FACTORS AFFECTING SHOULDER AND NECK PAIN OF OFFICE WORKERS IN HSINCHU AREA BY THE MODIFIED DELPHI METHOD AND ANALYTIC HIERARCHY PROCESS

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ABSTRACT
According to the statistical data of 2020, the total population of the Hsinchu area is 1,021,098, among which there are 156,261 people working in the Science Park. In addition to the high pressure, the life of "technological workers" is also characterized by overtime work, two-day work and two-day off, irregular diet, and low activity. Shoulder and neck pain refers to all kinds of pain from the root of the back of the head, and neck to the shoulder blades, and 85% of shoulder and neck pain is caused by muscle or ligament injury. Through long-term observation, we have learned that most of the muscle soreness of office workers in the Hsinchu area is mainly shoulder and neck pain, and musculoskeletal system injury is one of the important reasons for workers' incapacity.
This study discussed the related literature of shoulder and neck pain cognition, and adopted the Modified Delphi Method to collect the opinions of experts in the industry and academia. After identifying the influencing factors of shoulder and neck pain, a hierarchical structure was constructed, Finally, the analytic hierarchy process was used to conduct a questionnaire survey, weight analysis for each evaluation criterion, and consistency verification and ranking. The results show that the influencing factors of shoulder and neck pain of office workers in Hsinchu area are "lifestyle", "nature of work", "emotional form", and "pathological phenomenon" in order of importance. The analysis results provide a reference basis for office workers, traditional massage operators, and companies in management and decision-making.

Keywords: *Hsinchu area, shoulder and neck pain, Modified Delphi Method, analytic hierarchy process.*

1. INTRODUCTION

The office workers in Hsinchu area have muscle soreness, most of which are shoulder and neck pain. Musculoskeletal system injury is one of the important causes of workers' incapacity, and it is also the most important occupational disease that affects quality of life. The most vulnerable parts for such injuries are the shoulders and neck. Although shoulder and neck pain is not an acute disease, it greatly affects people's quality of life, and even affects work efficiency, mood, and sleep. Many people take medications for pain relief, or seek massage treatments, with little insight into the root cause of the pain. In addition, the industrial characteristics of the Hsinchu area may be related to the causes of shoulder and neck pain. The purpose of this study is to analyze the main influencing factors of the shoulder and neck pain of people in the Hsinchu area through the exact data weight, and construct the relative weights of different influencing factors of shoulder and neck pain.

2. LITERATURE REVIEW
2.1 Factors that affect the shoulder and neck pain of office workers

Based on literature from home and abroad, the cognition of office workers on shoulder and neck pain was summarized, including four aspects: lifestyle, nature of work, emotional form, and pathological phenomenon, which are respectively described, as follows:
(1)Lifestyle:
(a)Poor posture in life
Poor posture is usually caused by injuries to the muscles and surrounding tissues, or by the accumulation of long-term poor posture, tight muscles, and minor injuries [1].
(b)Improper long-term use of consumer electronic products
When using consumer electronic products, the neck must support the weight of the head, which will increase the

flexion angle of the extensor. When lifting the head up, it will increase the load on the muscles below the occipital bone, which will cause muscle pain in the long-term [2].

(c)Poor sleeping posture

Poor sleeping posture leads to pressure on the cervical spine, shoulders, and neck, resulting in shoulder and neck pain and other diseases [3].

(d)Unsuitable pillow

Unsuitable pillows cause poor posture of the cervical vertebra, shoulders, and neck in sleep, and then, compression of shoulder and neck, resulting in pain on the affected side [3].

(e)Lack of exercise

The office workers who lack exercise cannot support the weight of the bone due to the lack of muscle strength in the shoulders and neck, which causes compression of the cervical joint and shoulder and neck pain [4].

(2)Nature of work:

(a)Long hours of work.

Long hours of work leads to muscle overload, and long-term poor posture will cause injury to the shoulders and neck [5].

(b)Repetitive work

Repeated work for a long time tends to cause injuries to the skeletal muscles around the shoulders and neck [5].

(c)Work requiring long hours of computer use

Muscle and bone injuries of the neck and shoulders are common in people who work with computers for a long time [6].

(d)Poor working posture for a long time

Working in an improper posture for a long time, such as heavy use of computers and keyboards, fixed work on production lines, and operation of precision instruments, has resulted in a tendency of younger age groups with shoulder and neck pain [7].

(3)Emotional form:

(a)Mental stress

People who are prone to anxiety and emotional muscle tension due to mental stress at work often have shoulder and neck pain [8].

(b)Work stress

Work stress results from job pressure and lack of control over the job. Work stress can directly and indirectly harm muscles and bones, and then, cause pain [7].

(c)Nervous and anxious life

Generalized emotional anxiety can affect the quality of life, especially shoulder and neck tightness and headache, and even lead to depression or panic disorder in the long-term [8].

(d)Irritability

People who are irritable without proper control and treatment often suffer from shoulder and neck pain, even leading to greater health problems [9].

(e)Introverted people

Introverted people often lower their heads. If it goes on for a long time, it will cause shoulder and neck pain.

(4)Pathological phenomenon:

(a)Ligament injury

About 85% of shoulder and neck pain is caused by muscle or ligament injury [10,11].

(b)Adhesion of shoulder joint capsule

The adhesion of the shoulder joint capsule causes the decrease of upper limb function and shoulder pain [12].

(c)Muscle weakness

Spinal joint dislocation and compression of the nerve lead to nerve conduction myasthenia [10,11].

(d)Myofascial pain

Muscle pain in the myofascial pain syndrome is characterized by a myofascial trigger point with muscle tension. The most common clinical symptoms are shoulder stiffness and neck pain [13].

(e)Muscle overuse

Poor posture at work, fixed posture, improper application of force, repeated activities, and long working hours often cause pain in the head, lower back, neck and shoulder, wrist, etc. [7].

(f)Skeletal abnormalities

i. Cervical disc abnormalities

Due to cervical disc degeneration, cervical hyperplasia, soft tissue strain, and degeneration around the cervical spine, as well as muscle spasm on the path of the brachial plexus nerve root, can easily cause brachial plexus nerve root compression or stimulation, which can easily cause radiating pain or numbness of the neck, shoulders, and arms

[14].
ii. Absence of spinal curve
It may be a congenital abnormality of the nerves, muscles, or skeletal system, resulting in the absence of the curve of the spinal vertebra, which further causes changes in the radian of the cervical vertebra and lumbar vertebra, and clinical shoulder and neck pain [15].

2.2 The theory and application of the Modified Delphi Method
The Modified Delphi Method retains the characteristics based on the original Delphi method, and omits the steps of the first round of open-ended questionnaire, in order to smoothly conduct a research project. There are two ways to modify it:
(1)Omit the first-round of open-ended questionnaire
Based on the collected literature and experience, this study summarized and sorted out the relevant research items, or replaced them with expert interviews, and set up a structured questionnaire as the first round of the questionnaire survey. The advantage of this approach is that it does not waste time, and the structured questionnaire allows the expert group to focus on the research topic and avoid the speculation of the open-ended questionnaire [16].
(2)Merge the third and fourth round of research
In studies applying the Modified Delphi Method, expert opinions often appear in the first or second rounds, thus, it must go through at least two rounds of investigation. At most, consensus can be reached among experts in four rounds to form stability [17].

2.3 The theory and application of analytic hierarchy process
The Analytic Hierarchy Process is a decision theory published by Professor Thomas L. Saaty from the University of Pittsburgh in 1971. AHP mainly refers to the hierarchical construction of a problem through system decomposition, the use of pairwise comparisons to decompose the ratio between the relative important elements, and the selection of the schemes are arranged in order of importance as the basis for selecting the best scheme. The aim of AHP is to systematize complex problems, and takes an analytical and hierarchical structure for integrating relevant data, ideas, and intuitive discrimination, in order to conduct decision evaluation [18].

3.   RESEARCH METHOD
This study conducted a literature review of literature and journals regarding shoulder and neck pain at home and abroad, and then, conducted a questionnaire survey of the "Modified Delphi Method", which were completed by experts from the industry and academia, respectively, to examine the appropriateness of influencing factors, and construct the hierarchical structure of the evaluation criteria. Finally, the relevant weights of each criterion were obtained by AHP, and consistency testing and criterion ranking were carried out.

3.1 Research Subjects
There were two groups of subjects in this study. The first group was the experts interviewed through the modified Delphi method, and the second group was the subjects interviewed through the AHP questionnaire. The subjects were mainly office workers with shoulder and neck pain who live in the Hsinchu area of Taiwan. The participation of experts in the Delphi method was the focus of this study. The success of studies using the Delphi method is closely related to the professional quality and participation willingness of the selected subjects. A semi-open expert questionnaire was used to carry out the Modified Delphi Method. The participating experts could fully express their opinions in an anonymous manner, and repeated surveys were conducted until a consensus was reached. The aim was to identify the important factors affecting the cognition of shoulder and neck pain in office workers. Dalkey pointed out that an expert group with more than ten members had the lowest error value and the highest group credibility [19], thus, a total of ten experts were invited for this study, including professors from academia and experts from the industry. The list of experts is shown in Table 1:

Table 1. List of experts in the questionnaire

Category	Organization	Position
A1. Scholars and experts	Jenteh Junior College of Medicine, Nursing and Management	Director of Conditioning and Health Care Department
A2. Scholars and experts	National Taiwan University Hospital Zhudong Branch	President
A3. Scholars and experts	Taipei Veterans General Hospital Yuli Branch	Vice president

A4. Scholars and experts	Jenteh Junior College of Medicine, Nursing and Management	Lecturer
A5. Industry experts	Rende Shiang Health Management Consulting Company	General manager
A6. Industry experts	TCUC New Taipei City Union for Chiropractic	Director general
A7. Industry experts	Yong Kang Tang Health Centre Ltd.	Traditional chiropractor
A8. Industry experts	Hsinchu City Health Sports Association	Director general
A9. Industry experts	Ciyin Muscle and Bone Conditioning Center	Muscle and bone orderly
A10. Industry experts	International Chinese Kuoshu Federation	Director general

3.2 Research steps and implementation
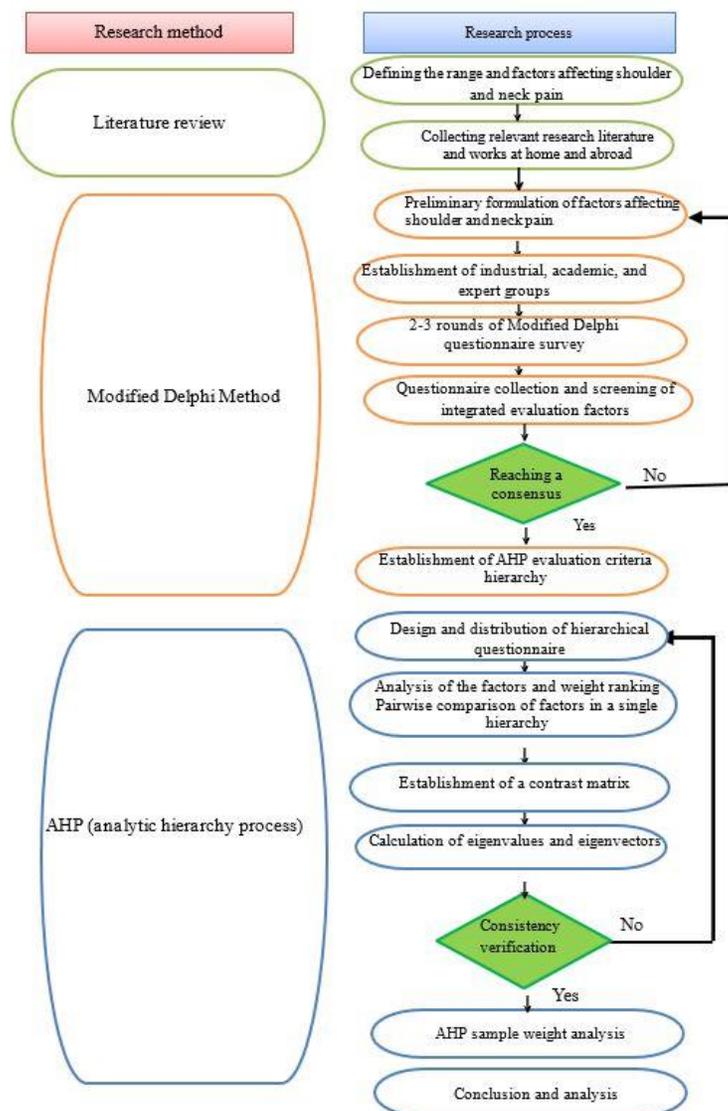The research of each stage is shown in Figure 1:

Figure 1. Framework of research methods

Step 1: The cognition of shoulder and neck pain in office workers was preliminarily defined through literature review

This study collected literature, works, and periodicals related to the cognition of shoulder and neck pain at home and abroad, which was combined with related studies on the causes of shoulder and neck pain, constructed the influencing factors of shoulder and neck pain in office workers, and preliminarily defined the four influencing dimensions and evaluation criteria, as shown in Table 2:

Table 2. Preliminary hierarchy and evaluation criteria

The first layer	The second layer	The third layer	
Target	Main criteria (Affecting dimensions)	Secondary criteria (evaluation criteria)	References
Affecting factors of shoulder and neck pain among office workers in Hsinchu area	A. Lifestyle	Al. Bad posture in life A2. Improper use of consumer electronic products A3. Bad sleeping posture A4. Unsuitable pillow A5. Lack of exercises	[1-4]
	B. Nature of work	Bl. Long hours of work B2. Repetitive work B3. Work requiring long hours of computer use B4. Bad working posture for a long time	[5] [7] [10,11] [21]
	C. Emotional form	C1. Mental stress C2. Work stress C3. Nervous and anxious life C4. Irritability C5. Introverted people	[4] [8]
	D. Pathological phenomenon	DI. Shoulder girdle injury D2. Adhesion of shoulder joint capsule (frozen shoulder) D3. Muscle weakness D4. Myofascial pain D5. Muscle fatigue D6. Skeletal abnormalities D7. Headache	[10,11] [14,15]

Source: Compiled by this study

Step 2: Modified Delphi Method- questionnaire design

This study summarized the cognition of shoulder and neck pain according to the literature review, listed four aspects and 21 evaluation criteria, used a semi-open Likert five-point scale to score the questionnaires, collected the questionnaire results of the first round, and adjusted the experts' opinions and evaluation factors. Then, we further verified the effectiveness of the influencing factors, designed the second round of expert questionnaire for the Modified Delphi Method, and summarized the main criterion level. In this step, experts' opinions were obtained through repeated questionnaire surveys. Finally, after integrating and analyzing the expert opinions and testing the consistency, a framework of relevant criteria for each hierarchy was established, which were used in the next step of the analytic hierarchy process.

First, the hierarchical dimensions and evaluation criteria of the cognitive influence of shoulder and neck pain were summarized, as based on literature review, and the "questionnaire on the influencing factors of shoulder and neck pain in office workers in the Hsinchu area" was developed, which was divided into four dimensions: 1) lifestyle, 2) nature of work, 3) emotional form, 4) pathological phenomena. There were a total of 21 evaluation criteria, and a Likert five-point scale was used to measure the influencing factors.

Step 3: Questionnaire analysis and evaluation criteria

(1) Average

According to the paper of Chen and Chen [20] in the Journal of Humanities and Social Sciences, the Likert scale was divided into "5 grades", where the middle answer of the total average "3" meant no opinion. Therefore, the

overall agreement degree for the experts and scholars were summarized, and when the result was above "3.5" (between no opinion and agree), it was regarded as the consensus reached by all the experts and scholars, and the agreement degree is 70%. By contrast, items with an agreement degree of less than 70% were classified as failing to reach a consensus. Therefore, each factor was statistically screened and the factors with an average value of above 3.5 were included in the final questionnaire items. After collecting the expert opinion questionnaire, the items that did not reach above 3.5 were deleted, and then, the second round of the expert questionnaire was prepared again.

(2)   Standard deviation
The results show the Delphi experts' opinions of the aspects and evaluation criteria of "cognitive discussion on the influencing factors of shoulder and neck pain of office workers in Hsinchu area", and the degree of dispersion. The larger the standard deviation, the more the representative opinions deviate from the topic. Therefore, when the standard deviation is greater than 1, the item will be deleted.

Step 4: Analytic Hierarchy Process –establishing the influencing factor hierarchy
This study compared the influence dimension and evaluation criteria of the modified Delphi method. According to Saaty's suggestion, in order to not affect the consistency, the number of factors for pairwise comparison at all levels should not exceed seven [18]. In order to obtain the relative importance of the evaluation criteria, the questionnaire was used to compare the influencing factors (main criteria) and evaluation criteria (secondary criteria) of shoulder and neck pain among office workers in the Hsinchu area.

4.   EMPIRICAL ANALYSIS
4.1 Analysis of the survey results of the Modified Delphi Method
Based on the Likert scale test benchmark of Wen-Liang Chen[19], the evaluation criteria with a mean less than 3.5 and standard deviation greater than 1 were deleted in the first round. The statistical results are shown in Table 3:

Table 3. Results of the first round of the Modified Delphi Method

Target layer	Main criteria	Secondary criteria	Standard deviation	Mean	Deleted or reserved
Affecting factors of shoulder and neck pain among office workers in Hsinchu area	A. Lifestyle	Al. Bad posture in life	0.67	4.70	Reserved
		A2. Improper use of consumer electronic products	0.32	4.90	Reserved
		A3. Bad sleeping posture	0.63	4.80	Reserved
		A4. Unsuitable pillow	0.71	4.50	Reserved
		A5. Lack of exercises	1.34	3.70	Deleted
	B. Nature of work	Bl. Long hours of work	0.48	4.70	Reserved
		B2. Repetitive work	0.70	4.60	Reserved
		B3. Work requiring long hours of computer use	0.48	4.70	Reserved
		B4. Bad working posture for a long time	0.00	5.00	Reserved
	C. Emotional form	C1. Mental stress	0.32	4.90	Reserved
		C2. Work stress	0.67	4.70	Reserved
		C3. Nervous and anxious life	0.48	4.70	Reserved
		C4. Irritability	0.48	4.70	Reserved
		C5. Introverted people	1.05	3.00	Deleted
	D. Pathological phenomenon	DI. Shoulder girdle injury	0.32	4.90	Reserved
		D2. Adhesion of shoulder joint capsule (frozen shoulder)	0.32	4.90	Reserved
		D3. Muscle weakness	0.70	4.60	Reserved
		D4. Myofascial pain	0.48	4.70	Reserved
		D5. Muscle fatigue	0.42	4.80	Reserved
		D6. Skeletal abnormalities	0.42	4.80	Reserved
		D7. Headache	1.49	3.70	Deleted

It can be seen from the above table that three evaluation criteria were deleted. The second round of the questionnaire test benchmark was more rigorous, with a mean less than 3.8 (less than 75% importance) and standard deviation greater than 1 as the criteria for deleting items, and reached the consensus of experts. The statistical results are

shown in Table 4.

Table 4. Results of the second round of the Modified Delphi Method (continued)

Target layer	Main criteria	Secondary criteria	Standard deviation	Mean	Deleted or reserved
Affecting factors of shoulder and neck pain among office workers in Hsinchu area	A. Lifestyle	Al. Bad posture in life	0.67	4.70	Reserved
		A2. Improper use of consumer electronic products	0.32	4.90	Reserved
		A3. Bad sleeping posture	0.63	4.80	Reserved
		A4. Unsuitable pillow	0.71	4.50	Reserved
	B. Nature of work	Bl. Long hours of work	0.48	4.70	Reserved
		B2. Repetitive work	0.70	4.60	Reserved
		B3. Work requiring long hours of computer use	0.48	4.70	Reserved
		B4. Bad working posture for a long time	0.00	5.00	Reserved
	C. Emotional form	C1. Mental stress	0.32	4.90	Reserved
		C2. Work stress	0.67	4.70	Reserved
		C3. Nervous and anxious life	0.48	4.70	Reserved
		C4. Irritability	0.48	4.70	Reserved
	D. Pathological phenomenon	DI. Shoulder girdle injury	0.32	4.90	Reserved
		D2. Adhesion of shoulder joint capsule (frozen shoulder)	0.32	4.90	Reserved
		D3. Muscle weakness	0.70	4.60	Reserved
		D4. Myofascial pain	0.48	4.70	Reserved
		D5. Muscle fatigue	0.42	4.80	Reserved
		D6. Skeletal abnormalities	0.42	4.80	Reserved

The results show that the mean of the main criteria and evaluation criteria is greater than 3.8 and the standard deviation is less than 1, thus, they were reserved, and we considered that the experts had reached a consensus. This study compared the factors of AHP, as based on the results of the second round of the Delphi survey, to determine the key factors for the cognition of shoulder and neck pain, and the AHP hierarchical structure is shown in Figure 2:
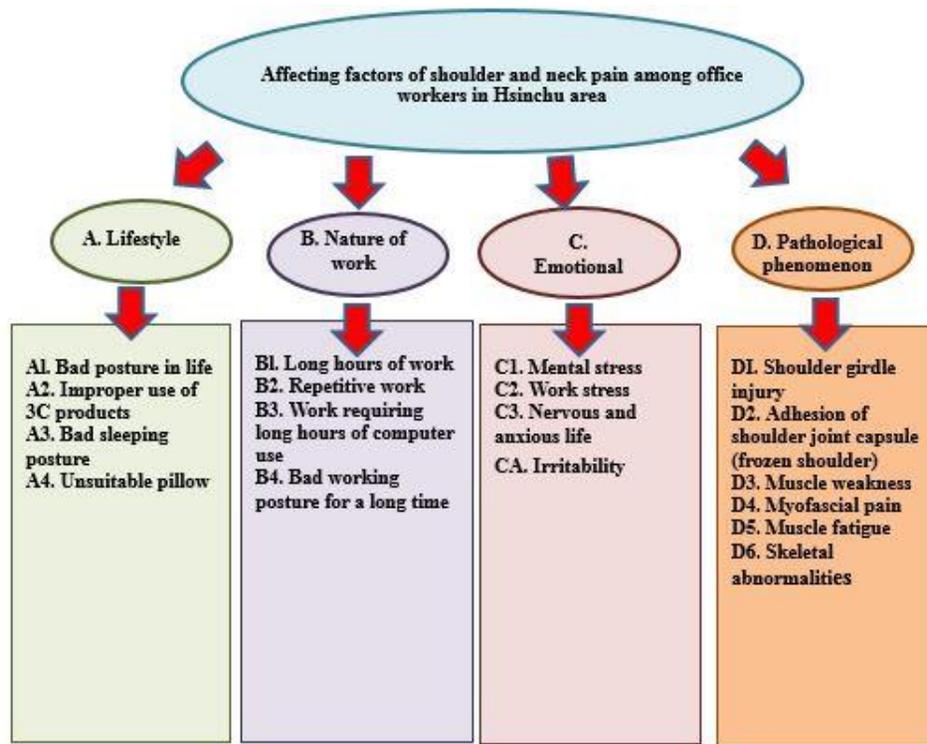
Figure 2. AHP hierarchy program structure chart

4.2 Analysis of AHP survey results:

According to the hierarchy structure chart in Figure 2, this study conducted an AHP survey on the shoulder and neck pain of office workers in the Hsinchu area. A total of 40 questionnaires were sent out and 30 valid questionnaires were collected. Among them, 15 workers had been working for more than 20 years, accounting for 50% of the survey, and the remaining 10 workers had been working for more than 10 years, accounting for 40% of the survey.

4.3 Analysis of the main criteria of the "shoulder and neck pain of office workers in the Hsinchu area":

First, the pairwise comparison of the four main criteria was carried out, with a total of 4(4-1)/2=6 times. The pairwise comparison matrix was established through Eq. 1, as shown in Table 5:

$$A = [a_{ij}] = \begin{bmatrix} 1 & a_{12} & a_{13} & a_{14} & a_{15} \\ a_{21} & 1 & a_{23} & a_{24} & a_{25} \\ a_{31} & a_{32} & 1 & a_{34} & a_{35} \\ a_{41} & a_{42} & a_{43} & 1 & a_{45} \\ a_{51} & a_{52} & a_{53} & a_{54} & 1 \end{bmatrix} = \begin{bmatrix} 1 & a_{12} & a_{13} & a_{14} & a_{15} \\ 1/a_{12} & 1 & a_{23} & a_{24} & a_{25} \\ 1/a_{13} & 1/a_{23} & 1 & a_{34} & a_{35} \\ 1/a_{14} & 1/a_{24} & 1/a_{34} & 1 & a_{45} \\ 1/a_{15} & 1/a_{25} & 1/a_{35} & 1/a_{45} & 1 \end{bmatrix}$$

(Eq. 1)

Table 5. Pairwise comparison matrix of main criteria

	A. Lifestyle	B. Nature of work	C. Emotional form	D. Pathological phenomenon
A. Lifestyle	1	1.531	1.560	2.750
B. Nature of work	0.653	1	2.605	2.326
C. Emotional form	0.641	0.384	1	2.026
D. Pathological phenomenon	0.364	0.430	0.494	1
Column sum	2.658	3.345	5.659	8.102

This study assumed that "lifestyle" is w_1, " nature of work" is w_2, "emotion form" is w_3, and "pathological phenomenon" is w_4. The weights of the criteria are calculated through Eq. 2, as follows:

$$w_i = \frac{1}{n} = \sum_j^n \frac{a_{ij}}{\sum_{i=1}^n a_{ij}} \quad i,j = 1,2,\dots\dots,n$$

(Eq. 2)

Lifestyle $w_1 = \frac{1}{4}\left(\frac{1}{2.658} + \frac{1.531}{3.345} + \frac{1.560}{5.659} + \frac{2.750}{8.105}\right) = 0.362$

Nature of work $w_2 = \frac{1}{4}\left(\frac{0.653}{2.658} + \frac{1}{3.345} + \frac{2.605}{5.659} + \frac{2.326}{8.102}\right) = 0.323$

Emotion form $w_3 = \frac{1}{4}\left(\frac{0.641}{2.658} + \frac{0.384}{3.345} + \frac{1}{5.659} + \frac{2.026}{8.102}\right) = 0.196$

Pathological phenomenon $w_4 = \frac{1}{4}\left(\frac{0.364}{2.658} + \frac{0.430}{3.345} + \frac{0.494}{5.659} + \frac{1}{8.102}\right) = 0.119$

Then Eq. 3 and Eq. 4 were used to calculate the consistency vector and average of the main criteria:

$$v_i = \sum_{j=1}^n w_j a_{ij} / W_i$$

(Eq. 3)

$$\lambda = \sum_{n=1}^n v_i / n$$

(Eq. 4)

Lifestyle $v_1 = \dfrac{0.362*1 + 0.323*1.531 + 0.196*1.560 + 0.119*2.750}{0.362} = 4.111$

Nature of work $v_2 = \dfrac{0.362*0.653 + 0.323*1 + 0.196*2.605 + 0.119*2.326}{0.323} = 4.167$

Emotion form $v_3 = \dfrac{0.362*0.641 + 0.323*0.384 + 0.196*1 + 0.119*2.026}{0.196} = 4.053$

Pathological phenomenon $v_4 = \dfrac{0.362*0.364 + 0.323*0.430 + 0.196*0.494 + 0.119*1}{0.119} = 4.086$

From the above results, we can obtain the average of the consistency vector, as follows:

$$\lambda = \frac{4.111 + 4.167 + 4.053 + 4.086}{4} = 4.104$$

The consistency index C.I. and consistency ratio C.R are calculated according to Eq. 5 and Eq. 6:
$$CI = (\lambda - n)/(n - 1) = (4.104-4)/(4-1) = 0.035$$

(Eq. 5)

$$CR = CI/RI = 0.035/0.9 = 0.039$$

(Eq. 6)

The results show that C.I.=0.051<0.1 and C.R.=0.057<0.1, which indicate an acceptable degree of consistency before and after comparison. According to the data of the four main criteria of AHP, the weight for lifestyle is 0.397, the nature of work is 0.317, the emotional form is 0.182, and the pathological phenomenon is 0.104. Therefore, it can be seen that the cognition of shoulder and neck pain of office workers in the Hsinchu area is mainly influenced by "lifestyle". "Lifestyle" has become the primary influencing factor of shoulder and neck pain.

The above weights and data in this study are integrated into Table 6, as follows:

Table 6.Weight analysis of main criteria for shoulder and neck pain of office workers in Hsinchu Area

Main criteria	A. Lifestyle	B. Nature of work	C. Emotional form	D. Pathological phenomenon	Weight	Order
A. Lifestyle	0.376	0.458	0.276	0.339	0.362	1
B. Nature of work	0.246	0.299	0.460	0.287	0.323	2
C. Emotional form	0.241	0.115	0.177	0.250	0.196	3
D. Pathological phenomenon	0.137	0.129	0.087	0.123	0.119	4
Column sum	1	1	1	1	1	
λmax=4.104、 C.I.= 0.035、 C.R.= 0.039, Consistent						

4.4 Analysis of secondary criteria for "shoulder and neck pain in office workers in Hsinchu area":
The evaluation criteria include four categories, with a total of 18 items. The four categories of factors are described in detail, as follows:
(1)Weight analysis of secondary criteria for lifestyle:
The secondary criteria for lifestyle include "A1. Poor posture in life, A2. Improper use of consumer electronic products, A3. Poor sleeping posture, A4. Unsuitable pillow". The comparison matrix obtained after pairwise comparison is shown in Table 7:

Table 7.Weight analysis of secondary criteria for lifestyle

A	A1	A2	A3	A4	Weight	Order
A1	0.402	0.511	0.320	0.314	0.387	1
A2	0.205	0.261	0.406	0.305	0.294	2
A3	0.228	0.117	0.182	0.253	0.195	3
A4	0.165	0.110	0.092	0.129	0.124	4
Column sum	1	1	1	1	1	
λmax=4.111、 C.I.= 0.037、 C.R.=0.041						

(2)Weight analysis of secondary criteria for nature of work:
The secondary criteria of the nature of work include "B1. Long hours of work, B2. Repetitive work, b3. Work requiring long hours of computer use, B4. Poor working posture for a long time". The comparison matrix obtained after pairwise comparison is shown in Table 8:

Table 8.Weight analysis of secondary criteria for nature of work

B	B1	B2	B3	B4	Weight	Order
B1	0.365	0.503	0.300	0.284	0.363	1
B2	0.165	0.227	0.380	0.276	0.262	2
B3	0.208	0.103	0.172	0.236	0.180	4
B4	0.262	0.167	0.148	0.204	0.195	3
Column sum	1	1	1	1	1	
λmax= 4.140、 C.I.= 0.047、 C.R.=0.052						

(3)Weight analysis of secondary criteria for the emotional form:
The secondary criteria of the emotional form include "C1. Mental stress, C2. Work stress, C3. Nervous and anxious life, C4. Irritability". The comparison matrix obtained after pairwise comparison is shown in Table 9:

Table 9. Weight analysis of secondary criteria for the emotional form

C	C1	C2	C3	C4	Weight	Order
C1	0.376	0.402	0.361	0.356	0.374	1
C2	0.233	0.249	0.275	0.254	0.253	2
C3	0.229	0.199	0.220	0.236	0.221	3
C4	0.163	0.151	0.143	0.154	0.153	4
Column sum	1	1	1	1	1	
λmax= 4.006、C.I.= 0.002、C.R.=0.002						

(4)Weight analysis of secondary criteria for the pathological phenomenon:
The secondary criteria of the pathological phenomena include D1. Ligament injury, D2. Adhesion of shoulder joint capsule (frozen shoulder), D3. Muscle weakness, d4. Myofascial pain, D5. Muscle fatigue, D6. Skeletal abnormalities. The comparison matrix obtained after pairwise comparison is shown in Table 10:

Table 10. Weight analysis of secondary criteria for the pathological phenomenon

D	D1	D2	D3	D4	D5	D6	Weight	Order
D1	0.205	0.395	0.274	0.248	0.206	0.157	0.247	1
D2	0.112	0.217	0.269	0.316	0.287	0.216	0.236	2
D3	0.081	0.088	0.109	0.111	0.113	0.144	0.108	5
D4	0.130	0.107	0152	0.156	0.199	0.209	0.159	3
D5	0.341	0.094	0.119	0.097	0.124	0.173	0.158	4
D6	0.130	0.100	0.076	0.075	0.071	0.100	0.092	6
Column sum	1	1	1	1	1	1	1	
λmax= 6.969 、C.I.= 0.1、C.R.=0.081								

4.5 Comprehensive analysis of the influencing factors of shoulder and neck pain among office workers in Hsinchu Area
The data analysis results of the main criteria layer and the secondary criteria layer are summarized in Table 11, and sorted according to the weight of each criterion in Table 12.

Table 11. Comprehensive analysis of the influencing factors of shoulder and neck pain among office workers in Hsinchu Area

	Criteria	Criteria weight	Secondary criteria	Secondary criteria weight	Overall weight	
A	A	0.362	A1	0.3867	0.1401	
			A2	0.2943	0.1066	
			A3	0.1949	0.0706	
			A4	0.1241	0.0450	
			Sum of secondary criteria weights	1.0000	Subtotal of overall weights	0.3623
			C.I.=	0.0369	C.R.=	0.0410

			B1	0.3629	0.1172
	B	0.323	B2	0.2621	0.0847
			B3	0.1798	0.0581
			B4	0.1952	0.0631
			Sum of secondary criteria weights	1.0000	Subtotal of overall weights 0.3230
			C.I.=	0.0467	C.R.= 0.0519
	C	0.196	C1	0.3739	0.0732
			C2	0.2526	0.0494
			C3	0.2209	0.0432
			C4	0.1526	0.0299
			Sum of secondary criteria weights	1.0000	Subtotal of overall weights 0.1957
			C.I.=	0.0019	C.R.= C.I.=
	D	0.119	D1	0.206	0.0245
			D2	0.287	0.0341
			D3	0.113	0.0134
			D4	0.199	0.0237
			D5	0.124	0.0147
			D6	0.071	0.0085
			Sum of secondary criteria weights	1.0000	Subtotal of overall weights 0.1190
			C.I.=	0.1002	C.R.= C.I.=
	Total weight sum			1.0000	
C.I.=		0.0347			0.0386

Table 12.Overall weight ranking of influencing factors of shoulder and neck pain among office workers in Hsinchu area

	Criteria	Criteria weight	Secondary criteria	Secondary criteria weight	Secondary sort	Overall weight	Overall sort
A	A	0.3623	A1	0.3867	1	0.1401	1
			A2	0.2943	2	0.1066	3
			A3	0.1949	3	0.0706	6
			A4	0.1241	4	0.0450	10

		B1	0.3629	1	0.1172	2
B	0.3230	B2	0.2621	2	0.0847	4
		B3	0.1798	4	0.0581	8
		B4	0.1952	3	0.0631	7
C	0.1957	C1	0.3739	1	0.0732	5
		C2	0.2526	2	0.0494	9
		C3	0.2209	3	0.0432	11
		C4	0.1526	4	0.0299	13
D	0.1190	D1	0.2060	2	0.0245	14
		D2	0.2866	1	0.0341	12
		D3	0.1129	5	0.0134	17
		D4	0.1992	3	0.0237	15
		D5	0.1239	4	0.0147	16
		D6	0.0715	6	0.0085	18

According to the overall weight of the above four main criteria and 18 evaluation criteria, the top four are ranked respectively as 0.1401 for the " poor posture in life", 0.1172 for "long hours of work", 0.1066 for "improper use of consumer electronic products", and 0.0847 for "repetitive work", accounting for 45% of the overall weight. " Poor posture in life" accounts for about 14% of the total, which means that the main cognition of office workers for shoulder and neck pain is poor posture in life. Therefore, office workers can effectively prevent and reduce many diseases that cause shoulder and neck pain through good living habits. In summary, "lifestyle", " nature of work", and "emotional form" account for 90% of the total weight. The above data indicate that the cognitive factors affecting shoulder and neck pain of office workers in the Hsinchu area account for 90%, while the "pathological phenomenon" only accounts for 10% of the total weight.

5.　CONCLUSION
Based on the expert opinions collected by the Delphi method, the four impact dimensions and 18 secondary criteria are used as the framework for AHP. According to the questionnaire survey and statistical analysis, the research results are, as follows:
(1) According to the weight of the main influencing dimension (the main criterion layer), it is found that "lifestyle" (36.2%) is the most important factor for the shoulder and neck pain of office workers in the Hsinchu area, followed by "nature of work" (32.3%).
(2) According to the weight of the secondary dimensions (evaluation criteria), for the shoulder and neck pain of office workers in the Hsinchu area, it is found that: poor posture in life ranks first in the "lifestyle"; long hours of work ranks first in the "nature of work"; mental stress ranks first in the emotional form, and the adhesion of shoulder joint capsule (frozen shoulder) ranks first in "pathological phenomena".
(3) According to the weight of the overall secondary dimension (evaluation criteria), it is found that the top five influencing factors for the cognition of shoulder and neck pain in office workers in the Hsinchu area are ranked as follows: 1) poor posture in life; 2) long hours of work; 3) improper use of consumer electronic products; 4) repetitive work.
In conclusion, poor posture in life and improper use of consumer electronic products are the important secondary weight factors of shoulder and neck pain in the lifestyle level, while long hours of work and repetitive work have become the important secondary weight factors of shoulder and neck pain in the level of nature of work.

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