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Original Article

An investigation into the cognitive flexibility of undergraduate dental hygiene students at two dental schools in Asia

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Abstract *Background/purpose:* Cognitive flexibility is a personality trait, which can influence how effectively a healthcare professional can manage a challenging clinical situation. This study explored the cognitive flexibility of undergraduate dental hygiene students at two universities in Asia to gather baseline information in order to consider whether there was an educational need for pre-clinical students with regards to this personality factor.
Materials and methods: Participants were all undergraduate dental hygiene students in the 2022 academic year at Tokyo Medical and Dental University (TMDU; n = 79) and Taipei Medical University (TMU; n = 88). An anonymous questionnaire was distributed, which included questions on demographic information and the Cognitive Flexibility Inventory (CFI).

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Results: The response rates were 97.5% (TMDU) and 89.8% (TMU). The CFI total scores were 91.77 for TMDU and 95.87 for TMU, and there was no significant difference between the two schools. The Alternatives scores were significantly higher in TMU than TMDU ($P = 0.044$), but there were no significant differences in the Control scores between the two schools. There were also no significant differences between school years of both universities.
Conclusion: The dental hygiene students from both dental schools exhibit moderate cognitive flexibility. The educators in both dental schools may consider whether they should investigate and develop this personality factor further during the undergraduate training of their dental hygiene students.

Introduction

Research on dental hygienists working in countries such as the USA and UK has shown that they experience work-related stressors that could contribute to burn-out, negative mental health disorders and low mental well-being.[1,2] Moreover, it was reported that since the start of the Covid-19 pandemic, anxiety levels among dental hygienists have risen further.[2] Increases in the symptoms of low mental well-being such as mental fatigue, can result in higher levels of absenteeism from work and a shortening of working life, which will impact on patient care and workforce recruitment and retention.[1,2] However, recent systematic reviews on the health and well-being of clinical dental care professionals and interventions on mental health and well-being in the field of dentistry have indicated that there is very little research and that mental well-being awareness should become a focal point for both the workplace and in dental education.[3,4]

The dental school curriculum and its environment have also been shown to be a demanding and stressful experience for students,[5,6] and stress has been shown to have a detrimental effect on students' physical and mental health.[7] A previous study on dental hygiene students in Asian dental schools in Taiwan and Japan showed that the overall stress levels in both schools were moderate or relatively low.[8] However, stress is perceived differently by each person and mental and emotional health can be affected by many factors. Personality traits such as extraversion, conscientiousness, agreeableness, neuroticism (emotional stability) and openness, are linked with self-esteem, and neuroticism was shown to be linked with symptoms of depression in adolescence.[9,10] Self-esteem has been shown to be related to the resilience of dental hygiene students and with regards to resilience, innate resilience as opposed to acquired resilience was a significant predictor of better self-rated health.[11,12] Two other personality factors that are important for mental health are the concepts of mindfulness and cognitive flexibility.[13]

Cognitive flexibility helps us adapt to changes in our lives, manage stressful encounters, and solve problems.[13] It has been described as a person's ability to be aware of the options and alternatives available and their willingness to adapt and be flexible in any particular situation.[14] Moreover, in any particular situation, a person has options on how they should behave, which is referred as self-efficacy.[14] Bandura first coined the term "self-efficacy" giving an example that people tend to avoid threatening situations that they think are beyond their coping skills but will become involved in activities that they judge themselves to be capable of handling,[15] and also described how "perceived self-efficacy" can directly influence not only the choice of activities and their settings but how long someone will persist in the face of barriers and undesirable experiences.[15] A certain level of cognitive flexibility is, therefore, necessary to successfully cope with life's challenges.

In dentistry, dental hygienists and dental hygiene students will face many clinical encounters that could be perceived as stressful and will rely on their flexibility and ability to adapt to manage these. The degree of "self-efficacy" a dental hygiene student possesses for example, may determine how long they persisted in providing care for a "challenging" situation, and how well the dental hygiene student could adapt to the challenging situation, thus influencing the level of anxiety created, and the perception of whether the situation was "stressful" or not. It has been reported that three aspects of cognitive flexibility are necessary for managing such situations; possessing a tendency for "*challenging encounters to be perceived as controllable*"; having an ability to see that there might be "*multiple alternative explanations for human behaviors and life occurrences*" and being able to come up with "*multiple alternative solutions to difficult situations*".[16] In order to measure these three aspects of cognitive flexibility, the Cognitive Flexibility Inventory (CFI), which is a self-reporting tool, has been developed.[16]

Our previous study indicated that soft skills acquisition might be essential for dental hygiene students,[8] however, there is little published research on the cognitive flexibility of healthcare professionals practicing dentistry and to date, there is no published information on the cognitive flexibility of dental hygiene students. The aim of this research was therefore to investigate the level of cognitive flexibility among dental hygiene students in different years of study in two schools in different countries with similar student numbers and composition, and to determine whether there might be an indication for interventions in their undergraduate training.

Materials and methods

This study was approved by the Academic Research Ethics Committee of Tokyo Medical and Dental University (TMDU), Tokyo, Japan (No. C2022-016), and the Institutional Review Board of Taipei Medical University (TMU), Taipei, Taiwan (TMU-JIRB No. N202211026).

Study populations and survey administration

All (first-to fourth-year) dental hygiene students in the 2022 academic year at TMDU (n = 79) and TMU (n = 88) were invited to participate in this study and were asked to complete an anonymous self-reported questionnaire. Participation was voluntary and those who agreed to participate were included in the data collection.

Data were collected in January 2023 and February 2023 at TMDU and TMU. In TMDU, students were asked to gather in the classroom, listen to an explanation from the researcher, and then answer the questionnaire, which was paper-based. In TMU, students had an explanation from the researcher and were then asked to read the explanatory notes and answer the questionnaire using Google Forms®.

Questionnaire and Cognitive Flexibility Inventory

The questionnaire consisted of two parts: demographic details (study year, age, gender, country of birth, and cultural background), and the Cognitive Flexibility Inventory (CFI).[16]

The CFI is a self-reporting inventory, which consists of 20 questions using a 7-point Likert scales (from strongly disagree to strongly agree). Thirteen items are named the "Alternatives" and are designed to measure "*the ability to perceive multiple alternative explanations for life occurrences and human behavior, and the ability to generate multiple alternative solutions to difficult situations*". Seven items are named the "Control", which are "*designed to measure the tendency to perceive difficult situations as controllable*".[16] The scores for each measure were calculated as follows: The scores were added up for the items on the Alternatives (items 1, 3, 5, 6, 8, 10, 12, 13, 14, 16, 18, 19, and 20) and for items on the Control (2, 4, 7, 9, 11, 15 and 17). Alternatives score ranged from 13 to 91, and Control score ranged from 7 to 49. Items 2, 4, 7, 9, 11, and 17 needed to be reversed while scoring. Higher scores on both scales indicated greater flexibility and there was no cut-off point for the CFI.[17]

Statistical analysis

Data were entered into IBM SPSS Statistics for Windows® (version 26.0, IBM Corp., Armonk, NY, USA), and statistical analyses were conducted. Cronbach's alpha was used to assess the internal consistency of CFI and the Shapiro-Wilk test was used to test the normality of the data. The Mann-Whitney U test was used to compare CFI mean scores (total, Alternatives, and Control) between the two schools (each study year, and also to see the differences of each item in between the two schools). The Kruskal-Wallis test was used to compare the differences in each study year among the two schools.

Results

A total number of 77 TMDU students and 79 TMU students participated, with a response rate of 97.5% (paper-based) and 89.8% (online survey), with a lower response rate for the online questionnaire. The mean age and age ranges of the students in TMDU and TMU were 20.5 (18—27 y/o) and 20.3 (18—24 y/o), respectively. Demographic data including gender, country of birth, and cultural background, are shown in Table 1. Cronbach's alpha of CFI was 0.84 considering the whole model with 0.79 for TMDU, and 0.86 for TMU respectively.

Cognitive Flexibility Inventory

The mean scores of total Cognitive Flexibility Inventory (CFI), Alternatives, and Control of both schools and every study year are shown in Table 2. The results of the Mann-Whitney U test indicated that TMU students recorded significantly higher Alternatives mean scores than TMDU students ($P = 0.044$), and there were no significant differences between the students of the two schools for each study year for the CFI total, Alternatives, or Control mean scores (Table 2). Table 3 shows that TMU students gave significantly higher mean scores than TMDU students for item 3 "*I consider multiple options before making a decision.*" (TMU 5.46, TMDU 5.01; $P = 0.007$), item 5 "*I like to look at different situations from many different angles.*" (TMU 5.10, TMDU 4.65; $P = 0.005$), and item 18 "*When I encounter difficult situations, I stop and try to think of several ways to resolve it.*" (TMU 4.90, TMDU 4.38; $P = 0.020$).

The results of the Kruskal-Wallis test indicated there were no significant differences among all the years of study at the two schools with regards to total CFI, Alternatives, or Control mean scores (Table 4).

Discussion

Despite cognitive flexibility being shown to help us adapt to changes in our lives, manage stressful encounters and solve

Table 1 Demographic data.

	TMDU n (%)	TMU n (%)	Total n (%)
Total	77 (100.0)	79 (100.0)	156 (100.0)
Gender			
Women	77 (100.0)	61 (77.2)	138 (88.5)
Men	0 (0.0)	18 (22.8)	18 (11.5)
Country of birth			
Japan	77 (100.0)	0 (0.0)	77 (49.4)
Taiwan	0 (0.0)	77 (97.5)	77 (49.4)
Indonesia	0 (0.0)	1 (1.3)	1 (0.6)
Malaysia	0 (0.0)	1 (1.3)	1 (0.6)
Cultural background			
Japanese	77 (100.0)	0 (0.0)	77 (49.4)
Taiwanese	0 (0.0)	78 (98.7)	78 (50.0)
Malaysian	0 (0.0)	1 (1.3)	1 (0.6)

Table 2 Comparison of Cognitive Flexibility Inventory (CFI) mean scores between TMDU and TMU.

	TMDU		TMU		*P*-value[a]
	n (%)	Mean (SD)	n (%)	Mean (SD)	
Total	77 (100.0)		79 (100.0)		
CFI total [20–140]		91.77 (10.44)		95.87 (12.79)	0.064
Alternatives [13–91]		63.39 (7.87)		66.18 (9.52)	0.044*
Control [7–49]		28.38 (5.13)		29.70 (6.65)	0.287
1st year	23 (29.9)		23 (29.1)		
CFI total [20–140]		91.74 (13.08)		99.17 (15.29)	0.116
Alternatives [13–91]		62.43 (9.18)		67.83 (9.60)	0.086
Control [7–49]		29.30 (6.36)		31.35 (7.81)	0.415
2nd year	24 (31.2)		21 (26.6)		
CFI total [20–140]		93.21 (9.38)		96.48 (10.88)	0.284
Alternatives [13–91]		64.92 (7.27)		66.29 (7.53)	0.515
Control [7–49]		28.29 (4.94)		30.19 (5.89)	0.344
3rd year	14 (18.2)		22 (27.8)		
CFI total [20–140]		91.57 (8.23)		93.55 (10.64)	0.785
Alternatives [13–91]		64.64 (7.11)		66.77 (10.05)	0.395
Control [7–49]		26.93 (3.95)		26.77 (5.02)	0.855
4th year	16 (20.8)		13 (16.5)		
CFI total [20–140]		89.81 (10.01)		93.00 (14.11)	0.503
Alternatives [13–91]		61.38 (7.37)		62.08 (11.13)	0.846
Control [7–49]		28.44 (4.44)		30.92 (7.11)	0.589

P-value: Using Mann-Whitney U test.
* Statistically significant at $P < 0.05$.
[a] Compared mean scores between two schools.

problems,[13] there is to date, no previously published research on the cognitive flexibility of undergraduate students studying dentistry, in particular dental hygiene. The present study investigated the cognitive flexibility of dental hygiene students across all four years of the undergraduate programs at one dental school in Japan and one in Taiwan. Regarding cognitive flexibility, the CFI looked at three aspects; "*the ability to perceive multiple alternative explanations for life occurrences and human behavior*", "*the ability to generate multiple alternative solutions to difficult situations*", which was called "Alternatives" and "*the tendency to perceive difficult situations as controllable*", as "Control".[16]

Regarding the "Alternatives" results for the four-year dental hygiene programs at the two dental schools, TMU students attained significantly higher mean scores than TMDU (Table 2), and TMU also recorded significantly higher mean scores for items 3, 5, and 18 (Table 3). These findings indicate that the TMU students, who participated might possibly exhibit higher flexibility in considering multiple alternatives when solving certain questions than the TMDU students who participated. With regards to the mean scores of total CFI, Alternatives, and Control, TMU students had higher scores than TMDU especially those of the first-year students, however, there were no significant differences in the scores between the same years of training at the two schools for all four years of the programs (Table 2), and there were no significant differences between the different years at both schools (Table 4). This was also true for the "Control" results across all four years and between the two

Table 3 Comparison of each items in Cognitive Flexibility Inventory (CFI)[16] between TMDU and TMU.

CFI items	TMDU Mean	TMU Mean	*P*-value[a]
1. I am good at "sizing up" situations.	4.58	4.71	0.834
2. I have a hard time making decisions when faced with difficult situations.	3.39	3.57	0.406
3. I consider multiple options before making a decision.	5.01	5.46	**0.007***
4. When I encounter difficult situations, I feel like I am losing control.	4.38	4.27	0.451
5. I like to look at difficult situations from many different angles.	4.65	5.10	**0.005***
6. I seek additional information not immediately available before attributing causes to behavior.	4.49	4.61	0.276
7. When encountering difficult situations, I become so stressed that I can not think of a way to resolve the situation.	3.84	4.15	0.168
8. I try to think about things from another person's point of view.	5.44	5.32	0.280
9. I find it troublesome that there are so many different ways to deal with difficult situations.	3.48	3.72	0.124
10. I am good at putting myself in others' shoes.	4.78	5.16	0.051
11. When I encounter difficult situations, I just don't know what to do.	4.18	4.47	0.191
12. It is important to look at difficult situations from many angles.	5.87	5.51	0.146
13. When in difficult situations, I consider multiple options before deciding how to behave.	5.00	5.18	0.329
14. I often look at a situation from different viewpoints.	4.92	5.22	0.089
15. I am capable of overcoming the difficulties in life that I face.	4.62	4.96	0.142
16. I consider all the available facts and information when attributing causes to behavior.	4.65	4.86	0.237
17. I feel I have no power to change things in difficult situations.	4.48	4.56	0.806
18. When I encounter difficult situations, I stop and try to think of several ways to resolve it.	4.38	4.90	**0.020***
19. I can think of more than one way to resolve a difficult situation I'm confronted with.	4.71	5.04	0.075
20. I consider multiple options before responding to difficult situations.	4.90	5.13	0.166

P-value: Using Mann-Whitney U test.
* Statistically significant at $P < 0.05$.
[a] Compared mean scores between two schools.

Table 4 Comparison of Cognitive Flexibility Inventory (CFI) mean scores among different study years in TMDU and TMU.

		CFI total Mean (SD) range 20—140	Alternatives Mean (SD) range 13—91	Control Mean (SD) range 7—49
TMDU				
1st year	n = 23	91.74 (13.08)	62.43 (9.18)	29.30 (6.36)
2nd year	n = 24	93.21 (9.38)	64.92 (7.27)	28.29 (4.94)
3rd year	n = 14	91.57 (8.23)	64.64 (7.11)	26.93 (3.95)
4th year	n = 16	89.81 (10.01)	61.38 (7.37)	28.44 (4.44)
***P*-value** [a]		0.506	0.212	0.609
TMU				
1st year	n = 23	99.17 (15.29)	67.83 (9.60)	31.35 (7.81)
2nd year	n = 21	96.48 (10.88)	66.29 (7.53)	30.19 (5.89)
3rd year	n = 22	93.55 (10.64)	66.77 (10.05)	26.77 (5.02)
4th year	n = 13	93.00 (14.11)	62.08 (11.13)	30.92 (7.11)
***P*-value** [a]		0.386	0.494	0.120

P-value: Using Kruskal-Wallis test.
[a] Compared mean scores among study years.

schools (Tables 2 and 4). These results may possibly indicate that within the undergraduate dental hygiene training programs at both dental schools, there were no significant interventions which might have improved the cognitive flexibility of the students as they progressed through their training.

In order to improve the "transferability" of the findings for the cognitive flexibility of undergraduate dental hygiene students to different schools, undergraduate students in two universities in two different countries were investigated. To date, regarding the relationship between the scores and classifications of high, moderate and low flexibility, it has been reported there is no established cut-off score.[17] The CFI scores for all four years at both dental schools were approximately two-thirds of the maximum score for the "Alternatives" and greater than half the maximum score for the "Control". These findings might indicate that at both schools, there was between medium

and high cognitive flexibility for the undergraduate dental hygiene students in the case of the "Alternatives", and medium flexibility for the "Control" for the students in the different years of training.

Previous research on cognitive flexibility and problem-solving skills using the CFI and Problem Solving Inventory showed that there was a high and positive correlation between the overall flexibility level and problem-solving skills, and it was concluded that cognitive flexibility skills were necessary to solve problems effectively.[18] This indicates that cognitive flexibility may have an important influence on the clinical decision-making of dental hygiene students and therefore warrants further research. Introducing a program to improve cognitive flexibility, which creates a "simulated" environment that allows for students to learn how to deal with the difficult situations in their career might therefore be beneficial.

To date though, there are no published education programs aimed at improving the cognitive flexibility of undergraduate students in healthcare programs. However, a theoretical model on flexible thinking in education has been published that might help the pedagogy for developing an intervention to improve cognitive flexibility.[19] On the other hand, high flexibility may not always be a good thing when it comes to undergraduate healthcare training since the correct way of undertaking a clinical procedure is often learnt in simulation and then carried out on a patient in a similar manner. In other words, procedures must be followed in a correct manner such as for example, when carrying out professional mechanical plaque removal on a patient. Therefore, further research is indicated on what level of cognitive flexibility might be appropriate for dental hygiene students during their undergraduate training.

The CFI self-report measure was chosen for the present study as it was developed and validated using undergraduate university students and was shown to have "convergent construct validity" with other measures of cognitive flexibility such as the Cognitive Flexible Scale (CFS) developed by Martin et al.[14,16] Moreover, the CFI has been used to investigate the cognitive flexibility of Iranian dentists in response to Covid-19 including their ability to manage their fear of becoming infected and concerns for their future career, which concluded that "interventions to enhance cognitive flexibility" should be provided for dentists to reduce the psychological burden faced during crises.[20]

This study was conducted to establish the cognitive flexibility of dental hygiene students, which could act as a baseline for future studies and it was observed that cognitive flexibility did not appear to increase throughout undergraduate training. However, the design was cross-sectional and only one university from each country was investigated. Further research employing a longitudinal design is indicated to determine any possible changes in cognitive flexibility. While the relationship of cognitive flexibility to other factors such as academic and clinical performance were not investigated, the results of this study could act as a baseline for future studies investigating the relationship of cognitive flexibility and other personality traits, and factors that could be important for the clinical training. The sample size may have made it difficult to determine differences in the CFI scores between and among the two universities. Further research on whether there is a relationship between the level of cognitive flexibility and the academic and clinical performance is also indicated.

However, the present study is to date, the first investigation on the cognitive flexibility of undergraduate students studying dentistry, in particular dental hygiene. Further research is therefore indicated on the cognitive flexibility of undergraduate students studying on other programs such as dentistry and dental hygiene and therapy at different universities, and whether educational interventions aimed at improving cognitive flexibility might be beneficial.

Declaration of competing interest

The authors have no conflicts of interest relevant to this article.

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