per each matrix we calculated the relative importance of each factors within its sub-category (Factor Importance, F.I.), of each sub-category within its category (Sub-category Importance, S.I.), and finally the relative importance of each category of factor for wellbeing (Category Importance, C.I.). The product of F.I. per S.I. of its sub-category gives the relative importance of each factor within its category (F.I.C). Similarly, the product of F.I.C. per C.I. of its category gives the Global Importance of each factor (G.I.). Finally, in order to easily communicate the final result, we calculated the Global Importance Ratio (G.I.R.) as the ratio between each G.I. and the minimum G.I among all factors.

G. Hierarchy graphical representation

The relative importance of each factor into a sub-category is used to weight the edge linking the corresponding leaf to its root. Iteratively, the relative importance of each sub-category of factors is the weight of the edge linking the corresponding root to its hyper-root. The same is done for roots and hyper-roots. The relative importance of each element of the hierarchy is assessed as further described.

3. Results

All the study involved 23 respondent. From these, 3 were secluded because did not answered to some questions, and 2 because give multiple responses.

We identified 5 categories, each containing 3 sub-categories (Figure 2). Nonetheless, the tree did not follow the structure of the pyramid, in order not to influence answerers. Each sub-category contained tree factors, as reported in Tables 2-6.

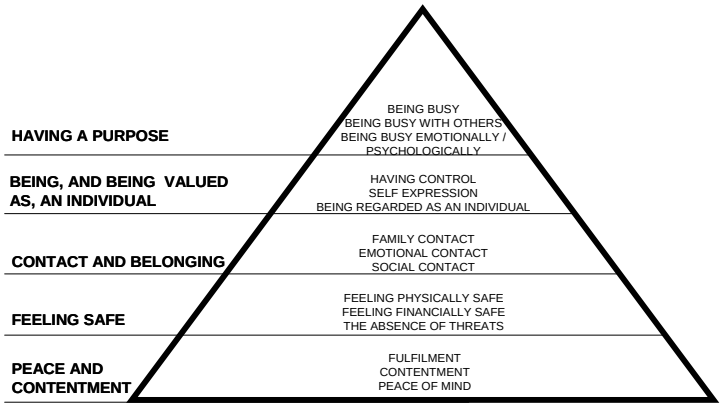

Figure 2. Piramid of Factors.

Table 2. factors grouped as "Having a purpose" category.

Factors	Sub-Group
Doing something I like	BEING BUSY
Pursuits, Pastimes, Interests	BEING BUSY
Travel and favourite places	BEING BUSY
Caring	BEING BUSY WITH OTHERS
Being helpful	BEING BUSY WITH OTHERS
Having motivation and drive	BEING BUSY WITH OTHERS
Knowing you are loved	BEING BUSY EMOTIONALLY / PSYCHOLOGICALLY
Freedom from pain	BEING BUSY EMOTIONALLY / PSYCHOLOGICALLY
Freedom from worry	BEING BUSY EMOTIONALLY / PSYCHOLOGICALLY

Table 3. factors grouped as "being, and being valued as, an individual" category.

Factor	Sub-Group
Having choices	SELF EXPRESSION
Having a say	SELF EXPRESSION
Having good morale	SELF EXPRESSION
Having control over your life	HAVING CONTROL
Doing what pleases you	HAVING CONTROL
Living independently	HAVING CONTROL
Being valued, respected, wanted	BEING REGARDED AS AN INDIVIDUAL
Being accepted unconditionally	BEING REGARDED AS AN INDIVIDUAL
Not being classed as old	BEING REGARDED AS AN INDIVIDUAL

Table 4. factors grouped as "contact and belonging" category.

Factor	Sub-Group
Having contact with my family	FAMILY CONTACT
Feeling part of a family	FAMILY CONTACT
Being with my family	FAMILY CONTACT
having contact with friends	SOCIAL CONTACT
Socializing	SOCIAL CONTACT
Meeting people with a smile and getting one back	SOCIAL CONTACT
Loving/being loved	EMOTIONAL CONTACT
Laughter	EMOTIONAL CONTACT
Having hugs	EMOTIONAL CONTACT

Table 5. factors grouped as "feeling safe" category.

Factor	Sub-Group
health	FEELING PHYSICALLY SAFE
disasters	FEELING PHYSICALLY SAFE
crime	FEELING PHYSICALLY SAFE
absence of threats for my family/friends	THE ABSENCE OF THREATS
absence of threats for me	THE ABSENCE OF THREATS
absence of threats for my property	THE ABSENCE OF THREATS
financial security	FEELING FINANCIALLY SAFE
knowing i owe nothing	FEELING FINANCIALLY SAFE
stability	FEELING FINANCIALLY SAFE

Table 6. factors grouped as "pace and contentment" category.

Factor	Sub-Group
Calm and Balance	PEACE OF MIND
Safe, Relaxation	PEACE OF MIND
Stability	PEACE OF MIND
Being happy with myself	FULFILLMENT
Doing things I like	FULFILLMENT
Having time for myself	FULFILLMENT
Having a positive outlook	CONTENTMENT
Being at peace	CONTENTMENT
Being content	CONTENTMENT

In order to allow pair-vise comparisons between all the pair of elements to each responded were submitted 21 questionnaires: one aiming to compare categories between them: 5 for compare sub-categories, within each category, 15 to compare factors within each sub-category. For each questionnaire was studied a layout in order to maximize elderly legibility ad to minimize errors (Figure 4).

Question 17: FEELING PHYSICALLY SAFE

How important is each factor on the left compared to the one on the right for you to feel PHYSICALLY safe.

HEALTH is	much less	less	equally	more	much more	important than CRIME
CRIME is	much less	less	equally	more	much more	important than DISASTERS
DISASTERS are	much less	less	equally	more	much more	important than HEALTH

Figure 3: layout of questionnaires. In the figure 1 of the 21 questionnaire submitted.

Analyzing the questionnaires, for each responded were constructed 21 judgment matrices: 15 to establish relative importance of each factors within its sub-categories, 5 to establish relative importance of each sub-categories within its categories and 1 to establish the relative importance of each category for wellbeing. The outcome of this step was a set of 441 matrixes, one per each questionnaire per each respondent 18.

For each respondent, was evaluated the degree of coherence. In the Figure 5, it is reported the total number of coherent responders per each questionnaire.

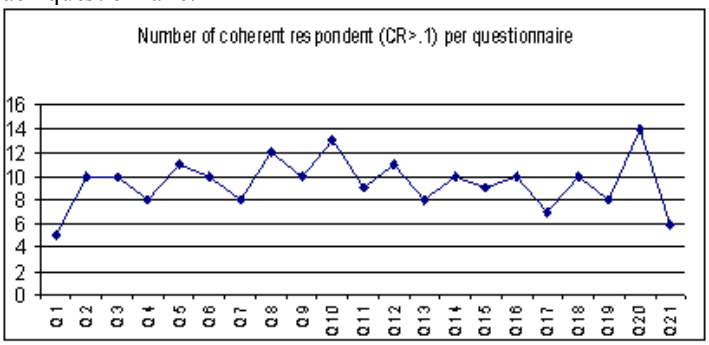

Figure 4. number of respondents coherent per questionnaire.

For each questionnaire, the geometric mean of the corresponding matrixes was calculated, including only coherent responders. The outcome of this step was a set of 21 averaged matrixes, one per questionnaire.
In table 7 are reported the 5 averaged matrices of judgments reflecting relative importance of pairs of sub-categories and the averaged matrices of judgments reflecting relative importance of pairs of categories. The last column reported the relative importance of each category, calculated as normalized elements of the main eigenvector. For instance the second element of the first matrices, says that "family contacts" are considered 1.6 times more important than "social contact" for the "feeling of belonging". Similarly, the last element of the fist column of the categories' matrices, says that "having a purpose" is 2.5 times more important than "feel safe" for wellbeing. We did

not report the 15 averaged matrices of judgments reflecting relative importance of pairs of factors for matter of space.

Table 7. averaged judgment matrices for sub-categories and categories of factors

CONTACT AND BELONGING

		A	B	C	S.I.
family contact	A	1.00	1.61	1.51	0.44
social contact	B	0.62	1.00	0.87	0.27
emotional contact	C	0.66	1.15	1.00	0.30

BEING. AND BEING VALUED AS. AN INDIVIDUAL

		A	B	C	S.I.
self expression	A	1.00	0.67	0.64	.25
having control	B	1.49	1.00	0.95	.37
being regarded as an individual	C	1.56	1.05	1.00	.39

PEACE AND CONTENTMENT

		A	B	C	S.I.
peace of mind	A	1.00	1.25	1.00	.36
fulfilment	B	0.80	1.00	0.83	.29
contentment	C	1.00	1.20	1.00	.35

HAVING A PURPOSE

		A	B	C	S.I.
being busy	A	1.00	0.90	1.12	.33
being busy with others	B	1.12	1.00	1.31	.38
being emot. / psycholog. busy	C	0.90	0.76	1.00	.29

FEELING SAFE

		A	B	C	S.I.
feeling financially safe	A	1.00	0.82	1.60	.35
feeling physically safe	B	1.21	1.00	2.02	.43
absence of threats	C	0.62	0.50	1.00	.22

CATEGORIES OF FACTORS

		A	B	C	D	E	C.I.
having a purpose	A	1.00	0.69	0.58	0.58	0.40	.12
being valued as. individual	B	1.44	1.00	1.00	1.00	1.00	.21
peace and contentment	C	1.73	1.00	1.00	1.20	1.00	.23
contact and belonging	D	1.73	1.00	0.83	1.00	1.00	.21
feeling safe	E	2.50	1.00	1.00	1.00	1.00	.24

S.I.: relative importance of each sub-category within its category; C.I.: relative importance of each category.

It is possible to prioritize the sub-categories by multiplying their local importance (S.I.) per the importance of categories (C.I.) (Table)

Table 8. Sub-categories priority

CATEGORIES AND SUB-CATEGORIES	C.I.	S.I	C.I.*S.I.
contact and belonging	0,209		
family contact		0,438	0,092
social contact		0,265	0,055
emotional contact		0,297	0,062
peace and contentment	0,225		
peace of mind		0,358	0,081
fulfillment		0,290	0,065
contentment		0,353	0,079
being, and being valued as, an individual	0,210		
self expression		0,247	0,052
having control		0,367	0,077
being regarded as an individual		0,386	0,081
having a purpose	0,122		
being busy		0,332	0,041
being busy with others		0,376	0,046
being busy emotionally / psychologically		0,292	0,036
feeling safe	0,235		
feeling physically safe		0,432	0,102
the absence of threats		0,217	0,051
feeling financially safe		0,351	0,082

From the 21 averaged matrixes it is possible to assess the relative importance of each element. In table 8 are reported all the factors, with its importance within its sub-category (F.I.), within its category, (F.I.C.) and its global importance (G.I.).

Table 9. importance of each factor.

Factors	F.I.	F.I.C.	G.I.
health	0,59	0,26	0,06
having contact with my family	0,41	0,18	0,04
being valued, respected, wanted	0,43	0,17	0,04
financial security	0,40	0,14	0,03
having control over your life	0,43	0,16	0,03
being accepted unconditionally	0,40	0,15	0,03
feeling part of a family	0,33	0,14	0,03
loving/being loved	0,47	0,14	0,03
calm and balance	0,36	0,13	0,03
safe, relaxation	0,36	0,13	0,03
knowing i owe nothing	0,34	0,12	0,03
having a positive outlook	0,36	0,13	0,03
being at peace	0,35	0,12	0,03
being happy with myself	0,42	0,12	0,03
disasters	0,27	0,12	0,03
having contact with friends	0,44	0,12	0,02
being with my family	0,26	0,12	0,02
being content	0,30	0,10	0,02
Stability	0,29	0,10	0,02
doing what pleases you	0,30	0,11	0,02
doing things i like	0,35	0,10	0,02
absence of threats	0,42	0,09	0,02
having choices	0,41	0,10	0,02
living independently	0,27	0,10	0,02
stability	0,26	0,09	0,02
laughter	0,31	0,09	0,02
absence of threats for me	0,37	0,08	0,02
caring	0,39	0,15	0,02
being helpful	0,36	0,13	0,02
having a say	0,31	0,08	0,02
socialising	0,29	0,08	0,02
doing something i like	0,39	0,13	0,02
having time for myself	0,23	0,07	0,02
meeting people with a smile and getting one back	0,27	0,07	0,01
having good morale	0,28	0,07	0,01
crime	0,14	0,06	0,01
pursuits, pastimes, interests	0,35	0,12	0,01
knowing you are loved	0,39	0,11	0,01
having hugs	0,22	0,07	0,01
not being classed as old	0,17	0,06	0,01
freedom from pain	0,34	0,10	0,01
having motivation and drive	0,25	0,10	0,01
travel and favourite places	0,26	0,08	0,01
absence of threats for my property	0,20	0,04	0,01
freedom from worry	0,27	0,08	0,01

Discussion

From the hierarchy emerged that the categories of needs are judged almost equally important, with exception of "having a purpose". Although, there are some sub-categories which are considered more important than other. It is the case of fiscal and financial safety, which are considered the most important categories. On the other hand, being busy is considered not as important as expected.

Analyzing the relative importance of each factor, it emerge that family contacts/belonging, to be valued/respected/ wanted/accepted, and to love/be loved are classified in the fist ten, although their sub-categories are not the most important. This proves that the AHP can be invariant in respect the definition of the tree, in respect to the final factors prioritized. It is not easy to find a correlation with Maslow pyramid, which is in any case relative and depending by the needs fulfilled by the subject. This is probably due to the different status of the respondents. Further investigation could give further insight.

The main limit of this study is in the difficulty reported by elderly in answering to such unfamiliar king of questionnaire. An electronic version of the questionnaire could solve partially this problem. Nonetheless, the percentage of inconsistent respondents is not significant different from other studies in which younger respondent were involved [Pecchia 2009].

Conclusions

In this paper, we investigated how AHP could contribute to qualitative researches assessing the priority of factors influencing the wellbeing in elderly. Our conclusions are that the AHP can contribute in assessing the hierarchy of these factors. The high number of factors individuated, the low difference between consecutive F.I., S.I. and C.I. do not allow us to identify a statistically significant classification of factors. Nonetheless, this study allows us clearly to individuate the factors considered the more relevant for the respondents. Further research could ask respondents to prioritize the most important factors, allowing a major significant classification. The final hierarchy provides new insights into elderly perceptions of factors affecting wellbeing. It is possible to calculate the G.I. of each factor by

multiplying the weight of edges linking the factor to the final goal, troughs roots and hyper-roots. For instance the global importance of the "health" is 0.06 as it is the product of its F.I. per the S.I. its sub-category "physical safety" per the C.I of its category "filing safe", respectively, .69, .43 and .24.

REFERENCES

Dolan, J.G., 1990. Can decision analysis adequately represent clinical problems?. Journal of Clinical Epidemiology 43 (3) 277–284.

Dolan, J.G., 2000. Involving patients in decisions regarding preventative health interventions using the analytic hierarchy process. Health Expectations 3 (1), 37–45.

Dolan, J.G., Bordley, D.R., 1993. Involving patients in complex decisions about their care: An approach using the analytic hierarchy process. Journal of General Internal Medicine 8 (4), 204–209.

Johnson M, Firoozbakhsh K, Moniem M, Jamshidi M. Determining flexor-tendon repair techniques via soft computing. IEEE Engineering in Medicine and Biology Magazine 2001; 20(6):176–183.

Kim J.K. and Choi S.H., "A utility range-based interactive group support system for multiattribute decision making," Comput. Oper. Res., vol. 28, no. 6, pp. 485–503, 2001.

Leys M. Health care policy: Qualitative evidence and health technology assessment. Health Policy 2003; 65 (3): 217-26.

Liberatore JM, Nydick RL, The analytic hierarchy process in medical and health care decision making: A literature review. European Journal of Operational Research, 2008, 189(1): 194-207.

Liberatore, M.J., Myers, R.E., Nydick, R.L., Steinberg, M., Brown, E.R., Gay, R., Powell, T., Powell, R.L., 2003. Decision counseling for men considering prostate cancer screening. Computers & Operations Research 30 (10), 1421.

Maslow A.H., A Theory of Human Motivation, Psychological Review 50(4) (1943):370-96.

Pecchia L., Bath P. A., Pendleton N., Bracale M. AHP and risk management: a case study for assessing risk factors for falls in community-dwelling older patients. ISAHP 2009 Symposium, July 29–August 1, 2009, Pittsburgh, Pennsylvania, USA. Proceeding: 1-15.

Peralta-Carcelen, M., Fargason Jr., C.A., Coston, D., Dolan, J.G., 1997. Preferences of pregnant women and physicians for 2 strategies for prevention of early-onset group B streptococcal sepsis in neonates. Archives of Pediatrics and Adolescent Medicine 151 (7), 712–718.

Pope C, Ziebland S, Mays N, Qualitative research in health care - Analysing qualitative data (Reprinted from Qualitative Research in Health Care), BRITISH MEDICAL JOURNAL 2001, 320(7227): 114-116.

R. Ramanathan and L. Ganesh, "Group preference aggregation methods employed in AHP: An evaluation and an intrinsic process for deriving the members' weightages," Eur. J. Oper. Res., vol. 79, no. 2, pp. 249–265, 1994.

Saaty T.L., "A scaling method for priorities in hierarchical structures," J. Math. Psych., vol. 15, pp. 234–281, 1977.

Saaty T.L., An essay on how judgment and measurement are different in science and in decision making, International Journal of the Analytic Hierarchy Process 2009, 1(1):61-62.

Saaty T.L., The Analytic Hierarchy Process. Pittsburgh, PA: RWS Publications, 1996.