Education in Medicine Journal

ORIGINAL ARTICLE

Title: The Development of Forensic Entomology Questionnaire for Health-Related Undergraduate Students from Universiti Teknologi MARA

Authors: Tania Ivorra, Chong Chin Heo, Azwandi Ahmad, Mohamad Rodi Isa

Submitted Date: 05-07-2022

Accepted Date: 09-04-2023

Please cite this article as: Tania Ivorra, Chong Chin Heo, Azwandi Ahmad, Mohamad Rodi Isa. The development of forensic entomology questionnaire for health-related undergraduate students from Universiti Teknologi MARA. Education in Medicine Journal. (Early view).

ORIGINAL ARTICLE

ARTICLE INFO

Submitted: 05-07-2022
Accepted: 09-04-2023

The Development of Forensic Entomology Questionnaire for Health-Related Undergraduate Students from Universiti Teknologi MARA

Tania Ivorra[1*], Chong Chin Heo[1,2], Azwandi Ahmad[3], Mohamad Rodi Isa[4]

[1]*Department of Medical Microbiology and Parasitology, Faculty of Medicine, Sungai Buloh Campus, Universiti Teknologi MARA, Sungai Buloh 47000, Selangor, Malaysia*

[2]*Institute of Pathology, Laboratory & Forensic Medicine (I-PerForM), Universiti Teknologi MARA, 47000 Sungai Buloh, Selangor, Malaysia*

[3]*Department of Pharmaceutical Life Sciences, Faculty of Pharmacy, Universiti Teknologi MARA, 42300 Bandar Puncak Alam, Selangor*

[4]*Department of Public Health Medicine, Faculty of Medicine, Universiti Teknologi MARA, 47000 Sungai Buloh, Selangor*

To cite this article: Tania Ivorra, Chong Chin Heo, Azwandi Ahmad, Mohamad Rodi Isa. The development of forensic entomology questionnaire for health-related undergraduate students from Universiti Teknologi MARA. Education in Medicine Journal. (Early view).

ABSTRACT

Forensic entomology research in Malaysia started in the 1950s but research in this field is still scarce and limited to a few institutions. The objective of this study is to develop and validate a self-constructed questionnaire of the knowledge and perception of forensic entomology. A cross-sectional validation study among health-related undergraduate students was conducted at Universiti Teknologi MARA (UiTM) in Selangor, Malaysia. The knowledge and perception questionnaire on forensic entomology underwent a content development and validation process through a pilot and a field-testing study. Psychometric properties have been explored using Principal Component Analysis (PCA) with Varimax rotation, scree plot, eigenvalues, Monte Carlo simulation, suppress small coefficients value below 0.40, communalities, inter-item correlation, internal consistency, and test-retest analyses. The content of the knowledge and perception questionnaire for forensic entomology were conceptually equivalent. The questionnaire was refined after face validation by five students. The pilot testing was conducted on 30 students. The refined version was then field-tested among 232 students. The Kaiser–Meyer–Olkin (KMO) test was 0.868, and Bartlett's test of sphericity was ≤ 0.001, indicating sampling adequacy. Two factors were identified which are knowledge and perception. The Cronbach's α for knowledge and perception was 0.939 and 0.819, respectively. The intra-class correlation coefficient ranged from 0.493 to 0.923. The knowledge and perception questionnaire for forensic entomology is valid, reliable, and fairly stable over time. This questionnaire

could be used to evaluate the levels of knowledge and perception on forensic entomology among undergraduate students in Malaysia.

Keywords: *Development, Validation, Knowledge, Perception, Forensic entomology*

CORRESPONDING Tania Ivorra, Department of Medical Microbiology and Parasitology, Faculty of Medicine, Sungai Buloh Campus, Universiti Teknologi MARA, Sungai Buloh 47000, Selangor, Malaysia

Email: tania.ivorra@gmail.com

INTRODUCTION

Forensic entomology is the study of arthropods and their utilization in death investigations (1). Arthropods associated with corpses are analysed by forensic entomologists to determine the time of colonization (TOC), also known as the minimum postmortem interval (minPMI). In addition, the insect species collected at the crime scene are able to determine the potential relocation of the corpse and cause of death (2). These insects, primarily the necrophagous Diptera species, are the most important subject in forensic entomology and are being used in criminal investigations (3) since they allow estimations on the duration of insect colonization of the corpse (4).

This is because necrophagous Diptera are distributed in a wide variety of habitats and are the predominant group of insects associated with animal carcasses and human corpses, arriving at the first stage of decomposition (3). The offspring of these Diptera feed and develop on the carcasses and have a reputation as a good "forensic indicator". The common families in this group that are most relevant in forensic investigations are blow flies (Calliphoridae), flesh flies (Sarcophagidae), house flies (Muscidae), lesser house flies (Fanniidae), coffin flies (Phoridae) and cheese skipper flies (Piophilidae) (2). The species of these flies may vary depending on the habitat, trophic source, environmental conditions, and the time of the year (5), whilst cosmopolitan species may demonstrate variations in their biological behaviour depending on their biogeographic origin as a consequence of more specific adaptations of their populations to local conditions (6).

Although the first use of insects in death investigation has been documented since the 13th century in China (7), the field of forensic entomology in Malaysia is still developing. The first reported case in Malaysia was in 1950 (8). Although application of forensic entomology has significantly developed, research in this area is still inadequate and predominantly localized in certain institutions. For examples, currently there are only a few universities actively conducting research in forensic entomology including Universiti Teknologi MARA (UiTM), Universiti Kebangsaan Malaysia (UKM) and Universiti Teknologi Malaysia (UTM). Therefore, the knowledge development in this field is limited, with many scientific aspects unexplored for the application to real criminal cases (8).

One of the challenges in forensic entomology is the determination of time of the death based on entomological evidence in the field handled by police officers and forensic pathologists with a lack of proper knowledge. Therefore, innovative experiments and carefully-planned investigations in future forensic entomology research are critical to solving the problem (9). Currently, only a few Malaysian universities offer detailed forensic entomology knowledge in their undergraduate course's syllabus. Others have included only minimal knowledge of forensic entomology and only in forensic science and medical laboratory technology programs. On the other hand, the need of forensic entomology to be taught in health-related undergraduate courses, especially for medical students has never been evaluated. A survey study using a validated questionnaire as a tool is the best practice to assess this issue. As there is no questionnaire available to measure forensic entomology knowledge, a valid questionnaire must first be developed.

Therefore, this study was carried out to develop and validate a questionnaire on knowledge and perception towards forensic entomology in Malaysia. The aim of this validated questionnaire is to assess the knowledge and perception of health-related undergraduate students to forensic entomology. The information gained from this survey could be used to recommend the incorporation of forensic entomology into syllabuses of more universities in Malaysia. This might promote more students to choose this field as their future career.

METHODOLOGY

Study Design and Population

This cross-sectional validation study was conducted from 27th January 2021 to 30th June 2021. The study population included the undergraduate students from both the Faculty of Medicine and the Faculty of Health Sciences in Universiti Teknologi MARA (UiTM), Selangor, Malaysia. The inclusion criteria involved undergraduate students from medical and health sciences faculties who understand English. The only exclusion criterion was the undergraduate students who did not give consent to participate.

There were two parts in the process of developing and validating the questionnaire. Part 1 included developing the knowledge and perception towards the forensic entomology questionnaire through the content experts, face validation study, and the pilot study. Meanwhile, Part 2 was the field testing and psychometric analysis of the English version of the knowledge and perception towards forensic entomology questionnaire. The conduction of the study is outlined in the flow chart presented in Figure 1.

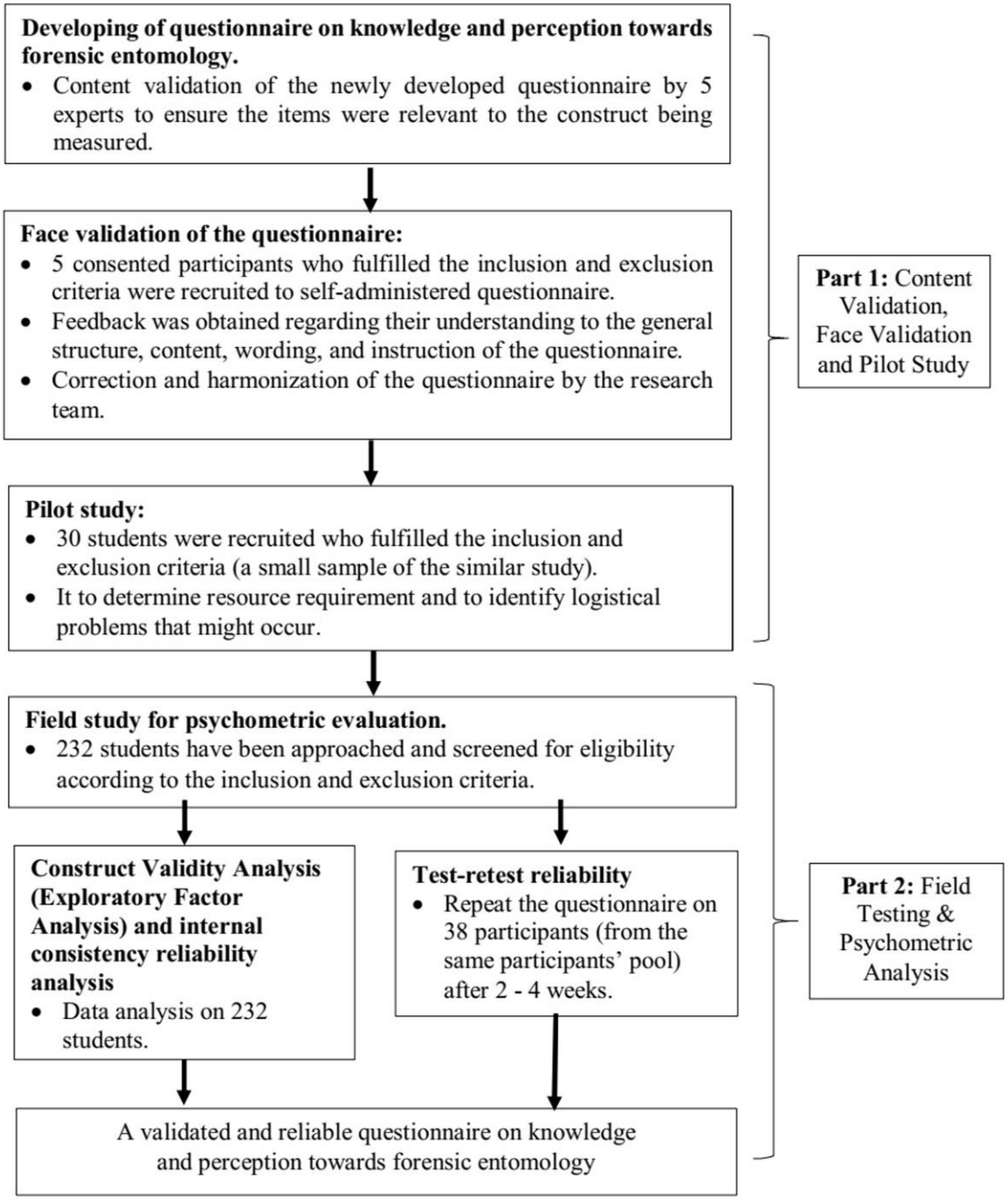

Figure 1 Flow chart of the validation and psychometric analysis of knowledge and perception towards forensic entomology.

Content validation

A panel of four experts from related fields were invited to review and give feedback on the knowledge and perception towards the forensic entomology questionnaire. The expert panels consisted of an entomologist, a biologist, a methodologist, and a biostatistician, each with more than 5 years of

experience in their respective field. They were invited to evaluate each domain in the questionnaires using the content validity index (CVI) (10). They were provided with the objectives of the study, conceptual framework of the study, definitions of overall variables within each domain and other related information about forensic entomology.

The content validity was assessed using CVI. CVI consists of item-CVI (I-CVI) and scale-CVI (S-CVI). It is an analysis to quantify the content validity of an instrument from the experts' viewpoints. The criteria of CVI are the relevance, clarity, simplicity, and ambiguity with a score of 1 to 4 (1 = not relevant, 2 = not important, 3 = relevant, 4 = very important) for each criterion. Experts were asked to score each criterion on a scale from 1 to 4 for each item. CVI for each item (I-CVI) is calculated when the numbers of experts score 3 and 4 for each item divided by the number of the whole content expert panels (11). A I-CVI with more than 0.79 indicates that the items are relevant. A S-CVI with more than 0.80 indicates that the items have an excellent content validity (11). After fine tuning by the research team and the panel of experts, both questionnaires were ready for face validity.

The questionnaire involved two sections (factors): the knowledge (factor 1) and the perception (factor 2) towards forensic entomology. In the knowledge section, there are eight constructs (concepts) asking about various aspects in forensic entomology including the definition of forensic medicine (four items), the importance of forensic medicine (four items), the insect groups (four items), entomological evidence (four items), colonization of insects on corpses (four items), utilization of entomology (four items), postmortem interval (PMI) (four items) and the question regarding myiasis (four items). The total number of items about forensic entomology knowledge is 32.

There are 10 items asking about three constructs (aspects) in the perception of forensic entomology. The concept (construct) measures perception towards forensic entomology including forensic investigations, studies in forensic entomology, and insect evidence in forensic entomology. These constructs were chosen based on the advice from the expert panel.

Face validation

Face validity is a part of validity tests that collect a subjective assessment from the sample of responders in the field to measure the presentation and relevance of the measuring instrument. The recommended sample size for face validation ranges from 5 to 40 respondents (11,12). In this study, a non-random sample of five respondents who fulfilled the inclusion and exclusion criteria were recruited. These respondents have been given the questionnaire to comment on all items.
The respondents were asked to write their comments on the presentation, relevance, suitability, comprehension, and ambiguity of the items. The results from the feedback were further discussed by the research team for additional adjustment of each item. The calculation of FVI is almost the same as CVI; however, FVI was done assessing the comprehensiveness of the questionnaire. The cognitive debriefing was conducted with respondents in face-to-face session. There were no probing questions, but it depended on the respondent's understanding of each item.

Pilot study

A pilot study is a small-scale study that has a small sample size of a similar study population and will be conducted similarly to the full-scale study (13,14). The purposes of conducting this study are various, among them includes the development and testing of the adequacy of the research tool, to assess the feasibility of the full-scale study, to collect preliminary data, to determine resource requirement and to identify logistical problems that might occur (13,14). According to Connelly (13), the sample size should be 10% of the full-scale study's sample, while Hill (15) and Isaac & Michael (16) suggest sample size of a pilot study should be between 10 to 30 participants. The participants

were asked to answer the questionnaire and to give comments regarding each item. Feedback acquired from the pilot study was used to enhance the questionnaire.

Field testing and psychometric evaluation

The questionnaire was field tested among medical and health sciences students who fulfilled the inclusion and exclusion criteria. The sample size for the field study was calculated using a sample to variable ratio (SVR), often denoted as N:p ratio, where N refers to the number of participants and p refers to the number of items studied. Several authors suggest a minimum sample size ranging from 100 to 250, while others suggest using the N:p ratio that ranges from 3:1 to 20:1 ratio (17,18). For psychometric analysis, the SVR 10:1 ratio was used. With the maximum total combination items of 42, the minimum sample size was 210 participants. Taking into consideration of 10% non-responders and non-eligible, the minimum sample size for this process was 232 participants.

Sampling method

The purposive sampling method was practised until the target sample size was achieved. This sampling method was chosen as there was difficulty in conducting probability sampling due to the Covid-19 pandemic. To minimize sampling bias, consecutive respondents were contacted via emails and links to Google Drive. The questionnaire was created through a Google form (https://docs.google.com/forms/d/1WJ-verVOg0Zzksd7QegTCgG793y9nyPxPZW4KVnzcjs/edit) where the instructions and objective of the questionnaire were provided. The estimated time of the whole questionnaire was 15 minutes.

Recruitment of the respondents

The recruitment of the respondents was conducted via emails, inviting them to participate in this study by answering the questionnaire. Due to the protection of the student's personal data under the University's data protection policy, we used the group email for undergraduate students provided by the Academic Office of the Faculty of Medicine, UiTM, where all the students received the same email while maintaining their anonymity. For the pilot study, the group email to the current Year-1 medical students was used, and once we obtained 30 answers, the questionnaire survey was closed immediately.

In the case of the field study, we used the group email to all the medical students (Year 1 to Year 5) in the UiTM Sungai Buloh campus, and the questionnaire was closed once the minimum participants required in this part of the study (n=232) have been achieved. In the case where there were double answers from the same individual, these responses were deleted from the survey before proceeding to statistical analyses.

Reliability test

There were 38 respondents recruited to participate in the test-retest of the questionnaires. The respondents were contacted randomly again by email within two to four weeks to participate in this study. There were given the same questionnaire for the test-retest reliability analysis.

Statistical Analysis

Data entry and analyses were conducted using IBM Statistical Package for the Social Sciences (SPSS) Version 27 (IBM Corp. Armonk, NY).

Descriptive statistics

The sociodemographic data of this study was presented in descriptive statistics. The categorical variables were presented in frequency and percentage while the continuous variables were presented in mean and standard deviation (SD).

Factor analysis

Psychometric evaluation of the knowledge and perception towards the forensic entomology questionnaire was performed using the Exploratory Factor Analysis (EFA). Prior to factor analysis, data suitability was tested by using the Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy and the Bartlett's Test of Sphericity. The KMO index with more than 0.5 and the Bartlett's Test of Sphericity must be significant rule is used to determine the factor extraction (p<0.05). The EFA was conducted on the 42 items in the knowledge and perception towards forensic entomology questionnaire by using Principal Component Analysis (PCA) with a varimax rotational method in order to establish the underlying dimension.

The lowest score of each domain was 1 and highest score in each domain was 5, with the scores for the knowledge and perception being the same. Each domain was scored by adding all scores in each item to get the overall total. The factor loading was set at 0.40. The factor retention was determined by the multiple criteria such as cumulative percent of variance extracted (communalities), Kaiser's criteria with eigenvalue more than 1 and scree plot (looking at the substantial decline changes (elbow) in the plot). The item with communalities of less than 0.3 were deleted.

Reliability analysis

The reliability analysis of the questionnaire was conducted by using the internal consistency reliability test and test-retest reliability. Cronbach's Alpha coefficient was used for the rest of the domains to test on each internal consistency. Cronbach's Alpha value with more than 0.7 was regarded as acceptable, while value equal or more than 0.8 and 0.9 considered good and excellent respectively (19). However, high value of alpha (>0.9) may suggest redundancies (19). The test-retest reliability was analysed using the two-way effect model, mean of k-measurement type and absolute agreement of intra-class correlation coefficient (ICC). Values of >0.75 indicate good reliability, values between 0.5–0.75 indicate moderate reliability while values of 0.5 or less indicate poor reliability (20).

RESULTS

A total of 232 students were involved in this study. The demographic characteristics of the students are shown in Table 1. The mean age was 22.09 ± 1.88. The majority of the students were female (75.0%), Malay (94.8%) and from the Faculty of Medicine, UiTM (94.9%).

Table 1 Demographic characteristics of the respondents

Variables	Percentage (N=232), n (%)	Mean ±SD
Gender:		
Male	58 (25.0%)	
Female	174 (75.0%)	

Age		22.09 ± 1.88
Ethnicity:		
Malay	220 (94.8%)	
Bumiputera Sabah	6 (2.6%)	
Bumiputera Sarawak	4 (1.7%)	
Others	2 (0.9%)	
Religion:		
Islam	226 (97.4%)	
Christianity	6 (2.6%)	
Marital status:		
Not married	231 (99.6%)	
Married	1 (0.4%)	
Educational level:		
Foundation Study	206 (88.8%)	
Diploma	24 (10.3%)	
MCE	2 (0.9%)	
Faculty:		
Health Sciences	12 (5.2%)	
Medicine	220 (94.9%)	
Current Academic Year:		
1	76 (32.8%)	
2	8 (3.4%)	
3	31 (13.4%)	
4	55 (23.7%)	
5	62 (26.7%)	
Do you ever hear about forensic entomology?		
Yes	170 (73.3%)	
No	62 (26.7%)	
If Yes, from where:		
Documentary	35 (15.1%)	
Movies	50 (21.6%)	
Syllabus	133 (57.3%)	
Internet	42 (18.1%)	

This study was just an exploratory study. However, the items need to be confirmed by using the confirmatory factor analysis (CFA) later or need to be conducted for the next study in the recommendation. There were no missing responses to the questionnaire items. The KMO value for the questionnaire was 0.868, and the Bartlett's test of sphericity was significant (p <0.001). The PCA using varimax rotation yielded a three-factor solution, with eigenvalues of more than one. This three-factor solution explained a cumulative of 59.474% of the variance in the data. Further analysis using the scree plot was conducted to aid in the decision of the number of factors to retain. The elbow of the scree plot occurred at factor two, suggesting that two factors should be retained. Since the PCA

yielded a three-factor solution, and the scree plot suggested a two-factor solution, we decided to choose the two-factor solution.

Therefore, a two-factor solution with varimax rotation was deemed to be the most conceptually appropriate for the questionnaire, i.e., Factor 1 (knowledge) and Factor 2 (perception). The data were reanalysed by fixing the number of factors at two. The eigenvalue for Factor 1 was 11.518, with a variance of 37.589%, while the eigenvalue value of Factor 2 was 4.979, which explained 11.865% of the variance in the data. The total variance for both factors was 49.474%.

Table 2 shows the results of the mean (± SD), communalities extraction and the factor loadings of the questionnaire on the final two-factor solution. All the items have factor loadings of more than 0.4. In the knowledge questionnaire, the item of K2c, K2d, K3a, K3b and K3d were deleted due to low factor loading (< 0.4) and the communalities extraction of less than 0.3. In perception questionnaire, the items of P1, P5, P8 and P10 were also deleted due to low factor loading and negatively worded. The other items were loaded at their own factor.

Table 2 Mean (SD), Communalities and Rotated Component Matrix of the Item

Item	Mean (SD)	Communalities Extraction	Rotated Component Matrix	
			Factor 1	Factor 2
K1a: I know forensic entomology is the study of insects and other arthropods to obtain information for legal investigations	3.72 (1.41)	0.530	0.685	
K1b: I know forensic entomology is the study of maggots to use it in larval therapy in human being	2.94 (1.44)	0.385	0.409	
K1c: I know forensic entomology uses the fly larval body length to estimate the time of death	3.58 (1.46)	0.524	0.663	
K1d: I know forensic entomology includes medico-legal, urban and stored-product subfields	3.03 (1.46)	0.411	0.514	
K2a: Forensic entomology is important for estimating the time of death	4.33 (0.93)	0.570	0.755	
K2b: Forensic entomology is important for determining the location of a murder where it happened	4.10 (1.08)	0.449	0.661	
K2c: Forensic entomology is important for identifying the criminal identity via DNA in gut content of the maggots	3.53 (1.21)	0.082	Deleted	
K2d: Forensic entomology is important for identifying the cause of death	3.59 (1.21)	0.072	Deleted	
K3a: The insects that can be found on dead body is butterflies.	1.79 (1.07)	0.161	Deleted	
K3b: The insects that can be found on dead body is dragonflies.	1.94 (1.10)	0.094	Deleted	
K3c: The insects that can be found on	4.13 (1.05)	0.325	0.474	

dead body is blow flies.			
K3d: The insects that can be found on dead body is honey bees.	1.83 (1.00)	0.084	Deleted
K4a: In entomological evidence, maggots, beetle larvae and adult flies should be collected from the dead body in a criminal investigation	3.81 (1.29)	0.535	0.644
K4b: In entomological evidence, fly larvae should be reared under controlled conditions in the laboratory and some of them should be killed with hot water	2.55 (1.34)	0.339	0.537
K4c: In entomological evidence, pupae must be preserved in 70% alcohol and should not be used to calculate the post-mortem intervals.	2.25 (1.09)	0.452	0.668
K4d: In entomological evidence, fly eggs are the only ones that serve to calculate the post-mortem intervals	2.38 (1.17)	0.371	0.602
K5a: The insect colonization of a corpse begins at the natural orifices such as mouth and nose	3.55 (1.38)	0.514	0.406
K5b: The insect colonization of a corpse begins from the head, advancing until reaching the extremities	2.43 (1.30)	0.525	0.698
K5c: The insect colonization of a corpse begins from the feet to the head	2.15 (1.17)	0.466	0.681
K5d: The insect colonization of a corpse begins at the inflicted pre-mortem wound	3.37 (1.49)	0.485	0.467
K6a: Beetles can be utilized in forensic entomology because it colonized the corpse after the arrival of blow flies	2.34 (1.33)	0.576	0.727
K6b: Beetles can be utilized in forensic entomology because it determines the minimum post-mortem interval	2.23 (1.23)	0.554	0.720
K6c: Beetles can be utilized in forensic entomology because it is a part of accidental insects	2.31 (1.22)	0.547	0.724
K6d: Beetles can be utilized in forensic entomology because it has shorter life cycles than blow flies	1.97 (1.07)	0.581	0.761
K7a: The estimation of post-mortem interval is the time that has elapsed between the death and the discovery of the body	3.37 (1.45)	0.526	0.429
K7b: The estimation of post-mortem interval is the duration of the oldest insects feeding on the body	2.82 (1.40)	0.416	0.502
K7c: The estimation of post-mortem interval is determined by the factors such	3.27 (1.46)	0.532	0.447

as ambient temperature and relative humidity				
K7d: The estimation of post-mortem interval is calculated using the accumulated degree-days method (ADD).	2.27 (1.38)	0.458	0.616	
K8a: Myiasis is divided into facultative, obligatory and accidental myasis.	2.46 (1.45)	0.527	0.673	
K8b: Myiasis is not important in forensic investigations.	1.80 (1.05)	0.301	0.444	
K8c: Myiasis by the facultative species is the significant group of myiasis-causing flies.	2.15 (1.22)	0.463	0.661	
K8d: Myiasis is the fly infestation on human host after death	2.65 (1.43)	0.312	0.482	
P1: I think the use of entomology evidence in the court is optional in a forensic investigation.	3.58 (1.20)	0.103	Deleted	
P2: I think forensic entomologists must always participate in postmortem investigations	4.33 (0.79)	0.256		0.504
P3: I think a close collaboration is needed between pathologists and forensic entomologists	4.55 (0.68)	0.624		0.615
P4: I think forensic entomology is relevant in postmortem cases involving a badly decomposed corpse	4.62 (0.63)	0.487		0.578
P5: I believe all forensic investigations can be solved without the need of forensic entomologists.	2.25 (1.10)	0.266	Deleted	
P6: I believe that forensic entomologist is essential in a forensic investigation in my country.	4.44 (0.71)	0.599		0.600
P7: I think forensic entomology is important to be included in my medical university syllabus.	4.06 (0.94)	0.441		0.418
P8: I think entomological evidence is commonly accepted in the court of law.	4.06 (0.84)	0.267	Deleted	
P9: I think forensic entomologist should be present in the crime scene for collecting entomological evidence.	4.44 (0.69)	0.633		0.689
P10: I believe that forensic entomologists are not necessary to be referred as a judicial expert.	2.38 (1.23)	0.264	Deleted	

Table 3 shows the intra-class correlation, inter-item correlation and Cronbach's alpha of the items. The intra-class correlation coefficient ranged from 0.493 (item K6c) to 0.923 (item K1a). It can be concluded that most of the items have fair to good reproducibility and were fairly stable over time. The corrected inter-item correlation ranged from 0.319 (item K3c) to 0.698 (item K7c). It can be

concluded that the lowest item in measuring the percent of the variance in a given variable was explained 31.9% by all the factors jointly.

For Factor 1 (knowledge towards forensic entomology), the Cronbach's α value was 0.939, whereas for Factor 2 (perception towards forensic entomology) was 0.819. The overall Cronbach's alpha was 0.935. These indicate that the questionnaire items within these two factors and the overall items were reliable.

Table 3 The intra-class correlation, inter-item correlation, and Cronbach's alpha of the items stated in the questionnaire.

Items	Intraclass Correlation (95%CI)	Corrected Inter-item correlation	Cronbach's alpha in each factor	Overall Cronbach's alpha
K1a	0.923 (0.843, 0.961)	0.629		
K1b	0.798 (0.611, 0.895)	0.519		
K1c	0.798 (0.744, 0.935)	0.651		
K1d	0.766 (0.573, 0.883)	0.616		
K2a	0.761 (0.539, 0.876)	0.492		
K2b	0.899 (0.805, 0.948)	0.489		
K3c	0.668 (0.366, 0.827)	0.317		
K4a	0.552 (0.147, 0.768)	0.681		
K4b	0.615 (0.269, 0.798)	0.532		
K4c	0.617 (0.273, 0.799)	0.525		
K4d	0.630 (0.301, 0.806)	0.496		
K5a	0.751 (0.522, 0.871)	0.680	0.939	
K5b	0.780 (0.580, 0.885)	0.618		
K5c	0.538 (0.112, 0.760)	0.511		
K5d	0.836 (0.687, 0.915)	0.668		
K6a	0.753 (0.506, 0.874)	0.656		
K6b	0.784 (0.555, 0.892)	0.635		
K6c	0.493 (0.044, 0.734)	0.607		
K6d	0.709 (0.435, 0.849)	0.565		
K7a	0.758 (0.538, 0.874)	0.689		
K7b	0.805 (0.624, 0.898)	0.630		0.935
K7c	0.820 (0.650, 0.907)	0.698		
K7d	0.702 (0.434, 0.844)	0.627		
K8a	0.637 (0.279, 0.815)	0.663		
K8b	0.678 (0.376, 0.833)	0.383		

K8c	0.513 (0.083, 0.744)	0.589	
K8d	0.879 (0.803, 0.947)	0.533	
P2	0.756 (0.535, 0.873)	0.356	
P3	0.665 (0.365, 0.824)	0.319	
P4	0.665 (0.364, 0.825)	0.370	0.819
P6	0.802 (0.623, 0.897)	0.324	
P7	0.738 (0.500, 0.863)	0.395	
P9	0.732 (0.490, 0.860)	0.341	

DISCUSSION

Forensic entomology in Malaysia is still considered as an underdeveloped discipline, due to the lack of knowledge and many research gaps in this field (8). One of the most important aspects that needs to be disclosed first is the current knowledge and perception of health-related undergraduate students in forensic entomology. Therefore, we aimed to develop and validate the questionnaire to assess the knowledge and perception on forensic entomology among medical and health sciences undergraduate students in UiTM. As a reference, there was only one previous survey study that assessed forensic entomology knowledge in Malaysia (21). This study was conducted on Malaysian professionals in the field of forensic entomology but not on undergraduate students. However, regarding the questions asked, only three questions about forensic entomology were included in the previous study, indicating an inability to assess knowledge level. Although the results in the previous study showed adequacy of sampling and good internal consistency, the results on factor loading in each item in the questionnaire is not mentioned. Bartlett's sphericity test, KMO value, and Cronbach's alpha were mentioned in their results. But there was no result on intraclass correlation (ICC) to indicate the stability of the questionnaire. The process of development of the questionnaire such as content validity, face validity, and pilot study were also not mentioned.

Regarding the internal consistency, our study has demonstrated that the questionnaire on knowledge and perception is reliable with a Cronbach's alpha value of 0.935. This is considerably higher than Kavitha *et al.* (21) , a study that exhibited a Cronbach's alpha value of 0.67 indicating a lower reliability, less than the recommendation of a reliable questionnaire (22).

All items for the definition of forensic entomology were found to be valid, reliable, and valid over time with the communality ranges from 0.385 to 0.530, factor loading ranges from 0.409 to 0.685 and intraclass correlation (ICC) ranges from 0.766 to 0.923. The items asking about definition are important to pass validity, and reliability test because the definition is the foundation of any discipline. However, in our questionnaire development process, two items addressing the important aspect of forensic entomology have been pulled out due to a poor factor loading and low communality (i.e., *for identifying the criminal identity via DNA in the gut of the maggots* and *for identifying the cause of death*). It could be due to the respondents who assumed that the cause of death will be determined by the medical examiners and coroners, and not by the forensic entomologists (23).

Out of the four groups of insects asked, only one item (i.e., blow flies) was retained in the questionnaire. It was possible that the respondents were unfamiliar with the scientific names of numerous insect species. In this case, it is suggested to use the image of each insect in the

questionnaire in order to ensure the target respondent recognizes various types of insects. Regarding this, we also realized that the respondents should not be asked too many items about different types of insects but one type of insect is sufficient.

On the dead body, the presence of insect larvae can provide evidence for the estimation of post-mortem interval (PMI) for up to one month (24) . All items for the entomological evidence were found to be valid, reliable, and stable over time with communality ranging from 0.371 to 0.535, factor loading ranging from 0.537 to 0.668 and ICC ranging from 0.552 to 0.630.

All items regarding the beginning of insect colonization on the corpse were found valid, reliable, and stable over time. The communality ranges from 0.466 to 0.525, the factor folding ranges from 0.406 to 0.698 and the ICC ranges from 0.538 to 0.836. It is known that insect colonization during warmer season can lead to a more precise PMI estimation than the estimation made during the winter season (25). In the later stages of body decomposition, beetles could provide significant entomological evidence (26). Studies by Al-Khalifa *et al.* (27) and Schroeder *et al.* (25) collected and identified more species of beetle and fly specimens associated with corpses found indoors compared with corpses that were found outdoors. All four items asking about the utilization of beetles in forensic entomology were retained in the questionnaire. All items showed a good validity, and reliability over time. The communality ranges from 0.547 to 0.581, factor loading ranges from 0.720 to 0.761 and the ICC ranges from 0.493 to 0.784.

Postmortem interval (PMI) is the estimation of the time of death by a temperature-dependent method (28). It is usually written as a summary of a minimum period or with a range estimated in hours, weeks, months or years (29). All items for the estimation of PMI were found to be valid, reliable and stable over time with the communality ranges from 0.416 to 0.532, factor loading ranges from 0.427 to 0.616 and ICC ranges from 0.702 to 0.820. On the other hand, myiasis is defined as the infestation of live vertebrates (humans and/or animals) with dipterous larvae (30). All items asking about myasis were also found to be valid, reliable and stable overtime with the communality ranges from 0.301 to 0.527, factor loading ranges from 0.481 to 0.673 and ICC ranges from 0.512 to 0.879.

This study proposed 10 items to assess the perception of forensic entomology. However, there were six items found to be valid, reliable, and stable over time with the communality ranging from 0.256 to 0.624, factor loading ranging from 0.418 to 0.689 and ICC ranging from 0.665 to 0.802. Four items have been deleted due to low communality and factor loading (i.e., *I think the use of entomology evidence in the court is optional in a forensic investigation*, *I believe all forensic investigations can be solved without the need of forensic entomologists*, *I think entomological evidence is commonly accepted in the court of law* and *I believe that forensic entomologists are not necessary to be referred as a judicial expert*). All deleted items are related to a court case. Since our population is medical and health science undergraduate students, they may not be familiar with court cases involving the use of forensic entomology.

All items that assess the knowledge of forensic entomology were not only valid but were also reliable with Cronbach's α of 0.939. The items also demonstrated satisfactory test-retest reliability, with intraclass correlation (ICC) in ranges between 0.493 to 0.932. This indicates that the items possessed moderate-to-good reliability (20). Five items have been deleted due to low communality and factor loading. Most of the items deleted tested the knowledge on the species of insects involve in forensic entomology. Both parts of the questionnaire (knowledge and perception) have good internal consistency (Cronbach's α = 0.935) (19) and the corrected inter-item correlation ranges from 0.317 to 0.698 for knowledge and 0.319 to 0.395 for perception.

Limitation of the Study

This study did not consider the Item-Response Theory (IRT) method, which includes the improvement of the accuracy and reliability measurements to verify each domain of knowledge. Therefore, the results cannot be compared to the Classical Test Theory to determine whether the results conform to each other. It is recommended to consider the IRT before the improvement of the questionnaire for the next study.

CONCLUSION

One of the important aspects in the application of forensic entomology is to increase the knowledge of health-related undergraduate students in this field. This can be achieved by rendering them an opportunity to learn more about forensic entomology in university courses. Our study has produced a valid and reliable questionnaire which can evaluate the knowledge and perception of undergraduate medical and allied-health sciences students on forensic entomology in Malaysia. However, the questionnaire is only useful to those who can read and understand English, which is one of the limitations of this study. However, improvements to the questionnaire can be made in term of languages in order to widen its applications to other countries. This will allow a significant improvement of future applications of forensic entomology in forensic cases due to the increased number of researchers in the field. The questionnaire presented in this study on the knowledge and perception towards forensic entomology is valid, reliable, and fairly stable over time. We hope that this questionnaire can be used to assess the status of knowledge and perception of forensic entomology among students and later serve as a recommendation to incorporate forensic entomology into the university syllabus in Malaysia and other countries as well.

ACKNOWLEDGEMENTS

We thank to all the participants in the survey; and to Dr Abby Jones for the English language correction and editing. The authors declare no conflicts of interest with respect to the authorship or publication of this article.

ETHICAL CONSIDERATION

The ethical approval was obtained from the Research Ethics Committee of Universiti Teknologi MARA [REC/01/2021 (MR/44)] prior to the study. The informed written consent was obtained from all participating students in this study.

REFERENCES

1. Joseph I, Mathew DG, Sathyan P, Vargheese G. The use of insects in forensic investigations: An overview on the scope of forensic entomology. Journal of Forensic Dental Sciences. 2011;3(2):89–91.

2. Byrd JH, Castner JL. Forensic entomology: The utility of arthropods in legal investigations. 1st editio. Byrd JH, Castner JL, editors. Boca Raton: CRC Press; 2001. 1–418 p.
3. Catts EP, Goff ML. Forensic entomology in criminal investigations. Annual Review of Entomology. 1992;37:253–72.
4. Greenberg B. Flies as forensic indicators. Journal of Medical Entomology. 1991;28(5):565–77.
5. Goff ML. A fly for the prosecution. How insect evidence helps solve crimes. Massachusetts: Harvard University Press; 2000. 1–225 p.
6. Martínez-Sánchez A, Smith KE, Rojo S, Marcos-García MA, Wall R. Geographic origin affects larval competitive ability in European populations of the blow fly, Lucilia sericata. Entomologia Experimentalis et Applicata. 2007;122:93–8.
7. Benecke M. A brief history of forensic entomology. Forensic Science International. 2001;120:2–14.
8. Nazni WA, Lee HL, Chew WK, Roziah A, Jeffery J, Heo CC. Malaysia. In: Tomberlin JK, Benbow ME, editors. Forensic Entomology International Dimensions and Frontiers. CRC Press; 2015. p. 19–35.
9. El-Kady EM. Problems Facing Application of Forensic Entomology. Pakistan Journal of Biological Sciences. 1999 Feb 1;2(2):280–9.
10. Zamanzadeh V, Rassouli M, Abbaszadeh A, Majd H, Nikanfar A, Ghahramanian A. Details of content validity and objectifying it in instrument development. Nursing Practice Today. 2014;1(3):163–71.
11. Polit DF, Beck CT. The content validity index: Are you sure you know what's being reported? critique and recommendations. Research in Nursing & Health. 2006 Oct;29(5):489–97.
12. Wild D, Grove A, Martin M, Eremenco S, McElroy S, Verjee-Lorenz A, et al. Principles of Good Practice for the Translation and Cultural Adaptation Process for Patient-Reported Outcomes (PRO) Measures: Report of the ISPOR Task Force for Translation and Cultural Adaptation. Value in Health. 2005 Mar;8(2):94–104.
13. Connelly LM. Pilot studies. Medsurg Nurs. 2008;17(6):411–2.
14. van Teijlingen E, Hundley V. The importance of pilot studies. Nursing Standard. 2002 Jun 19;16(40):33–6.
15. Hill R. What sample size is "enough" in internet survey research? Interpersonal Computing and Technology: An Electronic Journal for the 21st Century. 1998;6:3–4.
16. Isaac S, Michael WB. Handbook in research and evaluation. San Diego, CA: Educational and Industrial Testing Services; 1995.
17. Anthoine E, Moret L, Regnault A, Sébille V, Hardouin JB. Sample size used to validate a scale: a review of publications on newly-developed patient reported outcomes measures. Health and Quality of Life Outcomes. 2014 Dec 9;12(1):2.
18. Hogarty KY, Hines CV, Kromrey JD, Ferron JM, Mumford KR. The quality of factor solutions in exploratory factor analysis. The influence of sample size, communality and overdetermination. Educational and Psychological Measurement. 2005;65(2):202–6.
19. Tavakol M, Dennick R. Making sense of Cronbach's alpha. International Journal of Medical Education. 2011 Jun 27;2:53–5.
20. Koo TK, Li MY. A Guideline of Selecting and Reporting Intraclass Correlation Coefficients for Reliability Research. Journal of Chiropractic Medicine. 2016 Jun;15(2):155–63.
21. Kavitha R, Tan TC, Jeffery J, Sofian-Azirun M. Forensic entomology in Malaysia: Knowledge and practices. Asian Biomedicine. 2014;8(5):603–7.
22. Ursachi G, Horodnic IA, Zait A. How Reliable are Measurement Scales? External Factors with Indirect Influence on Reliability Estimators. Procedia Economics and Finance. 2015;20:679–86.
23. Nashelsky MB, Lawrence CH. Accuracy of Cause of Death Determination Without Forensic Autopsy Examination. American Journal of Forensic Medicine & Pathology. 2003 Dec;24(4):313–9.
24. Amendt J. Insect decline-a forensic issue? Insects. 2021;12(4):324.

25. Schroeder H, Klotzbach H, Püschel K. Insects' colonization of human corpses in warm and cold season. Legal Medicine. 2003 Mar;5:S372–4.
26. Kulshrestha P, Satpathy DK. Use of beetles in forensic entomology. Forensic Science International. 2001 Aug;120(1–2):15–7.
27. Al-Khalifa MS, Mashaly AM, Al-Qahtni AH. Insect species colonized indoor and outdoor human corpses in Riyadh, Saudi Arabia. Journal of King Saud University - Science [Internet]. 2020;32(3):1812–7. Available from: https://doi.org/10.1016/j.jksus.2020.01.034
28. Zhou C, Byard RW. Factors and processes causing accelerated decomposition in human cadavers - An overview. Journal of Forensic and Legal Medicine [Internet]. 2011;18(1):6–9. Available from: http://dx.doi.org/10.1016/j.jflm.2010.10.003
29. Gennard D. Forensic Entomology: An introduction. West Sussex: John Wiley and Sons; 2007. 1–224 p.
30. Francesconi F, Lupi O. Myiasis. Clinical Microbiology Reviews. 2012 Jan;25(1):79–105.