How do the Japanese Medical Students Evaluate the Effectiveness of Anti-smoking Strategies ? - An application of the Analytic Hierarchy Process -

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Abstract

In order to establish the effective strategies to reduce the smoking prevalence among teenagers in Japan, the author evaluated opinions of the 30 male medical students with smoking habit by the Analytic Hierarchy Process (AHP) method. In the AHP model, the six factors are considered to be important for the onset of teenagers smoking; smoking habit of peers, smoking habit of family members, tobacco advertising, convenience to buy cigarettes, social acceptance of smoking and knowledge of harmful effects of smoking, and the five strategies are proposed; tobacco advertising ban, higher pricing of tobacco, promotion of anti-smoking education, regulation on tobacco sales, and regulation on smoking area. According to the medical students' perspective, the strategy of 'higher pricing of tobacco' was considered to be the most effective strategy to reduce the smoking incidence of the teenagers, followed by 'regulation on tobacco sales', 'promotion of anti-smoking education', 'regulation on smoking area', and 'tobacco advertising ban'.

Key words: Analytic Hierarchy Process, Smoking, Teenagers, Priority

Introduction

There is no doubt that cigarette is one of the most harmful products to human's health. Tremendous number of studies have been implemented to clarify the factors associated with smoking habit as well as to reduce the smoking prevalence around the world. For example, educational attainment level, price of cigarette, smoking habits of parents, smoking habits of siblings, smoking habit of peers, advertising of cigarette, easy access to cigarette have been reported as such factors.¹⁾ According to these results, a series of anti-smoking policies, that is, anti-smoking education, advertising ban, higher pricing of cigarette, regulation of cigarette sales, regulation on smoking area, have been implemented in various countries.¹⁾ In the United States, for example, since the publication of the first Surgeon General's report on Tobacco and Health in 1964, the smoking prevalence has decreased by nearly 34% possibly due to these anti-smoking strategies.²⁾ On the other hand, in Japan, the reduction in smoking prevalence is rather slow and Japan still remains as one

of the highest smoking prevalence countries around the world (for adult: males 52.7%, females 10.6%; in 1995).³⁾ As smoking has an addictive characteristics, it will be difficult for the smokers to completely give it up. Therefore, the strategy to decrease the smoking incidence is more important. Given the evidence that individuals are unlikely to initiate smoking after age 21,⁴⁾ it is possible that the cohort of young persons will not start smoking if some effective anti-smoking strategies are implemented for the teenagers. In order to clarify such strategies, it will be very suggestive to know adolescents' perspective about anti-smoking strategies. In this study, the author applied the analytic hierarchy process (AHP) to the medical students in order to investigate the priorities among anti-smoking strategies for the teenagers in Japan.

Studied population and Methods

1. Focus group discussion about factors associated with the onset of smoking habits of teenagers

For the freshman medical students of University of Occupational and Environmental Health (UOEH) in 1996, the author organized a seminar on "applied mathematics in medical research", and four medical students participated in this seminar. In this seminar students were required to evaluate the effectiveness of anti-smoking strategies by the analytic hierarchy process (AHP).⁵⁾ At first, the author and students collected various papers on factors associated with smoking habits and on

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Fig. 1 Structure of the factors associated with the smoking onset of teenagers and corresponding strategies.

anti-smoking strategies. After the two weeks' focus group discussion about the factors associated with smoking habits and anti-smoking strategies, the author composed a two stage AHP models regarding factors associated with the onset of teenager's smoking habits and anti-smoking strategies as shown in Figure 1. In this model, six factors are considered to be important ones for the onset of teenagers' smoking. They are: smoking habit of peers, smoking habit of family members, tobacco advertising, convenience to buy tobacco, social acceptance of smoking and knowledge of harmful effects of smoking, while the five strategies proposed are as follows: tobacco advertising ban, higher pricing of tobacco, promotion of anti-smoking education, regulation on tobacco sales, and regulation on smoking area.

2. Studied population

Thirty first year's male medical students of UOEH who have smoking habit are selected and interviewed by the four medical students of the research team using the AHP questionnaire sheet (a pairwise comparison matrix table: see next paragraph) during the first week of July 1996. The average age of investigated students is 20.1 (SD 0.2).

3. AHP analysis

Based on the model structured as in Figure 1, weights of the elements at each level of the hierarchy of problems are determined with respect to the elements of the next higher level. This is done by means of pairwise comparisons of alternatives to indicate the strength with which one alternative dominates another vis-a-vis the criterion under which they are compared. Mathematically, the problem is to solve a homogeneous linear equation. The application of the concept of pairwise comparison and the prioritization procedure proceed as follows: In the model structured, n strategies are given, $A_1, \dots, A_n$, whose values of importance $w_1, \dots, w_n$ are measured by some known criteria, respectively. Here, consider the matrix A of pairwise ratios whose rows give the ratios of the values of importance of each alternative with respect to all others and then multiply it on the right by the vector of values of importance w . The result of this multiplication is shown in Figure 2. Thus, in order to recover the scale from the matrix of ratios we must solve the equation $Aw = nw$. It has a nontrivial solution only if the determinant of $(A - nI)$ vanishes, that is, n is an eigenvalue of A . In practice, we cannot give the precise values w_i/w_j , but only the corresponding

$$A = [a_{ij}] = \begin{matrix} & \begin{matrix} A_1 & A_2 & \dots & A_n \end{matrix} \\ \begin{matrix} A_1 \\ A_2 \\ \vdots \\ A_n \end{matrix} & \begin{pmatrix} w_1/w_1 & w_1/w_2 & \dots & w_1/w_n \\ w_2/w_1 & w_2/w_2 & \dots & w_2/w_n \\ \vdots & \vdots & \ddots & \vdots \\ w_n/w_1 & w_n/w_2 & \dots & w_n/w_n \end{pmatrix} \end{matrix} \begin{pmatrix} w_1 \\ w_2 \\ \vdots \\ w_n \end{pmatrix} = n \begin{pmatrix} w_1 \\ w_2 \\ \vdots \\ w_n \end{pmatrix}$$

where $a_{ij} = w_i/w_j$, $a_{ji} = 1/a_{ij}$

w_i = weight of i th alternative

Fig. 2 Multiplication of comparison matrix and weight vector.

estimates; A' (comparison matrix). Thus, the equation becomes $A'w' = l_{\max}w'$ where $l_{\max}$ is the largest or principal eigenvalue of A' . It has been demonstrated that the eigenvector corresponding to the largest eigenvalue of the matrix provides the relative priorities of the factors, and preserves ordinal preferences among the alternatives. Thus, from the matrix it is possible to form for paired comparisons a vector of weights (w') which reflects the relative importance. In the present study, each participant was required to choose one of three answers in order to construct the pairwise comparison matrix as follows: " A_i " is more important than " A_j " then $w_i/w_j = 2$, " A_i " is as important as " A_j " then $w_i/w_j = 1$, and " A_i " is less important than " A_j " then $w_i/w_j = 1/2$. In practice, at the first level, six factors were compared with one another regarding their relative importance. Then, five strategies were compared with one another regarding their relative usefulness for each of the six factors. For example, the question of the first step was as follows: As factors associated with the onset of smoking among teenagers, which factor is considered more important, "smoking habit of peers", or "tobacco advertising"? And the second step question was as follows: In order to cope with the factor "smoking habit of peers", which strategy is considered more important, "tobacco advertising ban" or "higher pricing of tobacco"? In order to obtain each value of the components in the pairwise comparison matrix, the geometric mean of 30 participants was calculated, according to the recommendation of Saaty.³⁾

Results

Table 1 shows the weights of each factor calculated by the comparison matrix. Smoking habit of peers was detected as the most important factor associated with the onset of smoking

among the teenagers, followed by convenience to buy tobacco, smoking habit of family members, social acceptance of smoking, tobacco advertising, and knowledge of harmful effects of smoking.

Table 2 shows the matrix of weights which represent the relative importance of each strategy to cope with these factors. To solve the problem associated with "smoking habit of peers", "smoking habit of family members" and "convenience to buy tobacco", "higher pricing of tobacco" was evaluated as the most effective strategy, followed by "regulation on tobacco sales", "regulation on smoking area", "tobacco advertising ban" and "promotion of anti-smoking education". For "social acceptance of smoking" and "knowledge of harmful effects of smoking", "promotion of anti-smoking education" was evaluated as the most effective, followed by "regulation on smoking area", "tobacco advertising ban", "regulation on tobacco sales" and "higher pricing of tobacco". In the case of the factor "tobacco advertising", "tobacco advertising ban" was evaluated as the most effective, followed by "promotion of anti-smoking education", "regulation on smoking area", "regulation on tobacco sales" and "higher pricing of tobacco".

Table 3 shows the relative importance of the five strategies calculated by the AHP method. The strategy of "higher pricing of

tobacco" was considered to be the most important strategy to control the onset of smoking among the teenagers, followed by "regulation on tobacco sales", "promotion of anti-smoking education", "regulation on smoking area", and "tobacco advertising ban".

Discussion

1. About the AHP method and studied population

In the present analysis, the author employed the AHP technique in order to investigate relative importance among the strategies to cope with problems of teenager smoking, based on the perception of 30 male medical students with smoking habit. This method, if applied properly, is very useful in the decision making process. However, there are some cautions that should be aware of when interpreting the results. The most important problem is that the structurization of the problem to be studied can be heavily influenced by the knowledge and capacity of the investigator. Furthermore, as the model was constructed without opinions of investigated students, there is a possibility that the model might not cover all factors associated with smoking habit of the investigated population. It would have been better to construct the model after investigated the students' opinion. Another important problem is that the results will vary according to the characteristics of members in the studied group. For example, the opinion of young male smokers might be different from that of young female smokers. The fact that the smoking rate of young women is rapidly increasing in Japan, contrasting with the gradual decrease in young men will suggest a different mechanism of the onset of smoking habit between men and women.³⁾ For this reason, the present results may not be universally applicable.

As the AHP technique is more time consuming method compared with other ordinary opinion survey such as the questionnaire method, its application may be limited to a small

Table 1 Comparison of factors associated with teenager smoking habit.

	F1	F2	F3	F4	F5	F6	Priorities
F1	1.00	1.22	1.64	1.64	1.64	1.64	0.23
F2		1.00	1.00	1.22	1.10	1.22	0.17
F3			1.00	0.82	0.67	1.22	0.14
F4				1.00	1.35	1.81	0.18
F5					1.00	1.22	0.16
F6						1.00	0.12

F1=Smoking habit of peers, F2=Smoking habit of family members

F3=Tobacco advertising, F4=Convenience to buy tobacco

F5=Social acceptance to smoking, F6=Knowledge of harmful effects of smoking.

Table 2. Comparison of strategies to overcome the factors associated with teenager smoking.

Smoking habit of peers							Social acceptance to smoking						
	S1	S2	S3	S4	S5	Priorities		S1	S2	S3	S4	S5	Priorities
S1	1.00	0.74	1.35	0.50	0.74	0.16	S1	1.00	1.64	0.61	1.49	0.82	0.20
S2		1.00	2.00	1.35	1.35	0.27	S2		1.00	0.61	0.91	0.67	0.14
S3			1.00	0.50	0.67	0.13	S3			1.00	2.00	1.64	0.30
S4				1.00	1.35	0.25	S4				1.00	0.61	0.14
S5					1.00	0.20	S5					1.00	0.22
Smoking habit of family members							Knowledge of harmful effects of smoking						
	S1	S2	S3	S4	S5	Priorities		S1	S2	S3	S4	S5	Priorities
S1	1.00	0.55	1.01	0.74	0.74	0.16	S1	1.00	1.49	0.61	1.49	1.00	0.20
S2		1.00	1.64	1.35	1.49	0.28	S2		1.00	0.50	1.00	0.67	0.14
S3			1.00	0.61	0.82	0.15	S3			1.00	2.00	2.00	0.32
S4				1.00	1.64	0.24	S4				1.00	0.67	0.14
S5					1.00	0.18	S5					1.00	0.20
Convenience to buy tobacco							Tobacco advertising						
	S1	S2	S3	S4	S5	Priorities		S1	S2	S3	S4	S5	Priorities
S1	1.00	0.61	1.10	0.61	1.74	0.15	S1	1.00	1.64	1.81	0.64	1.64	0.30
S2		1.00	2.00	1.49	1.49	0.29	S2		1.00	0.82	0.91	0.82	0.16
S3			1.00	0.50	0.82	0.14	S3			1.00	1.35	1.35	0.21
S4				1.00	1.64	0.25	S4				1.00	0.82	0.16
S5					1.00	0.18	S5					1.00	0.18

S1=Tobacco advertising ban, S2=Higher pricing of tobacco, S3=Promotion of anti-smoking education,

S4=Regulation on tobacco sales, S5=Regulation on smoking area.

Table 3. Comparison of priorities to solve problems of teenagers smoking.

	S1	S2	S3	S4	S5	Priorities
S1	1.00	1.49	0.61	1.49	1.00	0.187
S2		1.00	0.50	1.00	0.67	0.220
S3			1.00	2.00	2.00	0.193
S4				1.00	0.67	0.206
S5					1.00	0.191

S1=Tobacco advertising ban, S2=Higher pricing of tobacco,
S3=Promotion of anti-smoking education, S4=Regulation on tobacco sales,
S5=Regulation on smoking area.

population. Furthermore, the studied population must be well conscious of the problem as well as be competent to properly evaluate it. In this study, the author employed 30 freshman medical students with smoking habit. It will be reasonable to hypothesize that they are capable to objectively evaluate factors associated with the onset of their smoking habit because of their relatively high capability in understanding and short time lag after the onset of smoking habit. Furthermore, the author thinks that this kind of strategy oriented investigation could be very useful in sensitizing the investigated individuals, for it requires the participants to be actively involved in the study. Consequently the process could be more educational than other type of investigation.

2. Future anti-smoking strategies for the sake of the teenagers

As in other studies,⁶⁻⁸⁾ in this study smoking habit of peers was regarded as the most important factor associated with the onset of smoking for teenagers. Generally young people will start to smoke because they consider it an adult, sophisticated, attractive thing to do. Smoking habit of their colleagues and parents will enhance this notion. This study clarified that the increase of cigarette price is the most effective strategy to curtail the initiation of smoking habit among the teenagers through its effect on the smoking behavior of peers and parents. This result is concordance with the findings of the previous studies. For example, Grossman reported that the smoking participation price elasticity equaled -1.20 for teenagers, -0.54 for 20-25 years old, -0.44 for 26-35 years old, and -0.15 for persons above the age of 35.⁹⁾ This large teenage smoking participation elasticity implies that increase of cigarette price is a very effective tool to prevent the onset of such habitual behavior. The increase of tobacco excise tax is a strategy in this context.

According to the evaluation of the investigated students, the second most important strategy to curtail the onset of smoking among teenagers is regulation on tobacco sales. Especially, regulation on the vending machine is critical in Japan. In 1995, there were 498,800 cigarette vending machines in Japan, which sold 1,528,573 million yen in 1995 (3 million yen per one vending machine).¹⁰⁾ This amount constituted about 40% of total sales of cigarette in Japan. Though smoking under 20 years

old is prohibited by the law, it is quite easy for the teenagers to buy cigarette through the tremendous number of cigarette vending machines which are available 24 hours a day. Up to now there has been no regulation on this situation. In order to prevent teenager smoking, this easy access to cigarette for teenagers must be changed.

In general most of the smokers know well about the harmful effects of smoking. However, knowledge of harmful effects of smoking was given the least importance among the six factors to be evaluated in this study. In Japan, most of anti-smoking education programs for the teenagers focus too much on its harmful effects as well as its illegality and very frequently the use of scare approach. The previous results have indicated that comprehensive educational methods including psychosocial and behavioral interventions appear to be rather effective in tobacco use control compared with such conventional approaches.¹¹⁻¹³⁾ The health educators in Japan must change this paternalistic approach and adopt more sophisticated educational method based on sociological and behavioral theory.

Nowadays, even though the effect of advertising on smoking prevalence rate among the general population is concerned, there are some reports questioned its effect. For example, Bishop and Yoo reported that advertising was not very effective in inducing more demand, and that it perhaps caused a change in intra-industry market share.¹⁴⁾ Also in the present analysis, tobacco advertising ban was regarded the least important among the five strategies by the studied medical students. However, Rimpela et al. have suggested that tobacco sales promotion seems both to promote and reinforce smoking among the teenagers.¹⁵⁾ Also in the case of the Japanese teenagers, there have been some reports which support the hypothesis that advertising could reinforce the notion of adulthood of smoking and entice younger generation to experience with cigarette and initiate smoking habits.^{16,17)} For example, Muramatsu et al. reported that the affirmative image of smoking among the 273 Japanese teenagers became stronger after watching TV tobacco advertising.¹⁷⁾ In fact, there is no legal regulation on cigarette advertising in Japan. Only a few self-restrictions are implemented by the tobacco industry, such as the limitation of broadcast hours of TV advertising and ban in kids' and women's magazines. The Japanese government is strongly recommended to introduce some kind of regulations on the tobacco advertising in order to protect the teenagers from the harmful effects of smoking.

Lastly, there is question about the generalizability of the results of the present study because of small sample as well as of a possible inclusion of biases, for example, sampling bias. As discussed earlier, the result will vary according to the characteristics of the studied groups, especially, male and female teenagers. Therefore, it is required to repeat this investigation with other groups in order to evaluate the validity of the result of the present study.

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