WEIGHTS OF OBESITY FACTORS USING ANALYTIC HIERARCHY PROCESS

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ABSTRACT

Obesity is one of the most prevalent serious public health problems in today's ultra modern lifestyle. It is a condition of excessive fat accumulation to the body in which authentic factors contributed to obesity are very much inconclusive. Although many medical researches unveiled several factors may contribute to development of obesity but the extents of contribution or weight for each factor remain unknown. This paper aims to propose weights for the selected factors contributed to development of obesity using an analytical approach. The Saaty's Analytical Heirarchy Process (AHP) model is employed in computing weights for the factors. One hundred and fifty respondents from Kuala Terengganu Town Council of Malaysia were sampled to provide input data using a sixteen-item pair wise comparison questionnaire. Respondents' scaled data from 1 to 9 were averaged using arithmetic mean prior to computing using the five-step of AHP. The results show that the factor of sedentary lifestyle was received the highest weight followed by the factor of genetics and medical and psychiatric illness. The weights for the three factors were 0.6042, 0.2649 and 0.1304 respectively. The result implicates the importance of changing life style in minimising to development of obesity.

Keywords: *Obesity, Pair-wise comparison, Lifestyle, analytic hierarchy process, Decision making*

1. INTRODUCTION

Today's lifestyle is becoming increasingly characterised by technology and economics. This is especially true in developed societies where many of day life activities are no longer rely on physical endeavour to earn living. Most of activities relate to life are replaced by technology. As a result, growing numbers of people are chosen to practise inactive lifestyle. Physically inactive lifestyle is said to be the main cause of obesity. In other words, modern lifestyle where foods are abundance compounded with sedentary working environment promotes obesity. This statement echoed by Philipson and Posner [1] where their research showed that obesity is increasing over time because the inflation-adjusted cost of food has been falling at the same time that typical jobs have become more sedentary. Some would relate obesity with overeating and energy expenditure. For example, Prentice [2] says that in the context of the modern environment, it is essential to understand that overeating is a relative phenomenon, where the appropriateness of any level of energy intake is judged against a person's level of energy expenditure. Therefore the epidemic of obesity is a new serious problem in modern lifestyles.

In a simple laymen term, obesity is defined as the state of being well of above one's normal weight. A person has traditionally been considered to be obese if they are more than 20 percent over their ideal weight [3]. The ideal weight must take into account the person's height, age, sex, and build. Obesity scientifically defined as a condition of excessively high amount of fat or adipose tissue in relation to lean body mass [4]. Kopelman [5] defines the term obesity as "excess fatness" or fatness leading to pathology. The mount of excess fat, its distribution within the body, and the associated health consequences vary considerably between obese individuals. Obesity continues to be a prevalent public health problem in the developed countries, while there is strong epidemiological evidence indicating that the prevalence of obesity in developing countries often increases in communities emerging from lifestyles of subsistence into affluence. In developed countries the occurrence of obesity is higher in the lower socio-economic groups, whereas in developing countries this relationship is reversed [6]. The worldwide obesity problem can be viewed as a consequence of the substantial economic, social and cultural problems now observed in developing and newly industrialized countries. Obesity is a public health concern because of its association with a number of medical complications that lead to both increased morbidity and mortality. The most common complications are type 2 diabetes, hypertension, dyslipidaemia, cardiovascular disease, gallstones and cholecystitis, respiratory dysfunction and certain cancers [7]. These diseases represent far too great a burden for policy-makers, healthcare providers and researchers to ignore. The current trend in developed countries is the enormous cost of high technology and tertiary healthcare needed to diagnose and manage the high-incidence of obesity-related

complications. A similar demand in Malaysia imposes a huge burden on the human and economic resources of the country and is liable to disturb priorities in the healthcare or other sectors.

Obesity is said to come in different types. French physician Vague [8] was the first to point out that maybe three types of obesity namely Android, Gynoid and the Third type. Android type of obesity is likened to the shape of an apple. In Gynoid type obesity the lower part of the body has the extra flesh. Gynoid type of obesity is similar to pears. The flesh is somewhat flabby in the abdomen, thighs, buttocks & legs. The face and neck mostly give a normal appearance. Besides android and gynoid, there is one more type of obesity. Some people do not belong to any of the above type of obesity. Their whole body from head to toe looks like a barrel. The fat tissues in their body hinder the movement of all the internal organs and consequently affect their brisk functioning. The type of obesity does not receive very much attentions compare to factors associated with development of obesity. Medical fraternity comes up with multi factors linked to obesity. It is not a single disorder but a heterogeneous group of conditions with multiple factors. One of the key factors in today's lifestyle is inactive way of living. A sedentary lifestyle and less physically demanding work play significant role in obesity [9]. Several other factors may contribute to the development of obesity. Georges et al. [10] suggest a larger role for socio-cultural factors in the patterning of body fat distribution. Muller and Reid [11] suggested that environmental factors such as nutrition, stress and exercise have significant effect on subcutaneous fatness (body fat). The prevalence of obesity was inversely associated with the level of education and physical activity. Socio-economic status and behavioral factors are important determinants of weight gain and overweight [12]. Recent epidemiological trends in obesity indicate that the primary cause of the global obesity problem lies in environmental and behavioral changes. The world-wide obesity problem can be viewed as a consequence of the substantial economic, social and cultural problems now confronting developing and newly industrialized countries. Recent evidence has begun to shed light on the genetic contributions to obesity [13]. A person is more likely to develop obesity if one or both parents are obese. Certain physical and mental illnesses and the pharmaceutical substances used to treat them can increase risk of obesity. Certain medications may cause weight gain or changes in body composition; these include insulin, sulfonylurea, thiazolidinediones, atypical antipsychotics, antidepressants, steroids, certain anticonvulsants (phenytoin and valproate), pizotifen, and some forms of hormonal contraception [14]. Thus the causes and the types of obesity are multifactorial problems.

Although extensive researches have explored over the causal factors of obesity, much less research has investigated which factor is important than other. The continuing discussion of factors associated with obesity suggests the need for research in determining weight of factors that cause obesity. This paper provides a hierarchy process of multi-criteria decision making approach to address the issues of factor weight. One of the most well known methods in determining weight of factors or criteria is Analytic Hierarchy Process (AHP). The AHP method has been used successfully in many fields including health sciences. For example, Chow and Luk [15] used AHP framework to measure service quality in fast food restaurant industry. The AHP procedure provided a ranking order of firms with respect to the dimensions that define service quality. In a business related research, Kim, et al.,[16] applied the analytic hierarchy process to the evaluation of customer-oriented success factors in mobile commerce. Recently, Sambasivan [17] used the AHP to find the relative weights and priorities of critical success factors and benefits among Malaysian companies in the electrical and electronics sector. The technique also extended to healthcare analysis and several studies have applied the AHP for the evaluation of health care facilities and in health care policy analysis. Very recently, Liberatore [18] reviewed extensively the application of AHP in medical and health care decision making. In a case study, Abdullah, [19] taps the perception of people towards cancer risk using AHP . Thus the paper's central objective is to determine weight for the factors associated with the development of obesity using AHP. Information generated from this research may offer a greater understanding to public on causes and containment of obesity. The remainder of this paper is structured as follows. The AHP and its computational steps are explained in Section 2. A case study frames with AHP is elucidated in Section 3. Computational procedures of the case study and results are described in Section 4. The paper finally concludes in Section 5.

2. ANALYTIC HIERARCHY PROCESS

AHP was developed by Saaty [20], [21], [22] uses a process of pair wise comparison to determine the relative importance of alternatives in decision making. To do so, the AHP uses a fundamental scale of absolute numbers that has been proven in practice and validated by decision problem experiments. The fundamental scale has been shown to be a scale that captures individual preferences with respect to quantitative and qualitative attributes just as well or better than other scales [20]. It converts individual preferences into ratio scale weights that can be combined into a linear additive weight for each alternative. The resultant weight can be used to compare and rank the alternatives

and, hence, assist the decision maker in making a choice. Summarily, AHP is a decision making tool that consists of five basic steps. The steps are given as follows.

Step 1: Decide upon the factor for selection

Rate the relative importance of factors using pair-wise comparisons. Set up a matrix to compare each criterion to the others.

A = a_{ij} (i, j = 1,2,…,n)

$$\begin{bmatrix} 1 & a_{12} & \dots & \dots & a_{1n} \\ a_{21} & 1 & \dots & \dots & a_{2n} \\ \dots & \dots & \dots & \dots & \dots \\ \dots & \dots & \dots & \dots & \dots \\ a_{n1} & \dots & \dots & \dots & 1 \end{bmatrix}$$

Where a_{ij} is integer and 0<a<10 and a is a_{ij}, then $a_{ij} = {}^{1}/_{a}$, then $a_{ij} = 1$ if i = j.

Rank the degree of association of each criterion relative to the others, using the scale of association from 1 to 9.

Step 2: Find the eigenvector by normalized the pair-wise comparisons.
Divide each entry by the total of its column

$$A_{ij} = \frac{P_i}{P_j} \tag{1}$$

$$\frac{\frac{P_i}{P_j}}{\frac{\sum_{i=1}^{n} P_j}{P_j}} = \frac{P_i}{P_j} \times \frac{P_j}{\sum_{i=1}^{n} P_j} = \frac{P_i}{\sum_{i=1}^{n} P_j} \tag{2}$$

Divide total of row by the total of number of row:

$$\left(\frac{P_i}{\sum_{i=1}^{n} P_i} + \cdots + \frac{P_i}{\sum_{i=1}^{n} P_i} \right) \frac{1}{n} = \frac{n.P_j}{\sum_{i=1}^{n} P_i} . \frac{1}{n} = \frac{P_i}{\sum_{i=1}^{n} P_i} \tag{3}$$

Step 3: Rate each factor relative to each other factor on the basis of degree of risk for each selection factor. This is achieved by performing pair-wise comparisons of the choices.

Step 4: Normalized the pair-wise comparisons.

Step 5: Combine the ratings derived in Steps 2 and Step 4 to obtain an overall relative rating for each potential choice.

$$a_i = \sum w_i k_{ij}$$

where:

a_i = overall relative rating for factor i
w_i = average normalized weight for factor i
k_{ij} = average normalized rating for type j with respect to factor i.

The five steps are utilised to decide the most preferred alternative in a case study of factors associated with obesity.

3. A CASE STUDY

A questionnaire was constructed by the researchers to tap perception of public toward factors associated with obesity. The questionnaire was administered to one hundred and fifty respondents with the aim to identify their perceptions of factors associated with obesity. The age of respondents are varied from 15 to 40 years old. The data for the questionnaire were collected in the area of Kuala Terengganu Municipality Council, Malaysia. Respondents need to judge the relative comparison between criteria and the relative comparison between alternative with respect

to criterion in linguistic scales. Each of these judgments is then assigned an integer on a scale. In this experiment the original definition of scale given by Saaty [20] was adopted. The scale and their relative importance are explained in Table 1.

Table 1 The Saaty Rating Scale

Scale	The relative importance of the two sub-element
1	Equally important
3	Moderately important with one over another
5	Strongly important
7	Very strongly important
9	Extremely important
2,4,6,8	Intermediate values

In accordance with the purpose and method of this research, criteria and factors were identified. The three obesity types viz. Android (AT), Gynoid (GT) and Third type (TT) were the criteria in this decision model while the factors of obesity viz. Medical and Psychiatric Illness (MED), Sedentary Lifestyle (SED) and Genetics (GEN were the alternatives. The hierarchical structure of goal, criteria and alternatives are shown in Fig 1.

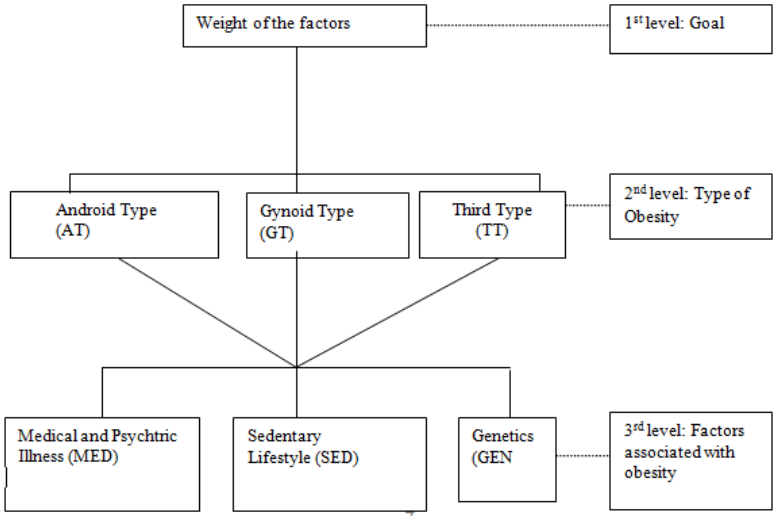

Figure 1 Hierarchical Structure of Model in Application

The first level states the goal of the AHP. The second and third levels address the pair wise comparisons among obesity types and also the pair wise comparisons of the factors associated with obesity based on each type of obesity. Respondents were asked to compare pairs of the factors (for example Genetics vs. Sedentary lifestyle) and to indicate whether they felt that one factor was 'strongly important' or 'extremely important ' to another factor on a nine-point degree of association scale. Armed with all the defined goal, criteria and alternatives in the AHP, computational procedures will follow suit prior to obtaining results.

4. COMPUTATIONAL PROCEDURES AND RESULTS

The relationship between the factors and obesity types are explained using AHP. The steps as prescribed in the section 2 are utilised throughout the computations. The results are presented according to the following steps.

Step 1 : Construct the hierarchical structure.

Data of the importance of the criteria in pair-wise comparison tabulated as Table 2

Table 2 Criteria pair-wise comparison of AHP

Criteria	AT	GT	TT
AT	1	5	3
GT	1/5	1	2
TT	1/3	1/2	1
Sum of Column	23/15	13/2	6

Pair-wise comparison data between alternatives with respect to criteria are presented in Table 3, Table 4 and Table 5

Table 3 Alternatives pair-wise comparison with respect to the criterion of AT

AT	SED	GEN	MED
SED	1	4	4
GEN	1/4	1	5
MED	1/4	1/5	1
Sum of Column	3/2	26/5	10

Table 4 Alternatives pair-wise comparison with respect to the criterion of GT

GT	SED	GEN	MED
SED	1	3	4
GEN	1/3	1	2
MED	1/4	1/2	1
Sum of Column	19/12	9/2	7

Table 5 Alternatives pair-wise comparison with respect to the criterion of TT

TT	SED	GEN	MED
SED	1	3	2
GEN	1/3	1	1
MED	1/2	1	1
Sum of Column	11/6	5	4

Step 2 : Compute the weights priorities for the hierarchy of criterion

The weights priority of AT are computed as

$$\text{AT} = \frac{\left(\frac{a11}{b1} + \frac{a12}{b2} + \frac{a13}{b3}\right)}{3} = \frac{\left(\frac{1}{23/15} + \frac{5}{13/2} + \frac{3}{6}\right)}{3} = 0.640$$

The weight priority of GT and TT are computed with the similar fashion and given as 0.2059 and 0.1537 respectively.

Futhermore, weight priorities for the hierarchy of alternatives with respect to each criterion are also computed. The weight priority for alternatives with respect to the criteria can be written as

$\boldsymbol{W_{AT}}$ = [SED GEN MED]^T
= [0.6119 0.2863 0.1017]

$\boldsymbol{W_{ET}}$ = [SED GEN MED]^T
= [0.6232 0.2395 0.1373]

$\boldsymbol{W_{CT}}$ = [SED GEN MED]^T
= [0.5485 0.2106 0.2409]

Step 3 : Compute the weighted performance, P for each alternatives with respect to each criterion.

Respect to AT
SED = 0.6119 (0.640) = 0.3916
GEN = 0.2863 (0.640) = 0.1832
MED = 0.1017 (0.640) = 0.0651

Respect to GT
SED = 0.6232 (0.2059) = 0.1283
GEN = 0.2395 (0.2059) = 0.0493
MED = 0.1373 (0.2059) = 0.0283

Respect to TT
SED = 0.5485 (0.1537) = 0.0843

GEN = 0.2106 (0.1537) = 0.0324
MED = 0.2409 (0.1537) = 0.0370

Step 4 : Compute the composite priority (overall weights in the entire hierarchy)

SED = 0.3916 + 0.1283 + 0.0843
= 0.6042
GEN = 0.2649
MED= 0.1304

Step 5 : Weights of the alternatives

Weights for the alternatives are finally established. It is shown in Table 6

Table 6 Weights of alternatives using AHP

Alternative	Weight
SED	0.6042
GEN	0.2649
MED	0.1304

Table 6 shows the weights for the respective factors. Factor of Sedentary Lifestyle is the first in ranking order followed by Genetics. Medical and Psychiatric Illness ranked as the third place. The highest factor weight is Sedentary Lifestyle (SED) with 0.6042. Of the three factors, Sedentary Lifestyle contributed approximately 60 percent to developing of obesity. Evidently AHP has successfully yields the weights for each factor.

5. SHORT CONCLUSION

The problem in identifyng conclusive factors contributed to the development of obesty motivates a new research with factors pair wise comparison approach. This paper has proposed the weight for the three causal factors of obesity based on the three types of obesity. The five-step computational procedure of AHP has successfully identified Sedentary lifestyle as the highest weight in describing factors contributing to obesity. Of the three factor, Sendendary lifestyle contributed approximately 60 percent to the obesity. Perhaps it was due to the fact that in the modern lifestyle nowadays, sixty percent of world's population gets insufficient exercise [23]. The factor of genetics contributed about 26 percent folllowed by medical and psychiatric illness. This preliminary research need to be extended by considering more causal factors and types to validate the feasibily and effiency of AHP especialliy in health related research.

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