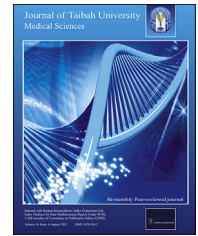




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Original Article

## Introducing integrated case-based learning to clinical nutrition training and evaluating students' learning performance



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### المخلص

**أهداف البحث:** إن تدريب التغذية العلاجية هو مقرر أساسي يجمع بين الدراسة النظرية والمهارات العملية في المجال السريري. الهدف من التدريب هو إعداد الخريجين ليكونوا أكفاء في مستقبلهم العملي. التعلم القائم على الحالات السريرية هو مناقشة تعليمية يشارك فيها الطالب لعلاج الحالات التي يتعاملون معها خلال فترة تدريبهم. والتعليم المدمج هو طريقة تدريس تتناول الجوانب المتعددة لحالة المريض وتأثيرها على حالته التغذوية بهدف تسهيل فهم الطالب لعلاقة العلوم ببعضها. يصف هذا البحث تجربة تدريس طلبة التغذية العلاجية بطريقة التعليم المدمج القائم على الحالة وتقييم تأثيرها على أداء طلاب التغذية خلال فترة تدريبهم السريري.

**طرق البحث:** استهدف هذا المشروع التعليمي تدريب طلاب التغذية العلاجية في جامعة الشارقة. حيث تم عقد ١٠ جلسات تعليمية بطريقة التعليم المدمج القائم على الحالة لتسعة وعشرين طالباً في أماكن تدريبهم. واستخدم الباحثون نتائج تقرير عملية الرعاية التغذوية لتقييم الأداء التعليمي للمتدربين قبل الجلسة التعليمية وبعدها. علاوة على ذلك، أجريت مقابلة مع مجموعة من الطلاب لتوضيح تأثير هذه الطريقة في التدريس على تجربة الطلاب التعليمية.

**النتائج:** شهد جميع الطلاب (١٠٠٪) تحسناً في أدائهم التعليمي خلال تدريب التغذية العلاجية. وارتفعت درجات تقارير الطلاب بنسبة ٥٥٪ وقد صرحوا بأنهم اكتسبوا مهارات تعليمية مفيدة لحياتهم العملية بعد هذه الجلسة التعليمية.

**الاستنتاجات:** أظهر تدريس طلاب التغذية العلاجية بطريقة التعليم المدمج القائم على الحالة السريرية خلال فترة تدريبهم أثراً على نتائجهم العملية وأسهم في

تحسين مهاراتهم العملية، مما أدى إلى تطور قدرتهم على وصف العلاجات التغذوية. وأوصى الطلاب باعتماد هذه الطريقة التعليمية لمقرر تدريب التغذية العلاجية لما اختبروه من تطور في قدرتهم على ربط مواد التغذية العلاجية ببعضها.

**الكلمات المفتاحية:** التعليم الطبي؛ التعليم القائم على الحالة؛ التعليم المدمج؛ تدريب التغذية العلاجية؛ عملية الرعاية التغذوية

### Abstract

**Objectives:** Clinical nutrition training is an essential course for clinical nutrition and dietetics (CN&D) students. The training combines theoretical knowledge with practical skills. The goal is to prepare competent graduates for future practice. Case-based learning is an active learning method based on cases from the clinical setting. This study aimed to introduce an integrated case-based learning (ICBL) method to the clinical training of a cohort of CN&D students and to evaluate its impact on the students' knowledge of nutrition care process.

**Methods:** This action research project employed an ICBL-method of teaching in the clinical training of senior students in the CN&D course at the University of Sharjah, United Arab Emirates. Ten integrated case-based learning sessions were conducted with 29 students. The record of the nutrition care process was used to evaluate the learners' performance through a pretest-posttest mechanism. Furthermore, a focus group interview was conducted to determine the impact of the ICBL-based training on the students' learning experience.

**Results:** All of the students (100%) showed improvement in their learning. There was a 55% improvement in their

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grades. There was also self-perceived improvement of their life-long learning skills after the ICBL sessions.

**Conclusion:** Integraed case-based learning positively influenced learning among CN&D students. Consequently, the students were able to describe appropriate and individualized nutritional care plans. The students were satisfied with the training and considered ICBL to be an effective method of clinical training.

**Keywords:** Case-based learning; Clinical nutrition training; Integrated learning; Life-long learning; Nutrition care process

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## Introduction

One of the major challenges of medical education is the lack of consensus on the best method of learning and integrating nutrition into clinical practice.<sup>1</sup> The literature on nutrition education reveals a gap in the development of innovative teaching models to enhance clinical nutrition knowledge and training.<sup>2</sup> Several authors have proposed that delivering nutrition education requires new techniques.<sup>3</sup> Therefore, student-centred teaching strategies have been developed to improve the learning process. These types of learning methods focus on educating students on how to learn actively and independently.<sup>4</sup> The clinical field has a complex and demanding context, which requires its educational methods to enable students to build clinical competency through the analysis of cases.<sup>5</sup> Case-based learning (CBL) is an educational method that provides students with a learning context similar to real practice.<sup>6</sup> Teaching students through active discussions of actual cases from the clinical environment supports integrated learning.<sup>7</sup>

The clinical training course is a compulsory course that offers insight into clinical nutrition practice. The information offered in this course is vital to students, as it links together their education and professional future. This course aims to develop students' roles in establishing appropriate and individualized nutritional care plans. During several field visits that involved monitoring and supervising students during clinical training, the researchers noticed that students could not apply previous knowledge to the presented cases. Students usually study basic theoretical sciences for 3 years before hospital visits; subjects include, for example, Introduction to Nutrition, Nutrition Through the Life Cycle, Medical Nutrition Therapy, and Diet Planning. All these courses contain rich information to be used in understanding hospital cases. Therefore, real cases should be used to integrate the perception of that knowledge. However, students were not aware of how to integrate their knowledge.<sup>8</sup>

Consequently, the students' educational attainment was not meeting the competencies which they needed to master.

Moreover, clinical training aims to prepare graduates for practice involving a multidisciplinary team working for patient care. Hence, there is a gap in studying the relationship between nutrition and other disciplines and their role in the patient care process.

It has been found that clinical nutrition cannot be learned as an isolated subject.<sup>9</sup> Using integrated case studies, we attempted to enable nutrition students to acquire knowledge from different disciplines and discuss its impact on the nutritional aspect of the case.<sup>10</sup> Interdisciplinary teaching that is provided by the process of vertical integration has been found to assist students in acquiring a complete picture of the learned topic instead of receiving incoherent information.<sup>11</sup> Vertical integration is an effective educational strategy that gathers several subjects together to be taught at the same time.<sup>3</sup> It includes presenting all the related information from previous years about a specific topic based on a clinical case and elucidates their relationships to one another. This method was considered in the literature to act as a stimulus to facilitate students' learning process in the clinical field. In addition, it was found to facilitate holistic management of cases.<sup>12</sup> When it was applied in the field of nutrition, it improved the quality of the nutrition care provided by trainees.<sup>3,13,14</sup>

The nutrition care process (NCP) is an organized, problem-solving model that provides a systematic method of providing nutritional care. It includes assessment, diagnosis, intervention, monitoring, and evaluation.<sup>15</sup> This model has been shown to develop critical thinking and problem-solving skills.<sup>15</sup> In clinical training, the NCP combines the learning of basic, applied, and clinical nutrition sciences.<sup>14</sup> One Canadian study found that NCP training based on case studies contributed to the acquisition of fundamental skills for professional practice among dietitians.<sup>16</sup> The NCP has been shown to improve documentation accuracy during learning and practice and patient care quality among dietitians.<sup>17</sup>

In a study conducted by the Academy of Nutrition and Dietetics on the impact of CBL among nutrition students,<sup>10</sup> it was concluded that undergraduate nutrition students need sophisticated learning methods like case-based learning to apply their knowledge to clinical nutrition practice. Many teachers in the clinical nutrition field have used CBL during application of the nutrition care process.<sup>10</sup> Because effective learning methods are context-dependent,<sup>18</sup> the rationale for introducing ICBL is that it provides a learning environment that is similar to that of actual practice. Case-based learning provides reality-based situations while vertical integration offers a meaningful learning environment.<sup>7</sup> This technique can foster life-long self-learning skills and improve professional performance.

This study aimed to introduce the ICBL method in the clinical training of a cohort of CN&D students and to evaluate its impact on the students' knowledge of nutrition care process, by evaluating the trainee's performance in writing appropriate and individualized NCP records after ICBL clinical sessions.

## Materials and Methods

### Participants

This research was an educational action project which applied ICBL discussion sessions to CN&D clinical training. The study was conducted in the Department of Clinical Nutrition and Dietetics at the University of Sharjah. The Clinical Nutrition and Dietetics major is a 4-year specialty. The students undergo clinical training during their fourth year (senior year), which involves hospital visits twice each week for 12 weeks. The implementation took place during the Fall semester of the fourth year, 2018–2019. Twenty-nine students were involved in the project with a participation rate of 100%, which included all the students who had undergone clinical training that semester. There was no sampling because this was an educational experiment that provided the same benefit to all students, in accordance with academic ethics.

### Preparation

After the approval, an orientation session was held by the researchers for the participants. The aim of the study and the role of the students were clearly defined. Each student has signed an informed consent during that meeting.

### Implementation

Ten integrated case-based learning sessions were held in the hospitals' lecture rooms during the clinical training of each group (3–4) of students. This size of the groups was based on the hospital's capacity to receive trainees, which the facilitator could not adjust. The facilitator was the author of this paper, who got training on educational methods and strategies, including ICBL, while studying for her master's degree. The cases were those of the actual patients that the students had met and reported on in their first week. The patient medical cases covered included post-bariatric surgeries, cardiovascular diseases, diabetes mellitus, and surgical and critical cases that required intensive care unit admission. Each student wrote one NCP report after attending the dietitian's assessment interview with the patient. The student/trainee collected assessment information about the medical diagnosis, medical history, medications (for any drug–nutrient interaction instructions), and nutrition-related biochemical laboratory data. These reports were used as the educational material of the ICBL discussion. For each case, medical nutrition therapy was discussed during the session, and a brief background about the disease's pathophysiology, nutrition-related risk factors, drug–nutrient interaction, and nutrition education skills used with the patients was given. The topics were discussed using vertical integration strategy. This strategy involved explaining all the related nutritional issues of the case, and at the same time, helping students understand the relevance of the information. All these topics were used to write appropriate NCP records. The teacher used the small group active discussion method, and the dialogue was dependent on the researcher's questions and students' interaction.

Each session lasted for 40 min and was broken down as follows: 5 min of explaining the teaching method, 5 min for students' determination of their learning outcomes, 5 min for students' presentation of their submitted cases, 15 min of active discussion with the teacher, and finally, 10 min for questions and feedback.

### Evaluation

The NCP case record (Appendix 1) was adopted from the UOS to evaluate the trainee's performance in prescribing appropriate and individualized nutrition intervention. This documented case report is usually used in the Department of CN&D as a graded assignment required from the students, in order to follow their training progress. It includes collecting data and multiple questions on anthropometric measurements, medical diagnosis, medications prescribed, biochemical data, and the patient's 24-h food intake. Based on this information, students were required to assess cases by providing a proper nutritional diagnosis, diet prescription, and individualized nutritional education for each case. All the questions are short answers; some could be obtained from the patient's file, others require calculating the dietary needs, and others examine the students' problem-solving and critical thinking skills.

Mastering the skills of writing individualized nutritional management was measured by comparing students' NCP grades before and after the ICBL session. Students were given 1 week to submit 1 NCP out of 10 points. This NCP was graded and reviewed by the researcher and another faculty before implementing the project. Another clinical week after the session was given for students to submit the 2nd NCP of the same record with different cases to be considered the post-test.

## Results

### Quantitative data

Pre- and post-tests were administered to compare students' NCP records grades (out of 10 points) before and after implementation of the learning sessions. The response rate for the project was 100%. A total of 29 participants responded and submitted their NCPs before their planned

**Table 1: SPSS analysis of students' results before and after the project's implementation.**

Results of the paired sample t-test			
		Pre-test grades	Post-test grades
N	Valid	29	29
	Missing	0	0
Mean		5.8534	9.0776
Median		5.7500	9.0000
Std. Deviation		1.76336	0.66179
Minimum		2.25	7.75
Maximum		9.25	10.00
Percentiles	25	4.6250	8.7500
	50	5.7500	9.0000
	75	7.2500	9.5000

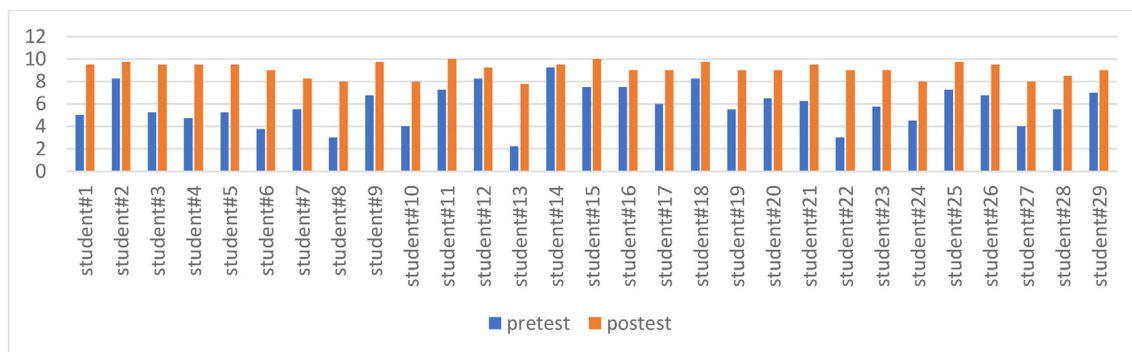


Figure 1: Pretest-posttest NCP results.

sessions. These NCPs were corrected and were considered the pre-test. Because the sample was less than thirty, a paired sample t-test was performed with SPSS statistical analysis software (version 17.0), as shown in Table 1. It showed the impact of the project on students’ grades. Furthermore, the statistics clarified the mean, median, and standard deviation before and after. All the participating students improved their score by an average of 3.2 points after application of the ICBL method.

Additionally, Figure 1 clarifies the difference in detail by representing each student’s grades before and after the learning session. The percentage of improvement detected by our pretest-posttest results was 55%. One hundred percent experienced academic improvement. These results were drawn from the increased scores of the case records (NCP). After the sessions, 75% of the students got 9.5 out of 10. The p-value for the analysis was 0.0.

Qualitative data

A 60-min focus group interview was conducted to investigate the effects of the sessions on the students’ learning experience. Five of the students were contacted by telephone and invited to participate in the group interview. All participants provided prior written informed consent and approved the recording of the interview. The students were coded from one to five (S1–S5). The facilitator led the session by asking a previously prepared set of questions. The

questions were designed to promote full discussion of the students’ perceptions regarding the learning sessions. Finally, the results were obtained using simple descriptive analysis.<sup>19</sup> The audio recording was transcribed and analysed several times for themes and subthemes.

The focus group interview was conducted to enrich the results with students’ descriptions of the experiment. The questions were planned to measure the student’s achievement of specific learning skills. The session was led objectively to allow participants to express their points of view. The results obtained from the thematic analysis of the focus group interview are summarized in Table 2.

Discussion

This study found the ICBL method to effectively improve clinical nutrition students’ training. Evidence shows that health care providers base diagnostic and therapeutic decisions on their past cases. This occurs because knowledge consists of context-similar experience in addition to theoretical information.<sup>4</sup> The integrating of nutrition education based on clinical cases has been found to result in the translation of knowledge of theory into clinical practice.<sup>2</sup> The main feature of integration is getting the benefit of learning several subjects at the same time.<sup>12</sup>

The present study’s findings were aligned with the published results in the literature on case-based and integrated learning. Harvard Medical School has introduced an

Table 2: Thematic analysis for the focus group interview.

	Comments
1. The small group was preferable	“I found the small group a strongly effective way of learning ...”
ICBL was learner-centred	“I felt that the session was made for me ...”
ICBL increased student confidence	“This session boosted my self-confidence ...”
2. ICBL increased practical skills	“The session allowed me to integrate my knowledge ... I became aware of how to use information wisely.”
Knowledge presentation was consistent	“... I liked best the sequential delivery of information, how I answered my questions by myself.”
ICBL created a positive learning environment	“ICBL discussion presented coherent knowledge.”
	“I was happy because of the atmosphere ... There was positive energy, and we were motivated.”
3. Interactive learning	“Although I am a reserved person, I learned and interacted with others using this method.”
Deepened learning skills	“... I acquired a sense of analysis and logical thinking ...”
Precision	“I learned to pay attention to specific issues related to the case.”

integrated nutrition curriculum to enhance the way students handle nutritional sciences. It was found that active case-based learning and student-centred educational initiatives were good strategies for delivering the message.<sup>8</sup> Educating using integrated case studies reinforced the attainment of nutrition care process learning outcomes.<sup>10</sup> Boston University of Health and Rehabilitation also considered the integrated nutrition model to attain learning outcomes related to human nutrition.<sup>14</sup> Using integrated case studies enables nutrition students to acquire knowledge from different nutritional topics and utilize that knowledge for a better understanding of the cases.<sup>10</sup> One study conducted in KSA and Egypt compared problem and case-based learning during the clinical clerkship. This study showed that both methods were feasible and applicable. However, 70% of students reported that case-based learning was more effective during clinical training, in particular.<sup>20</sup> One post-test experimental study carried out at the University of Nebraska—Lincoln found that case-based teaching enhanced students' perceptions of the physiology course. That study showed a real increase by  $P < 0.04$  in CBL students' performance over traditional education.<sup>21</sup> In comparison, the significance of this study's improvement, which was implemented in the United Arab Emirates, was 0.0. The College of Medicine at the University of Colorado has included vertically integrated nutrition in its curriculum during clinical training years since 2001 and has stressed the importance of learning nutrition by practicing in the clinical field.<sup>14</sup>

#### *Students' feedback*

The present authors expected small group learning to be an effective method in the study. During the focus group, the students pointed out that the ICBL session was efficient because of the small number of participating students. The participants indicated that because the sessions were more individualized it was easy and convenient to express their opinions and to learn. Similarly, the vice dean at the University of Pennsylvania found using small group, case-based discussions to teach nutrition to be highly effective.<sup>22</sup> Many authors have also suggested that learning in small groups gives the students a better opportunity to express themselves and to learn more.<sup>6,23</sup> Small group learning increases the levels of satisfaction among students.<sup>24</sup> Integrated case-based learning is considered to be a learner-centred teaching method.<sup>25</sup> In the present study, the students noted that the sessions seemed to be more focused on them. They also reported having more ability to acquire knowledge on their own. Canadian dietitians reported increases in students' confidence levels after they learned and implemented the NCP. They suggested that implementing the NCP was appropriate for the clinical training objectives.<sup>15</sup> In the present study, the five participants in the interview strongly agreed that the ICBL sessions increased their self-confidence. During the sessions, they felt confident enough to participate and learn. After the sessions, they were more convinced of the correctness of their nutritional assessment and diet plan decisions. Other research

in medical education has also found that case-based learning enhances students' confidence levels.<sup>26</sup>

#### *Impact of ICBL on students' learning experience*

The use of case studies has been found to be strongly associated with theoretical and practical aspects of education.<sup>6</sup> Students in the present study reported that the ICBL sessions helped them to integrate theoretical knowledge into their practice. After completing the sessions, students had increased their ability to integrate knowledge and were able to make better use of it. The students claimed that the integrated way of learning helped them in focusing on multiple aspects of the case. It has been suggested that case discussions reinforce student's sense of clinical relevance. The CBL-based discussions elucidated the course's clinical relevance, making it easy for students to understand the general science.<sup>21</sup> Cambridge University has found vertical integration to improve students' understanding of the clinical relevance of learning. They achieved a successful educational initiative using CBL as a teaching method.<sup>14</sup> These results foster integration, which is teaching for understanding.<sup>21,27</sup>

The ICBL sessions also involved merging clinical nutrition with the medical, pharmaceutical, and biochemical aspects of cases. We planned for this based on the idea that clinical nutrition cannot be learned in isolation.<sup>9</sup> It has been shown that integrated case discussions enable students to recognize the relationships between clinical nutrition and other disciplines.<sup>10</sup> It has also been shown that interdisciplinary teaching plays an essential role in providing the students with a holistic image of the learned topic.<sup>11</sup> Multidisciplinary teaching is a critical aspect in nutrition education and is encouraged by Cambridge University.<sup>3</sup> Therefore, consistency in the delivery of information enriches the student's learning experience. Case-based learning is an inquiry-based learning method that provides students with knowledge based on the case's questions. Students need to answer the questions in a methodical, thought-out manner to reach a solution.<sup>6</sup>

Findings of the present study suggest that ICBL creates a positive learning environment. The participants reported that the active discussion encouraged them to engage in the learning process and motivated them to learn. This outcome was in line with those of other research, which revealed that case-based learning creates an effective learning atmosphere for students. The educational environment has a crucial role in determining students' satisfaction and readiness to learn.<sup>27</sup> Furthermore, it has been found that teaching nutrition in a vertically integrated, multidisciplinary approach creates an active learning environment, which leads to a distinctive learning experience.<sup>3</sup>

#### *Effect of ICBL on learning skills*

In one study conducted at Boston University, vertically integrated learning was found to improve the learning skills related to clinical training.<sup>28</sup> This research involved examining the effect of integrated case discussions on students' learning skills development. As a result of active sessions, students reported that they could deeply process

the information. Students could analyse the case elements effectively to solve the problem. In another study, NCP was found to improve critical thinking and problem-solving skills, which can help students later in the future when handling cases.<sup>17</sup> Students grew more conscious of their way of thinking and understanding the case through the discussions. Accordingly, they increased their awareness of the rationale of their nutritional decisions. One study conducted in India indicated that the CBL method facilitated the development of essential skills in clinical settings.<sup>12</sup> The positive effect of CBL discussion on students' critical and creative thinking has also been demonstrated in the literature.<sup>29</sup> Other authors also found that this method helps students develop deep learning skills, critical thinking, clinical reasoning, problem-solving, and decision-making.<sup>5,6,10,26,29</sup> It was found in the literature that integrated learning assisted students in developing the skills that allowed them to handle clinical cases in a comprehensive manner.<sup>12</sup>

Interactive learning is one of the functional skills that enhances the quality of the learning experience.<sup>5</sup> Case-based learning offers students the opportunity to learn actively by sharing.<sup>30</sup> Studies have reported that active case discussions foster more effective learning.<sup>21,29</sup> These results are in line with those of the present study regarding students' perceptions of ICBL. In the present study, clinical nutrition students enjoyed interactive learning during the ICBL sessions. They preferred this method of group learning, commenting that traditional teaching methods lack this beneficial interaction. They also indicated that they learned to be more focused and precise when dealing with the information.

Studies worldwide have suggested that the implementation of integrated CBL leads to a positive learning environment and to improvement in the learning process in several aspects.<sup>6,10,26,29,30</sup>

This study had two major limitations. The first was due to constraints during the initiation and planning phases. The work schedules of the key stakeholders were full, which made it difficult to plan meetings and discussions. It was not easy to obtain other parties' feedback on the implementation phases sequentially. However, consultations were carried out with the coordinator of the course and continuous project updates were provided. The second limitation of the study was the relatively small number of participants. A total of 29 students were included in the study, which was the total number of students enrolled in clinical training during the study. However, all participants showed positive results, and they all achieved the intended outcomes of the project.

## Conclusion

Integrated case-based learning sessions positively influenced the learning of clinical nutrition and dietetics students. Our findings suggest that this type of active discussion strongly impacts the learning process. The results of the students' pretest-posttest showed improvement in their nutrition care process records documentation. Also, they provided extremely positive feedback during the focus group

interview. This effect was also reflected in the improvement in their academic achievement.

Moreover, this project's participants developed advanced learning skills, leading to better achievement of graduates' outcomes. Graduating qualified clinical nutrition specialists is an accomplishment to the College of Health Sciences and the university as a whole. Skilful graduates who are capable of meeting the needs of the community are always a strength to the University as an organization responsible to the community.

## Recommendations

Integrated case-based learning sessions could be implemented at other Medical and Health Science Colleges, including the College of Medicine, Dental Medicine, Pharmacy, and all Health Sciences departments.

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## Conflict of interest

The authors have no conflict of interest to declare.

## Ethical approval

This study was approved by the research ethics committee at the College of Medicine, University of Sharjah on 17-02-2019 (approval number: REC-19-01-09-01).

## Authors contributions

RAF conceived and designed the study, conducted research, analysed results, and drafted the manuscript. MH supervised the project's implementation and edited the manuscript. SAK contributed to the design of the project and edited the final manuscript. All authors have critically reviewed and approved the final draft and are responsible for the content and similarity index of the manuscript.

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## Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.jtumed.2021.03.005>.

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