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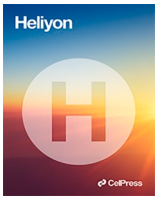

# Development of a social cognitive career theory scale for measuring the intention to select surgery as a career

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ABSTRACT

*Background:* Surgeon shortages have emerged as a prominent global issue. Although various studies have explored the factors that influence medical students in choosing surgery as a career, addressing the need for surgeons requires a multifaceted approach. However, there is currently a lack of a theoretically grounded scale to evaluate the effectiveness of surgical career development or policy promotion. Thus, this study aimed to develop a questionnaire for assessing the preference for a surgical career by adopting the Social Cognitive Career Theory (SCCT).

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*Materials and methods:* The study aimed to develop the Social Cognitive Career Theory Scale toward Surgery (SCCTSS) by adopting the framework of SCCT. The questionnaire was created through expert consensus and the content validity index (CVI) calculation. Subsequently, a pilot version of the SCCTSS was administered to 222 medical students in their clinical clerkships, and the collected data underwent item analysis. Additionally, the validation of the SCCTSS by gender was performed.

*Results:* The SCCTSS comprised 16 items that passed expert panel evaluation, with a CVI >0.8, mean ≥ 3.00, and an interquartile range ≤1. Item analysis demonstrated that the quality of the SCCTSS met the qualifying threshold. Furthermore, the SCCTSS questionnaire effectively validated gender differences in surgical career preference.

*Conclusions:* We developed an internally consistent and reliable scale and validated it through an expert panel method and feedback from medical students. Further research is required to evaluate the targeted interventions that may assist in recruiting medical students into the field of surgery through the application of the SCCTSS.

**Abbreviation**

| | |
|---|---|
| SCCTSS | social cognitive career theory scale toward surgery |
| CVI | content validity index |
| SCCT | Social cognitive career theory |
| CI | confidence interval |
| IQR | interquartile range |

## 1. Introduction

Surgeon shortages, stemming from their uneven distribution among medical specialties, have emerged as a global concern [1–7]. Numerous studies have investigated factors influencing medical students' career choice in surgery, including exposure prior to clerkship, clinical experience, mentorship, the surgical lifestyle, and personality traits [8–12]. Addressing the shortage of surgeons necessitates a comprehensive approach encompassing increased investment in training and educational programs, innovative care delivery models, improvements in working conditions, and incentives for practice [7]. However, there is a lack of a theoretically grounded scale for assessing the effectiveness of surgical career development and policy promotion. Hence, we have developed and validated a scale that evaluates the factors influencing the preference for a surgical career by adopting the social cognitive career theory.

Social cognitive career theory (SCCT), derived from Bandura's general social cognitive theory [13], is widely used in the field of career development [14]. SCCT encompasses interconnected components, including self-efficacy, interests, outcome expectations, and personal intentions/goals, as depicted in Fig. 1 [15]. Self-efficacy refers to an individual's belief in their ability to perform a specific behavior, and this belief can be dynamic and subject to change. Outcome expectations reflect an individual's anticipation of the outcomes associated with engaging in a particular behavior, with higher positivity increasing the likelihood of behavior engagement. Interest development emerges in light of the interplay between self-efficacy and outcome expectations. Personal goals are aligned with

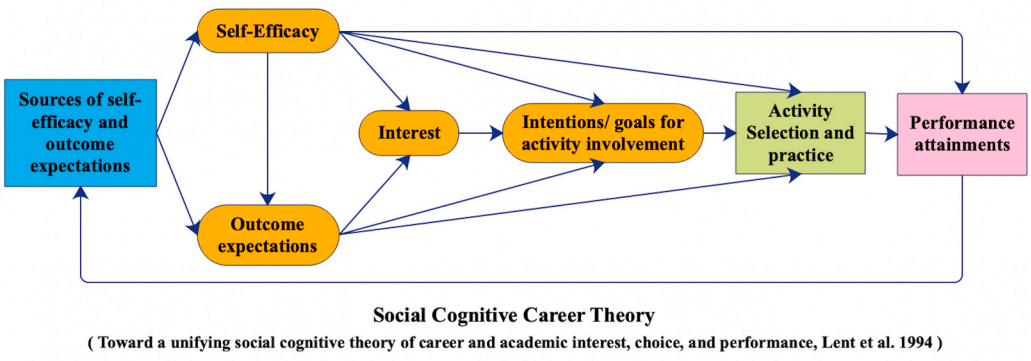


**Fig. 1.** Diagram of Social Cognitive Career Theory (SCCT): Adopted from Lent et al., 1994; Toward a unifying social cognitive theory of career and academic interest, choice, and performance.

an individual's self-efficacy and outcome expectations, guiding their behavior and commitment to specific actions. Therefore, SCCT provides a valuable framework for investigating the underlying factors in career decision-making. Notably, SCCT emphasizes the significance of personal agency for individuals [16,17], a factor often overlooked in the career development process. Additionally, SCCT facilitates the identification of critical factors, including personal, contextual, and behavioral variables, that influence the development of career interests, abilities, goals, and choices. While SCCT has been successfully applied to various occupational domains such as engineering, science, mathematics [18,19], and medicine [20–23], its application in surgery remains limited.

Given the global concern regarding insufficient applicants for surgery residency, it is crucial to examine the career preferences of medical students prior to their graduation and selection of a specialty residency. Previous studies have indicated that factors such as gender, personality, and curriculum structure play significant roles in career selection; however, the underlying process of medical career decision-making remains incompletely understood [11]. Consequently, this study aimed to develop a scale based on the SCCT to explore the factors influencing medical students' decision to pursue surgery as a career.

## 2. Materials and method

### 2.1. Participants

The study involved two distinct groups of participants. The first group consisted of eight experts, including three surgeons, three medical education professors, and two professors specializing in education. These individuals formed the expert panel responsible for the development stage of the Social Cognitive Career Theory Scale Toward Surgery (SCCTSS).

The second group comprised 222 sixth-year medical students currently undergoing clinical clerkships. It is worth noting that most medical schools in Taiwan offer a 6-year medical doctor (MD) program, which includes pre-medical courses, clinical courses, and clerkship training spanning a total of 6 years. The participants in this study were explicitly sixth-year students who were in their second year of clerkship training and approaching graduation. After obtaining oral informed consent, the students were surveyed after completing their surgery clerkship. It is important to emphasize that participation in the survey was voluntary and not mandatory as part of their coursework.

Furthermore, the completion of the questionnaire was unrelated to their academic grades. Participants were given the option to decline participation without having to provide any explanation. Ethical approval for the study was obtained from the institutional review board of our institution (N201702059).

### 2.2. SCCTSS questionnaire development process

The Social Cognitive Career Theory Scale Toward Surgery (SCCTSS) was developed to assess self-efficacy, outcome expectations, surgical interests, and the likelihood of choosing surgery as a career among medical students. The development of the SCCTSS involved two distinct phases, as illustrated in Fig. 2 [24].

#### 2.2.1. Phase I: development of SCCTSS

The first phase of the SCCTSS questionnaire development involved five steps. Firstly, the initial draft of the SCCTSS was created by adopting the SCCT framework, which consists of four domains: self-efficacy, outcome expectations, interests, and intentions (Fig. 1).

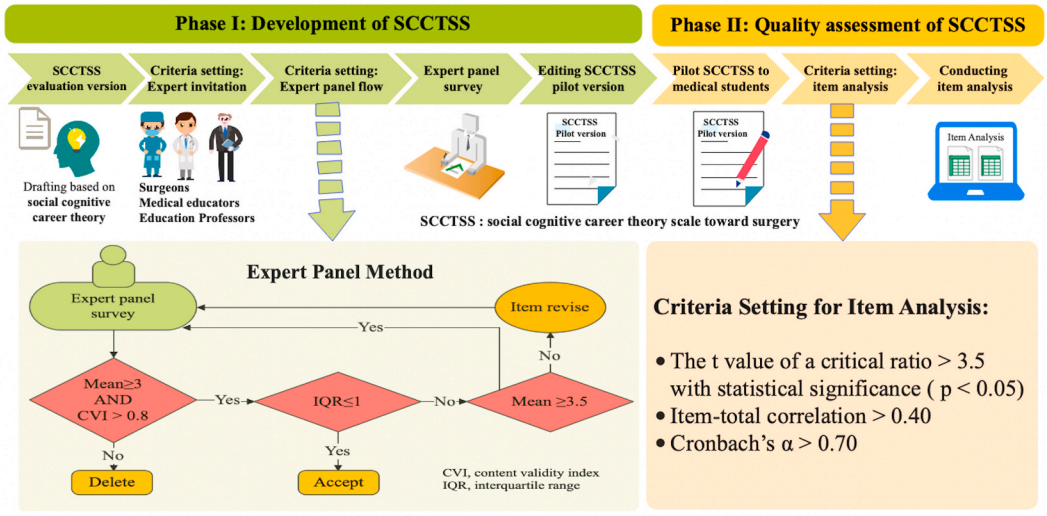


**Fig. 2.** SCCTSS questionnaire development process and criteria of the item analysis.

Four items were drafted within each domain, resulting in 16 items (Table 1). Secondly, criteria were established to invite experts with teaching and research experience to review the scale (step 2). Surgeons with over ten years of clinical teaching experience, physicians in medical education, and professors specializing in education were invited to participate in the panel. Thirdly, the expert panel method was implemented, as illustrated in Fig. 2 (step 3). Fourthly, the experts evaluated the SCCTSS pilot version by scoring the items on a 4-point Likert scale (step 4). The scores ranged from 1 to 4, with each value indicating a specific recommendation: (1) deletion, (2) major revision required, (3) minor revision required, and (4) suitable (Supplementary Table 1). Each item was assigned a mean and an interquartile range (IQR) based on the ratings from the Likert scale. The content validity index (CVI) was calculated by dividing the number of experts rated each item by the total number of experts. Items with a mean score greater than 3 and a CVI greater than 0.8 were retained or revised, while items with a mean score less than 3 or a CVI less than 0.8 were excluded. Finally, the SCCTSS pilot version was developed using the expert panel method (step 5, Fig. 2).

#### 2.2.2. Phase II: Quality assessment of SCCTSS

The second phase of the study focused on the quality assessment of the questionnaire and consisted of three steps. Firstly, to evaluate the quality of the questionnaire (Supplementary Table 2), the SCCTSS pilot version was administered to a group of medical students (step 1). Secondly, criteria for item analysis were established based on several statistical methods, as presented in Fig. 2 [24–27]. These criteria included: (1) a critical ratio t-value greater than 3.5 with statistical significance ($p < 0.05$) and a 95 % confidence interval (CI) that did not include 0, (2) item-total correlation exceeding 0.40, and (3) Cronbach's alpha coefficient greater than 0.70 (step 2). Finally, item analysis was conducted, and any item that exhibited a Cronbach's alpha coefficient lower than 0.7 was eliminated from the scale (step 3).

### 2.3. Data analysis

Data analyses were performed using Statistical Package for Social Sciences, version 19. Descriptive statistics such as mean, interquartile range (IQR), and content validity index (CVI) were calculated based on the expert panel survey data. To assess the quality of the survey results among experts with diverse backgrounds, the Kruskal-Wallis test was employed. In cases where significant differences were detected in the Kruskal-Wallis test, Dunn's test was conducted as a post hoc test.

The item analysis of the SCCTSS pilot version involved calculating the critical ratio, item-total correlation, and Cronbach's α, as depicted in Fig. 2. In the quality assessment phase, item analysis was employed to evaluate the individual test items' quality. This analysis provided information on whether an item effectively measured the intended content and construct. Item discrimination was assessed by comparing the performance of an item between different groups, with the groups categorized based on a measure of the construct. The responses were sorted in ascending order based on the individual sum score of the SCCTSS. High-score and low-score groups were then identified from the top and bottom one-third, respectively, using a cutoff to differentiate the two groups. The critical ratio was utilized to determine the differences between the high-score and low-score groups, with a threshold greater than 3.5. Furthermore, the item-total correlation was employed to assess the correlation between each item and the total score [26]. A higher

**Table 1**
Content validity of the SCCTSS established through a 16-item investigation by an expert panel method.

| Item | Question | Mean | IQR | CVI | Judge |
|---|---|---|---|---|---|
| **Domain 1. Self-efficacy of surgical competency** | | | | | |
| 1 | I will be capable of performing surgical tasks. | 3.63 | 1 | 1 | Accept |
| 2 | I will be competent in developing my skills for a career in surgery. | 3.75 | 0.75 | 1 | Accept |
| 3 | I will be competent in acquiring surgical knowledge for a career in surgery. | 3.75 | 0.75 | 1 | Accept |
| 4 | I will be competent as an attending surgeon. | 3.88 | 0 | 1 | Accept |
| **Domain 2. Outcome expectations for a career as a surgeon** | | | | | |
| 5 | I will have a sufficient or satisfactory income as a surgeon. | 3.5 | 1 | 1 | Accept |
| 6 | As a surgeon, I will obtain high social status. | 4 | 0 | 1 | Accept |
| 7 | As a surgeon, I will develop or reach my potential. | 4 | 0 | 1 | Accept |
| 8 | I will assist those in need as a surgeon. | 3.88 | 0 | 1 | Accept |
| **Domain 3. Interests in surgery** | | | | | |
| 9 | I would like to collaborate with surgeons. | 3.75 | 0.75 | 1 | Accept |
| 10 | I would like to learn about surgical advancements. | 4 | 0 | 1 | Accept |
| 11 | I would like to practice more skills related to surgery. | 3.88 | 0 | 1 | Accept |
| 12 | I would like to join more curricula related to surgery. | 3.88 | 0 | 1 | Accept |
| **Domain 4. Intention to have a career as a surgeon** | | | | | |
| 13 | Performing surgeries is my dream. | 3.75 | 0.75 | 1 | Accept |
| 14 | Surgical activities are in line with my interests and personality. | 4 | 0 | 1 | Accept |
| 15 | I like hands-on skills in the medical field. | 3.88 | 0 | 1 | Accept |
| 16 | I want to become a surgeon. | 3.88 | 0 | 1 | Accept |

◇IQR: interquartile range; CVI: content validity index.
◇Eight experts: three surgeons, three medical education professors, and two professors with expertise in education.
◇The experts surveyed the SCCTSS evaluation version by scoring items using a 4-point Likert scale. Scores 1, 2, 3, and 4, respectively, indicated their recommendations: (1) deletion, (2) major revision needed, (3) minor revision needed, and (4) suitable.
◇Content Validity Index (CVI) was computed as the number of experts rating each item divided by the total number of experts.

coefficient value indicated a stronger correlation between the item and the total test score, with a threshold greater than 0.40 [27]. Additionally, Cronbach's α was calculated to evaluate the reliability of the SCCTSS, with a value exceeding 0.70 considered favorable [25]. Moreover, we examined the gender differences in SCCTSS scores. Statistical significance was determined when the p-value was below 0.05, or the 95 % confidence interval did not include 0.

## 3. Results

### 3.1. Development and analysis of the SCCTSS

The expert panel developed the pilot version of the SCCTSS, following the framework of SCCT [15], which encompasses four domains: self-efficacy, outcome expectations, interests, and career intentions. Each domain consisted of four items, resulting in 16 items. Following the expert panel survey, all 16 items met the inclusion criteria, including a content validity index (CVI) greater than 0.8, a mean equal to or greater than 3.00, and an interquartile range (IQR) less than or equal to 1. As a result, the 16 items were incorporated into the SCCTSS with minimal modifications to the pilot version (Table 1).

The expert panel survey, including three surgeons, three medical educators, and two educators, was analyzed and presented in Table 2. The results indicated no significant differences observed in the domains or items among the experts with diverse backgrounds. The mean scores ranged from 3.00 to 6.00, while the chi-square values ranged from 0 to 3. Moreover, all the p-values were greater than 0.05, suggesting no statistically significant variations among the experts.

### 3.2. Quality assessment of the SCCTSS

The quality analysis conducted with the 222 medical students revealed good discrimination, and reliability of the SCCTSS items, as presented in Table 3. Regarding item discrimination, the t-values for all 16 items ranged from 8.05 to 19.66, indicating statistical significance ($p < 0.001$). The *t* values for domains 1 (self-efficacy of surgical competency), 2 (outcome expectations for a career as a surgeon), 3 (interests in surgery), and 4 (intention to have a career as a surgeon) ranged from 12.40 to 15.78, 19.66 to 8.05, 13.61 to 18.14, and 12.58 to 19.41, respectively, with all values indicating high discrimination (all p-values <0.001). The coefficients of item-total correlation ranged from 0.489 to 0.806. For item-total correlations (*r*) and correlations of domains 1 (self-efficacy of surgical competency), 2 (outcome expectations for a career as a surgeon), 3 (interests in surgery), and 4 (intention to have a career as a surgeon) ranged from 0.677 to 0.782, 0.489 to 0.860, 0.739 to 0.787, and 0.732 to 0.833, respectively. Regarding the reliability of the SCCTSS, Cronbach's α was calculated to be 0.954 for the 16 items. When each item was removed separately, Cronbach's α ranged from 0.949 to 0.953. The final version of the questionnaire is presented in Supplementary Table 3.

### 3.3. Gender differences in the SCCTSS

In Table 4, 222 medical students, consisting of 120 men and 102 women, completed the SCCTSS questionnaire. No significant

**Table 2**
Analysis of differences among expert panel members for the SCCTSS.

| Domain/item | Surgeons | Medical educators | Educators | Kruskal–Wallis test | |
|---|---|---|---|---|---|
| | Rank Mean | Rank Mean | Rank Mean | $X^2$ | p |
| Domain 1. Self-efficacy of surgical competency | 4.67 | 5.00 | 3.50 | 0.62 | 0.734 |
| 1. I will be capable of performing surgical tasks. | 4.67 | 4.67 | 4 | 0.16 | 0.925 |
| 2. I will be competent in developing my skills for a career in surgery. | 4.17 | 5.50 | 3.50 | 1.56 | 0.459 |
| 3. I will be competent in acquiring surgical knowledge for a career in surgery. | 4.17 | 5.50 | 3.50 | 1.56 | 0.459 |
| 4. I will be competent as an attending surgeon. | 5.00 | 5.00 | 3.00 | 3.00 | 0.223 |
| Domain 2. Outcome expectations for a career as a surgeon | 4.33 | 4.33 | 5.00 | 0.13 | 0.936 |
| 5. I will have a sufficient or satisfactory income as a surgeon. | 4.00 | 5.17 | 4.25 | 0.49 | 0.782 |
| 6. As a surgeon, I will obtain high social status. | 4.50 | 4.50 | 4.50 | 0 | 1.000 |
| 7. As a surgeon, I will develop or reach my potential. | 5.00 | 3.67 | 5.00 | 1.67 | 0.435 |
| 8. I will assist those in need as a surgeon. | 4.17 | 4.17 | 5.50 | 0.78 | 0.678 |
| Domain 3. Interests in surgery | 3.00 | 5.00 | 6.00 | 2.63 | 0.269 |
| 9. I would like to collaborate with surgeons. | 3.17 | 4.83 | 6.00 | 2.26 | 0.323 |
| 10. I would like to learn about surgical advancements. | 4.50 | 4.50 | 4.50 | 0 | 1.000 |
| 11. I would like to practice more skills related to surgery. | 3.67 | 5.00 | 5.00 | 1.67 | 0.435 |
| 12. I would like to join more curricula related to surgery. | 3.67 | 5.00 | 5.00 | 1.67 | 0.435 |
| Domain 4. Intention to have a career as a surgeon | 3.50 | 5.33 | 4.75 | 1.04 | 0.594 |
| 13. Performing surgeries is my dream. | 3.33 | 4.67 | 6.00 | 2.02 | 0.364 |
| 14. Surgical activities are in line with my interests and personality. | 4.50 | 4.50 | 4.50 | 0 | 1.000 |
| 15. I like hands-on skills in the medical field. | 3.67 | 5.00 | 5.00 | 1.67 | 0.435 |
| 16. I want to become a surgeon. | 5.00 | 5.00 | 3.00 | 3.00 | 0.734 |

◇Eight experts: three surgeons, three medical education professors, and two professors with expertise in education.

**Table 3**
Item analysis of 16 items in the SCCTSS.

| Items | Critical ratio | | Item-total | Cronbach's α |
|---|---|---|---|---|
| | *t* value | 95 % CI | correlations | if item deleted |
| Domain 1. Self-efficacy of surgical competency | | | | |
| 1. I will be capable of performing surgical tasks or procedures in a surgical career. | 15.78* | 3.18 to 4.09 | 0.755 | 0.951 |
| 2. I will be capable of obtaining the required skills for a surgical career. | 15.63* | 3.22 to 4.16 | 0.782 | 0.950 |
| 3. I will be capable of obtaining the required surgical knowledge for a surgical career. | 12.40* | 2.58 to 3.56 | 0.677 | 0.953 |
| 4. I will be capable as an attending surgeon. | 14.30* | 3.44 to 4.54 | 0.719 | 0.952 |
| Domain 2. Outcome expectations for a career as a surgeon | | | | |
| 5. As a surgeon, I will earn a sufficient income. | 8.05* | 1.69 to 2.79 | 0.489 | 0.956 |
| 6. As a surgeon, I will obtain high social status. | 8.32* | 1.84 to 2.99 | 0.566 | 0.954 |
| 7. As a surgeon, I will develop or reach my potential. | 19.66* | 3.55 to 4.34 | 0.860 | 0.949 |
| 8. As a surgeon, I will assist individuals in need. | 11.24* | 2.22 to 3.16 | 0.723 | 0.952 |
| Domain 3. Interests in surgery | | | | |
| 9. I would like to work with surgeons and surgical teams. | 18.14* | 3.60 to 4.48 | 0.787 | 0.950 |
| 10. I would like to learn about surgical advancements. | 13.88* | 2.59 to 3.46 | 0.739 | 0.952 |
| 11. I would like to practice my surgical skills. | 13.63* | 2.59 to 3.47 | 0.767 | 0.951 |
| 12. I would like to participate in surgical curricula. | 13.61* | 2.67 to 3.58 | 0.768 | 0.951 |
| Domain 4. Intention to have a career as a surgeon | | | | |
| 13. One of my ambitions is to perform surgeries. | 16.25* | 3.82 to 4.88 | 0.785 | 0.951 |
| 14. Surgical activities are in line with my interests and personality. | 19.41* | 4.25 to 5.21 | 0.833 | 0.949 |
| 15. I prefer hands-on activities in the medical field. | 12.58* | 2.89 to 3.97 | 0.732 | 0.951 |
| 16. I want to be a surgeon. | 18.31* | 4.26 to 5.29 | 0.806 | 0.950 |
| Criteria | >3.5 | Do not cross 0 | >.40 | >.070 |

Medical students: 222 in total.
Asterisks (*) indicate $p < 0.001$.; 95 % CI: 95 % confidence interval.

differences were observed in the overall scores or domain 3 (interests in surgery) scores between male and female medical students. However, female students demonstrated lower scores in domain 2 (outcome expectations for a career as a surgeon) compared to their male counterparts, with a 95 % confidence interval (CI) ranging from 0.37 to 3.76 ($p = 0.017$). Specifically, lower scores were observed for item 5 (satisfactory income; 95 % CI: 0.20 to 1.18; $p = 0.006$), item 6 (high social status; 95 % CI: 0.22 to 1.20; $p = 0.005$), and item 7 (development potential; 95 % CI: 0.10 to 1.15; $p = 0.020$). Additionally, female students had lower scores for item 4 (competence as a surgeon; 95 % CI: 0.36 to 1.58; $p = 0.002$), item 14 (consistent with my interests and personality; 95 % CI: 0.02 to 1.31; $p = 0.042$), and item 16 (want to be a surgeon; 95 % CI: 0.13 to 1.45; $p = 0.020$).

**Table 4**
SCCTSS validation by gender.

| | Men (Mean ± SD) | Women(Mean ± SD) | 95 % CI | p-value |
|---|---|---|---|---|
| Domain 1. Self-efficacy of surgical competency | 25.68 ± 8.19 | 23.90 ± 6.76 | −0.20 to 3.76 | 0.077 |
| 1. I will be capable of performing surgical tasks or procedures in a surgical career. | 6.82 ± 2.18 | 6.64 ± 2.03 | −0.38 to 0.74 | 0.529 |
| 2. I will be capable of obtaining the required skills for a surgical career. | 6.93 ± 2.22 | 6.58 ± 1.99 | −0.22 to 0.91 | 0.225 |
| 3. I will be capable of obtaining the required surgical knowledge for a surgical career. | 6.18 ± 2.08 | 5.89 ± 1.81 | −0.24 to 0.80 | 0.285 |
| 4. I will be capable as an attending surgeon. | 5.77 ± 2.54 | 4.79 ± 2.05 | 0.36 to 1.58 | 0.002* |
| Domain 2. Outcome expectations for a career as a surgeon | 29.23 ± 6.36 | 27.17 ± 6.42 | 0.37 to 3.76 | 0.017* |
| 5. As a surgeon, I will earn a sufficient income. | 7.32 ± 1.65 | 6.63 ± 2.06 | 0.20 to 1.18 | 0.006* |
| 6. As a surgeon, I will obtain high social status. | 7.53 ± 1.69 | 6.82 ± 2.00 | 0.22 to 1.20 | 0.005* |
| 7. As a surgeon, I will develop or reach my potential. | 6.90 ± 2.02 | 6.27 ± 1.94 | 0.10 to 1.15 | 0.020* |
| 8. As a surgeon, I will assist individuals in need. | 7.82 ± 1.76 | 7.65 ± 1.64 | −0.28 to 0.62 | 0.461 |
| Domain 3. Interests in surgery | 31.23 ± 7.32 | 30.47 ± 6.16 | −1.05 to 2.56 | 0.412 |
| 9. I would like to work with surgeons and surgical teams. | 6.88 ± 2.22 | 6.49 ± 2.17 | −0.19 to 0.98 | 0.185 |
| 10. I would like to learn about surgical advancements. | 7.95 ± 1.83 | 78.2 ± 1.71 | −0.34 to 0.60 | 0.597 |
| 11. I would like to practice my surgical skills. | 8.25 ± 1.96 | 8.20 ± 1.55 | −0.43 to 0.53 | 0.823 |
| 12. I would like to participate in surgical curricula. | 8.14 ± 1.92 | 7.96 ± 1.75 | −0.31 to 0.67 | 0.467 |
| Domain 4. Intention to have a career as a surgeon | 28.33 ± 8.82 | 26.67 ± 8.40 | −0.63 to 3.95 | 0.155 |
| 13. One of my ambitions is to perform surgeries. | 7.23 ± 2.31 | 6.84 ± 2.54 | −0.26 to 1.02 | 0.243 |
| 14. Surgical activities are in line with my interests and personality. | 6.88 ± 2.46 | 6.22 ± 2.39 | 0.02 to 1.31 | 0.042* |
| 15. I prefer hands-on activities in the medical field. | 7.64 ± 2.10 | 7.82 ± 2.12 | −0.74 to 0.38 | 0.522 |
| 16. I want to be a surgeon. | 6.58 ± 2.48 | 5.78 ± 2.52 | 0.13 to 1.45 | 0.020* |
| Total | 117.83 ± 27.20 | 111.28 ± 23.28 | −0.22 to 13.3 | 0.058 |

Medical students: 222 in total; men/women = 120/102.
Asterisks (*) indicate statistical significance.

## 4. Discussion

The global shortage of surgeons has become a significant issue of concern [1–6]. To contribute to the understanding of factors influencing medical students' career choices, we developed a scale based on the Social Cognitive Career Theory (SCCT) specifically tailored to the field of surgery. This scale can be a valuable tool for future studies exploring the determinants of career preferences among medical students. The SCCTSS questionnaire was meticulously drafted and validated through an expert panel method. The feedback and evaluations from the expert panel were instrumental in refining and finalizing the SCCTSS pilot version. Furthermore, the questionnaire was administered to 222 medical students to assess its quality, and item analysis criteria were established based on statistical principles. Additionally, the scale's validity was further examined through gender-based analysis.

Numerous studies have examined the factors influencing medical students' career choices in surgery, revealing gender, mentorship, pre-clerkship exposure, clinical experience, surgical lifestyle, personality, and salary as key determinants [9–12]. Given these factors' multifaceted and dynamic nature, we developed a scale based on the Social Cognitive Career Theory (SCCT), which has proven effective in various domains [18,19]. The global shortage of surgeons is a complex issue with wide-ranging implications. Integrating theoretical frameworks in research is crucial as it provides a basis for comprehending and interpreting empirical observations. By adopting the SCCT, we sought to explore and gain insights into this phenomenon. Utilizing a theoretical framework ensures that the study is firmly grounded in established knowledge and can build upon existing research. Furthermore, employing a theory enhances the generalizability and applicability of findings beyond the specific context, making a theoretical framework indispensable for advancing scientific inquiry in medical education [28,29].

The SCCT encompasses various factors, such as emotions, motivation, experiences, and expectations, to elucidate career development and decision-making processes. According to this theory, individuals' career-related behaviors are influenced by their beliefs in self-efficacy, outcome expectations, personal goals, and environmental factors, including social support and opportunities for learning and personal growth. Emotions, motivation, and experiences are pivotal in shaping individuals' self-efficacy beliefs and outcome expectations, impacting their career choices and behaviors. Thus, the social cognitive career theory offers a comprehensive framework for comprehending the intricate interplay between individual attributes, environmental factors, and behavior, ultimately shaping career choices and development [15]. Personal agency, defined as the belief that one is the causal agent of their actions, is a prominent aspect of SCCT; however, it is often overlooked in evaluating career development processes [16,17]. Incorporating personal agency into longitudinal follow-up studies can provide valuable insights into medical career decision-making and identify critical factors that influence career interests, abilities, and goals, including personal, contextual, and behavioral variables. Additionally, SCCT functions as a process model where self-efficacy and outcome expectations are causal antecedents to interests and goals [15,30]. Self-efficacy, which refers to an individual's belief in their ability to perform tasks or achieve goals successfully, is a fundamental component of social cognitive theory [31,32]. Research in various domains has consistently shown that self-efficacy plays a crucial role in predicting and explaining the successful initiation and maintenance of behavioral changes [33–35]. Therefore, further investigation in surgery can explore how sources of self-efficacy, such as mastery experiences, vicarious experiences [36], verbal persuasion, and somatic and affective states, can be effectively manipulated to enhance engagement levels and improve surgical performance.

Utilizing the social cognitive career theory (SCCT) to develop a questionnaire for surgical career development offers several strengths [37]. Firstly, SCCT is a well-established theoretical framework that provides a systematic and comprehensive approach to comprehending the factors influencing the development of surgical aptitude. The theory emphasizes the significance of social learning, self-efficacy, and personal goals in shaping career development, thus enabling researchers to identify critical constructs and factors that impact surgical aptitude. Secondly, employing SCCT in questionnaire development enhances the reliability and validity of the instrument. By grounding the items in a robust theoretical foundation, researchers ensure their relevance and meaningfulness to individuals aspiring to pursue a surgical career. Thirdly, using SCCT facilitates identifying specific areas that may require targeted interventions or support to foster the development of surgical skills and competencies. For instance, if the questionnaire reveals low levels of self-efficacy among surgical trainees, interventions such as skills training or mentorship programs can be implemented to address this issue. Despite these advantages, SCCT has not yet been applied to the context of career decision-making in surgery.

There were limitations in adopting the SCCT to develop a scale for surgical career development [37]. First, the theory may overemphasize individual factors and not fully consider broader social and systemic factors that influence surgical career development, such as organizational culture and access to training opportunities. Second, the SCCT framework primarily focuses on cognitive factors and may not fully capture the importance of non-cognitive factors, such as personal values and life circumstances, in shaping career decisions and outcomes. Furthermore, SCCT-based questionnaires rely on self-report measures, which may be subject to response biases and social desirability effects. Lastly, the SCCT-based questionnaires have limited predictive validity regarding actual career outcomes, such as job satisfaction, career advancement, and retention [37].

The quality assessment in questionnaire development in our study involved examining the validity and quality of the questionnaire items, as well as the questionnaire's structure and design [38]. This process was critical to ensure the questionnaire provided reliable and valid data when presented to participants. Several steps were involved in evaluating the quality of the questionnaire, including content validity, face validity, construct validity, and reliability. A panel of experts, comprising subject matter experts, clinicians, and researchers, as shown in Tables 1 and 2, evaluated the questionnaire items for content validity, which included determining their relevance, appropriateness, and comprehensiveness. The experts also provided feedback on the clarity and comprehensibility of the items, which related to face validity. As presented in Table 3, the questionnaire was further administered to 222 medical students to evaluate its construct validity, measuring whether the questionnaire items corresponded to the intended constructs. The strength of the relationship between the questionnaire items and other related measures was determined through statistical analyses, such as correlation analysis. We also assessed reliability by evaluating the consistency and stability of the questionnaire items among medical

students in Table 3. Moreover, we validated the scale by gender in Table 4.

Regarding gender diversity issues, surgery is male-dominated in most countries, even though female medical students have accounted for half of all medical students in the United States since 2008 [39]. Therefore, promoting gender diversity and attracting women to pursue a surgical specialty have been major international concerns [40–42]. In this study, we found no gender differences in interest in surgery. However, the female medical students had lower scores in self-efficacy and aspiration to become attending surgeons. Conversely, male students had higher scores in outcome expectations for a career as a surgeon, such as income, social status, and personal development. These findings align with previous research [40]. Mentorship and role model identification have been considered crucial factors in recruiting female students and fostering a supportive culture for gender diversity [41–43]. Further studies could apply longitudinal surveys using the SCCTSS to investigate the impact of mentoring systems. The SCCTSS scale has shed light on the current situation and successfully validated gender differences in the intention to pursue surgery as a career. Indeed, the gender issue mentioned above remains a global concern and warrants further exploration and attention in future studies.

Item analysis is a statistical procedure used to evaluate the quality of individual items on a questionnaire. It can be used to assess the validity and reliability of a questionnaire. The item-total correlation is the correlation between each item and the total score on the questionnaire, while Cronbach's alpha is a measure of internal consistency reliability. Setting the lowest and highest scores is typically done by dividing the total score range into equal intervals. The specific cutoffs for low and high scores should be determined based on the study's goals and the properties of the questionnaire or test being analyzed. Selecting from the top and bottom one-third of the scores is a common method for identifying high and low scorers in the item-total analysis [44].

Nunnally and Bernstein suggest that item-total correlations should be at least 0.3 for individual items on a scale [45]. The 0.3 threshold for the coefficient of item-total correlation is a widely cited guideline in psychometrics, although it does not originate from a specific empirical study or standard. Instead, it is a convention that has emerged based on general principles of scale development and validation. Many researchers have since adopted this guideline as a rough benchmark for assessing item quality in scales. However, it is essential to note that the threshold for the coefficient of item-total correlation may vary based on the context and purpose of the analysis. In our study, we employed a stricter threshold of 0.4.

The optimal sample size for assessing the reliability and validity of a questionnaire depends on several factors, such as the research objectives, the complexity of the construct under investigation, and the statistical methods employed. Some researchers have recommended a minimum sample size of 100–200 participants to achieve sufficient power and accuracy in reliability and validity analyses [46]. In our study, we employed convenience sampling, and 222 medical students, which accounts for 70 % of the total population, voluntarily participated. The participants voluntarily filled in the questionnaire for the quality assessment of the SCCTSS. This was not required as part of their coursework and was not related to their grades. They were given the option to decline participation without providing any explanation.

Our study has several limitations that should be acknowledged. Firstly, the generalizability of the SCCTSS findings may be limited as it was only tested on medical students from our institution, and results may vary among students from different countries or educational settings. Secondly, the participants in our study were in their sixth year of medical school and had not yet decided on a specialty. It is important to note that in our context, students are required to complete compulsory military service and additional postgraduate training before applying for a specialty. Therefore, a follow-up study with these students would provide valuable insights into their career decision-making process. Lastly, future research should consider conducting longitudinal surveys using the SCCTSS to explore how contextual factors, learning experiences, and student demographics influence their specialty preferences and ultimate career choices.

## 5. Conclusion

The process of selecting a surgical specialty poses significant challenges for medical students. In light of the global concern regarding surgeon shortages [1–6], we developed and validated the pilot SCCTSS. The pilot SCCTSS demonstrated good internal consistency and reliability, indicating its suitability as a measurement tool. The scale's development and validation involved gathering expert opinions and feedback from medical students, ensuring its relevance and applicability. Notably, the SCCTSS successfully identified gender differences in the intention to pursue a surgical career. The shortage of surgeons and the need for increased female representation in the field remain pressing worldwide, warranting further exploration and practical solutions.

In future research, longitudinal surveys will be essential for assessing the changes in SCCTSS scores over time and evaluating the impact of interventions such as mentorship programs, improvements in surgical curriculum, increased hands-on skill practice, and enhancements to the learning environment in the operating room. Using a quantitative scale, we can measure the sequential changes in SCCTSS scores following the implementation of these interventions, observing the effects months or years later. Furthermore, those longitudinal studies utilizing the SCCTSS will help to uncover the influence of interventions, contextual factors, and relationships on the decision-making process of medical students regarding the pursuit of surgery as a career. Additionally, it is necessary to conduct long-term follow-up studies that track medical students after graduation to validate the SCCTSS scores against their eventual career choices in surgery.

## Data availability

The data associated with our study has not been deposited into a publicly available repository. Data will be made available on request.

## CRediT authorship contribution statement

**Hsin-Yi Chiu:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Chi-Ming Chiang:** Writing – review & editing, Writing – original draft, Validation, Methodology, Investigation, Data curation, Conceptualization. **Yi-No Kang:** Writing – review & editing, Writing – original draft, Validation, Methodology, Data curation, Conceptualization. **Chia-Che Chen:** Writing – review & editing, Writing – original draft, Validation, Methodology, Investigation, Data curation. **Chien-Chih Wu:** Writing – review & editing, Writing – original draft, Supervision, Methodology, Investigation, Data curation. **Yu-Han Chiu:** Writing – review & editing, Writing – original draft, Validation, Software, Methodology, Formal analysis, Data curation, Conceptualization. **Kung-Pei Tang:** Writing – review & editing, Writing – original draft, Supervision, Methodology, Data curation. **Chih-Chin Kao:** Writing – review & editing, Writing – original draft, Supervision, Investigation, Data curation. **Po-Li Wei:** Writing – review & editing, Writing – original draft, Supervision, Resources, Methodology, Conceptualization.

## Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests:Hsin-Yi Chiu reports financial support was provided by TMU111-AE1-B13 and National Science and Technology Council: NSTC 107-2635-H-038-001.

## Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.heliyon.2023.e21685.

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