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ORIGINAL ARTICLE

Level of clinical competence in seven cohorts of medical students at the end of the internship

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Abstract

Introduction: *Objective structured clinical examination is the instrument with more validated evidence to assess the degree of clinical competence of medical students. Objectives: To assess the degree of clinical competence of medical students at the end of their internship; to assess the reliability of the instruments with G theory.* **Methods:** *This was an observational, longitudinal, and comparative study. The target population was composed of 5,399 interns of seven generations that finished their internship at the Faculty of Medicine of UNAM, between 2009 and 2015. The instrument used was 18 OSCE stations, three in each subject of the internship.* **Results:** *The undergraduate medical interns show a sufficient degree of clinical competence to be general practitioners. The laboratory interpretation and physical examination had the highest scores. The interpretation of imaging studies was the component with the lowest score. The Family Medicine disciplinal area had the highest average score in the OSCE; in contrast, Pediatrics obtained the lowest score on average. The reliability was measured with Generalizability Theory and ranged between 0.81 and 0.93.* **Conclusions:** *The clinical competence of undergraduate medical interns is considered sufficient. The results also show the subjects that require educational interventions to improve clinical competence of students.* (Gac Med Mex. 2016;152:608-15)

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Introduction

Knowledge and technological development continuous advance in medicine regularly multiplies information volume and complexity, in such a way that professional practice of the physician has been modified to answer to the health necessities of an increasingly informed and demanding society that requires doctors with an adequate degree of clinical competence that allows for them to provide comprehensive, continuous and humanistic care.

Medicine undergraduate education is intended to train general practitioners, with these being understood as professionals that have the knowledge, skills and attitudes required to diagnose and solve with medical

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treatments and procedures the majority of ailments human beings suffer from throughout their lives[1].

In our country, the general practitioner is a central figure in the provision of health services, since he/she looks for the vast majority of medical appointments offered every day and solves 80%-90% of the population's health problems[2].

Assessment of the degree of clinical competence of general practitioners is a priority in the national and international context. Areas of strength should be identified in order to consolidate them, as well as areas of opportunity, to be able to increase the quality of the educational process in the training of the general practitioner and fully comply with the profile of graduate students.

Clinical competence is understood as the combination of knowledge, skills, attitudes and values that, interrelated with each other and based on reasoning, scientific evidence and critical judgment, allow for efficient professional performance.

Clinical competence is acquired during undergraduate studies, mainly in the setting of real-world health care of the National Health System institutions, in the development of which medical care and doctor-patient relationship play an essential role.

Clinical teaching articulates theory and practice, and it rests on biomedical and sociomedical sciences and on the best available scientific evidence that supports the development of clinical competence, the capacity to carry out clinical and clinical-surgical procedures, laboratory and imaging results interpretation, the development of reasoning and diagnostic judgment, therapeutic reasoning, recognition and treatment of situations that are life-threatening for the patient and, when it corresponds, implementation of adequate and opportune actions for rehabilitation, prevention, reference and counter-reference.

The development of clinical competence should be continuously evaluated. The purpose of evaluation in the medical education setting goes beyond the demonstration of knowledge, and its essentially educational function is increasingly recognized, which allows for achievements and shortages in the training of medicine students to be identified and to plan actions allowing to consolidate goals and to devise plans for continuous improvement. Educational evaluation allows improving the development of clinical competence and reinforcing the function of tutors and academic program curricula. In our setting, clinical competence is assessed by teachers using exams with real patients (RP), simulators and intermittent evaluations over the training process.

Objective Structured Clinical Evaluation (OSCE) has been shown to be a practical instrument with consistent validity and reliability sources of evidence, and it is the clinical competence assessment method with the highest degree of objectivity[3-6]. Some of the components of clinical competence that are assessed by means of OSCE are the following: interrogation, physical examination, laboratory and imaging tests interpretation, diagnosis and management plan, and communication in the doctor-patient relationship[7]. These components are the ones considered in the assessment performed by the Faculty of Medicine of the National Autonomous University of Mexico (UNAM – *Universidad Nacional Autónoma de México)* to undergraduate students.

In the UNAM Faculty of Medicine, professional examination is comprised by two phases: a theoretic phase, with an objective exam with multiple choice items, which the student has to approve to gain access to the second, practical phase, where he/she can choose the traditional, long case with RP or the OSCE. The latter, selected by over 90% of examinees, assesses different areas representing the physician's professional competence, such as knowledge, capacity to apply it and problem solving.

The assessment by means of the OSCE implies establishing a value judgment on the student's performance, quantifying the knowledge acquired by the student, as well as the scope and achievement of the program objectives, and justifying the decision on the attainment or not of the degree of medicine; i.e., evidence is obtained that the examinee possesses the clinical competence required to adequately practice as a professional of medicine.

In our country, students' clinical competence evaluation in medicine schools by using instruments with different sources of validity and reliability evidence is still scarce. At the UNAM Faculty of Medicine, an accurate diagnosis is required on the degree of clinical competence of students who finish their internship, prior to undertaking the mandatory social service. The information provided by the OSCE is fundamental to the students, teachers and to the Faculty of Medicine itself feedback on the program's continuous improvement processes.

Method

A longitudinal, comparative, observational investigation was conducted at the Faculty of Medicine of the UNAM. The target population was comprised by 5,399 students

of the classes that completed the medical degree Unified Curriculum from 2009 to 2015. The inclusion criteria were that the participants should have completed all Unified Curriculum courses and the theoretical phase of the professional examination. The only exclusion criterion was the selection by the student of the modality with RP.

The OSCE was applied annually from 2009 to 2015 as a practical professional examination modality to assess the degree of clinical competence of undergraduate intern physicians who recently completed all the curriculum courses.

The assessment instruments were constructed by expert committees with the following characteristics: being professors of the Faculty of Medicine, having at least 10 years of clinical experience, belonging to an OSCE specialty such as surgery, obstetrics and gynecology, family medicine, internal medicine, pediatrics or emergency medicine and having experience as assessors on at least three educational examinations with this methodology. Eighteen specialists constructed the OSCE stations and, subsequently, a group of six family doctors validated these stations following several stages:

- First stage: the skills to be evaluated were selected based on the Faculty of Medicine Unified Curriculum and on the profile of the most common clinical problems the general practitioner is confronted with.
- Second stage: based on this profile, the committee members established the number of OSCE stations according to the clinical skill that was regarded as the most representative for each medical condition and that, in addition, was amenable to be assessed in the 6 min each station lasted. Based on the table of specifications, the number of stations and components of the clinical competence, the OSCE was comprised by 10 interrogation, 3 physical examination, 2 radiographic interpretation, one diagnosis and management, one laboratory tests interpretation and one medical research work analysis stations.
- Third stage: the material required for each station was put together, including clinical summaries of real cases, checklists and laboratory tests. To ensure interrater reliability and to record relevant clinical performance on each station, specialists in each area created the checklists to be used, which were reviewed by the research group and validated by another group of physicians of the corresponding area.
- Fourth stage: first, real patients and non-sick individuals were selected and trained to consistently enact a medical problem, as standardized patients. Subsequently, two types of stations were formed:
  - Procedural stations, which assessed the student's capability to interrogate or examine standardized patients and to establish presumptive diagnoses.
  - Stations for laboratory and/or imaging tests interpretation, where diagnostic integration and the capability to devise a comprehensive management plan were also assessed.
- Fifth stage: finally, the OSCE ended up comprised by 18 stations, three for each area of knowledge of the medical internship program: surgery, obstetrics and gynecology, family medicine, internal medicine, pediatrics and emergency medicine. The OSCE was planned to have a 2-h duration and, therefore, each station took 6 min, including two resting stations. It should be mentioned that stations were different year after year, and only 50% of the previously applied stations was preserved, trying for them to be equivalent as much as possible since, each year, the same clinical competence components were evaluated. The used cases contained a clinical introduction with the clinical scenario and an instruction form in order for the student to focus on the problem and adequately develop it.

The checklists used to assess the examinee's clinical performance contained statements related to the activity to be performed, either interrogation, physical examination, counseling, integration of one or several diagnoses, management indications proposal, laboratory and imaging studies abnormalities interpretation and research article analysis. In the stations with standardized patients, the assessor would rate the checklist and issue a global grade on interpersonal communication skills, following a global scale from 1 to 9, where 1 t 3 corresponded to unsatisfactory, 4 to 6, to satisfactory and 7 to 9, to superior[8].

The number of statements to be assessed in the procedural stations with patients ranged from 20 to 40, and in the laboratory and imaging studies interpretation stations, from 6 to 22. Each statement was rated as 0 or 1; one statement made received 1 point and one not made or incorrectly made, 0 points. The grade of a station was obtained by adding the results of its components. In the case of the procedural stations, 4 weighted components were assessed: interaction with

patients, interrogation, physical examination and management (65%), formulation of diagnoses (20%), interpersonal communication skills (10%) and assessment by the patient (5%). The stations of laboratory or imaging interpretation had 2 components: normal and abnormal data that are interpreted (80%) and establishment of a diagnosis (20%). The exam's final grade was the average of the grades of all stations; the scale used ranged from 0 to 100 in percentages.

Analysis

Statistical analyses were carried out with central tendency and dispersion measures for each analyzed cohort using version 11 of the John's Macintosh Project (JMP) program. The ANOVA test was performed for 3 or more samples in order to assess the differences with a level of significance of $p \leq 0.05$. A study based on the generalizability theory with a random effect cross-sectional design was also performed to identify the main sources of variation. The assessors, the patients and the cases were regarded as a single facet in the analysis.

Ethical aspects

This study was part of the Institutional Evaluation Plan of the UNAM Faculty of Medicine. For the purposes of this work, individual identifiers were eliminated and only aggregated results were presented, with confidentiality of the students being preserved in the preparation of the manuscript.

Results

To assess the students' clinical competence al the completion of the undergraduate medical internship, the 18-station OSCE was applied to 5,399 students. The number of students for each graduate class was the following: 709 students in 2009, 675 in 2010, 776 in 2011, 700 in 2012, 719 in 2013, 896 in 2014 and 924 in 2015.

The reliability of the instrument was calculated with Cronbach's α, with the following results being obtained: $\alpha = 0.61$ in 2009, $\alpha = 0.55$ in 2010, $\alpha = 0.64$ in 2011, $\alpha = 0.50$ in 2012, $\alpha = 0.60$ in 2013, $\alpha = 0.61$ in 2014 and $\alpha = 0.59$ in 2015. In addition, the generalizability coefficient was calculated for each application: G = 0.88 in 2009, G = 0.85 in 2010, G = 0.93 in 2011, G = 0.81 in 2012, G = 0.87 in 2013, G = 0.84 in 2014 and G = 0.82 in 2015.

Figure 1 shows the global results obtained by the examinees in the OSCE. Global mean of all cohorts was lower than 70. The population obtained homogeneous scores with regard to the degree of clinical competence, since data dispersion was not wide. There were significant differences ($p \leq 0.05$) between the 3 cohorts with the lowest averages (2012, 2013 and 2014) and the 4 remaining cohorts (2009, 2010, 2011 and 2015).

Figure 2 shows that the two OSCE components with the highest score averages were laboratory tests interpretation in the classes of 2009, 2010 and 2011 and physical examination in the 2011, 2013 and 2015 cohorts. The components with the lowest score averages were radiographic interpretation and literature analysis.

Figures 3 and 4 show that the internal medicine area obtained the highest mean in the classes of 2009 to 2012. In all cohorts, the family medicine area obtained the most consistent and homogeneous results, as well as the highest average. The pediatrics area obtained the lowest average in all cohorts.

Discussion

Everyday practice of a general practitioner includes multiple activities that demand different degrees of skills, but few are as complicated to develop as clinical competence, which includes the capability to arrive to an early and accurate diagnosis, as well as to adequate and opportune treatment of the medical condition, in order to solve health problems.

In the present study, according to the obtained results, we document that, from a global point of view, the Unified Curriculum managed to build sufficient levels of clinical competence in medicine students. In the assessments made by means of the OSCE to seven cohorts of undergraduate intern physicians, a mean of 61.4 was obtained (65.6 in 2009, 61.9 in 2010, 62.3 in 2011, 60 in 2012, 59.8 in 2013, 58.5 in 2014 and 62 in 2015.

The results are similar to those in other countries. Students obtain lower grades on OSCEs than in examinations with multiple choice items[5,6]. The experts and the psychometric analysis of the OSCE stations establish that the lowest general average to consider the students as being competent according to their results is 55.

In 5 schools of Switzerland, in a measurement at the completion of the medicine undergraduate curriculum, an OSCE with 12 stations of 13 min each, with total duration of 3 h and 45 min, was carried out, and a

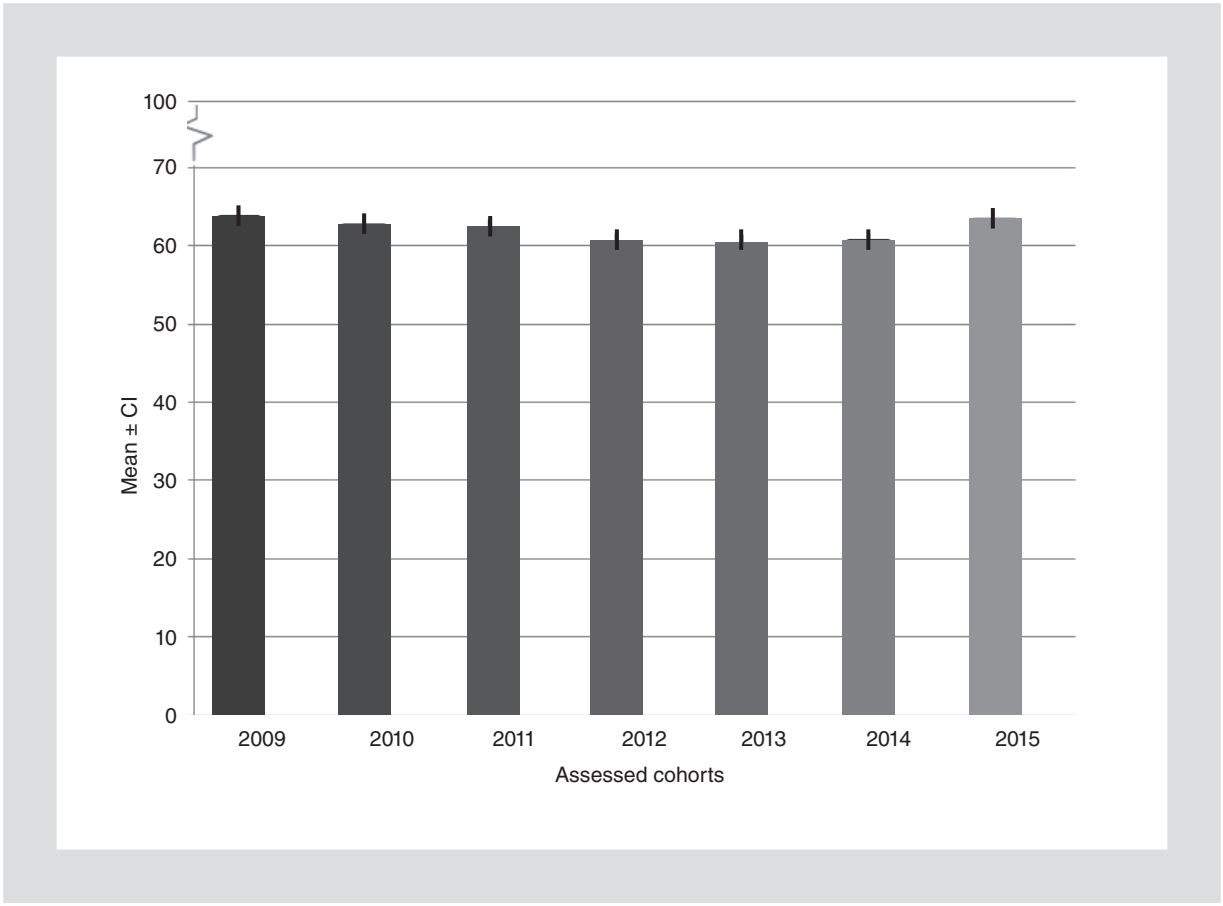

Figure 1. *Global results obtained by the examinees in the OSCE by assessed cohort (n = 5,399). The abscissas represent the graduate classes from 2009 to 2015, and the ordinates, the scores average. The vertical lines on top of the bars represent the 95% confidence intervals (CI).*

mean of 73.8 was obtained (43.5 minimum and 87.9 maximum)[9].

In the USA, an OSCE with 8 stations of 12 min each was applied to 106 residents just at the completion of the medicine undergraduate curriculum, and a mean of 64.2% was obtained[10].

Clinical competence has several components, including the ability to conduct an adequate interrogation and an efficacious physical examination. By means of these activities, data and information are obtained, which are used by the general practitioner to base, reject or modify probable diagnoses for the patient. In addition, the physician uses laboratory and imaging studies as evidence to arrive to a definitive diagnosis.

In our study, the laboratory tests interpretation component had the highest mean, followed by physical examination. A possible explanation for this fact is that clinical skills are acquired during the third and fourth years of undergraduate studies, and are fundamental to corroborate or reject diagnoses, and allow for students to learn how to base their hypotheses on everyday professional practice[11,12].

Radiographic interpretation deserves special attention, since it obtained the lowest scores as related to the other clinical competence components. This suggests the possibility of an educational intervention to be carried out in order to strengthen this skill.

Interrogation and physical examination had a global mean of 63.1 and 71.5, respectively, which are similar to previously reported results[13], where a mean of 53.9 right answers were found in the interrogatory stations and 62.3 in those of physical examination, which constitutes an evidence of added validity to the findings of the present study.

The area of the family medicine discipline obtained the OSCE highest average score. This may be due to the fact that teachers in this area give great importance to the profile of medicine graduates, which strengthens the idea of improving the rotation of interns in this area, which might be a more appropriate context for the

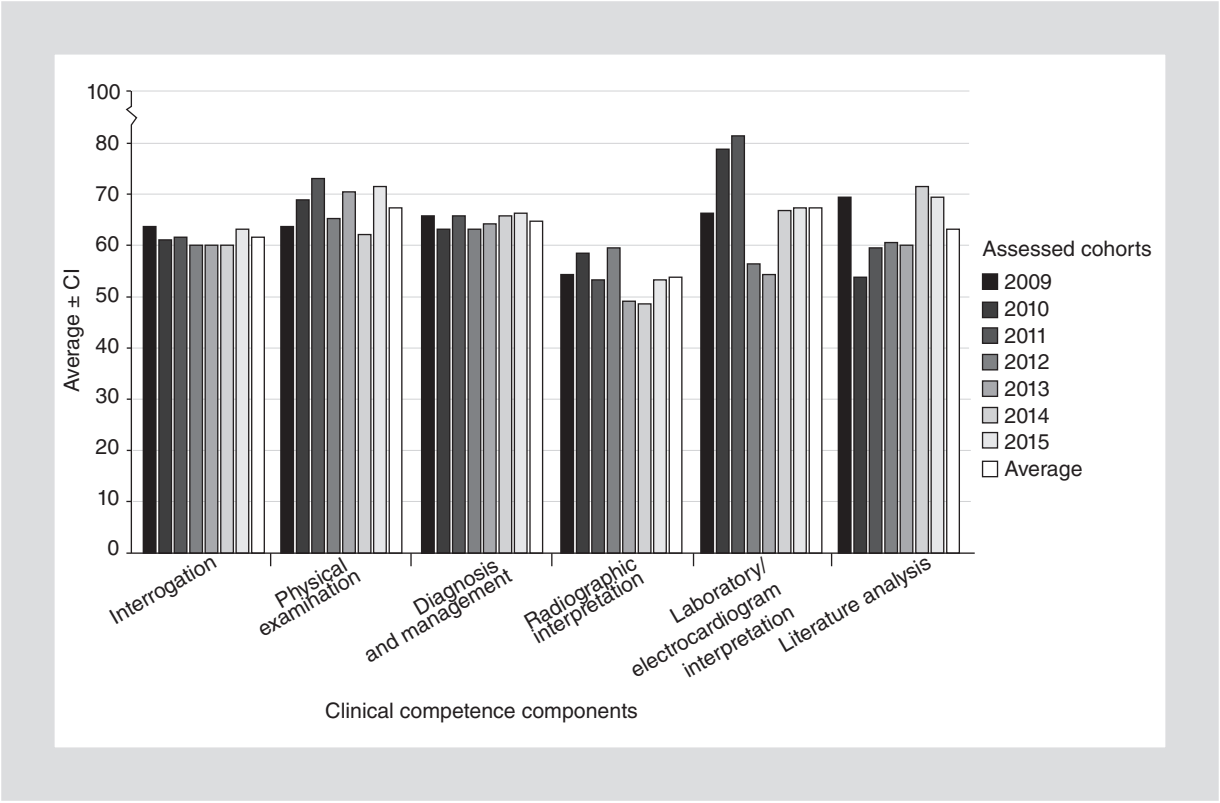

Figure 2. *Results obtained by the examinees for each clinical competence component.*

training of general practitioners with a more preventive focus, which is what our country requires. This score may also be due to other factors, such as collaboration with teachers in the management of patients with the most common medical conditions, homogeneity of the academic program and discussion of clinical cases, reflexive and constant clinical experiences and complementary clinical activities.

General practitioners have few opportunities to practice their profession in our country, since in the work setting there is a marked orientation towards specialized medicine; therefore, most medicine graduates aspire to train to become specialists[14,15]. However this trend can change if teaching on primary care is strengthened in undergraduate education –clinical practice's natural niche–, which can guide and motivate students to embrace general medicine.

The next area with higher average in the OSCE was internal medicine. This may be due to the fact that, at third and fourth year, the courses corresponding to internal medicine are developed at the hospital level[11,12], and these courses study the most common morbidities and mortalities of our country. These results are similar to those obtained in the 2002 to 2004 medicine degree OSCE, a situation that also contributes to add validity evidence to the present study[16,17].

The discipline area with the lowest average in this study was the area of pediatrics; therefore, strengthening the learning of this important area with appropriate educational interventions is important.

The emergency medicine area had a mean of 60.2 correct answers. When an OSCE with two types of stations was applied to 45 last-year students of a medicine school from Frankfurt, a mean of 83.6% was found with one type and of 79.6% with the second type in the emergency medicine area[18].

The applied OSCE had a Cronbach's α-measured reliability of 0.58 on average for the 7 cohorts, a figure approaching the 0.7 value established by Streiner and Norman for a high-consequence examination[20]. It is also feasible assessing and complementing the information on reliability of the instrument with the generalizability theory[20].

The G coefficient measures the proportion of total variation owing to the students' true knowledge variation. When the G-value is higher, it implies that other sources of variation are less important in comparison with the variation among students.

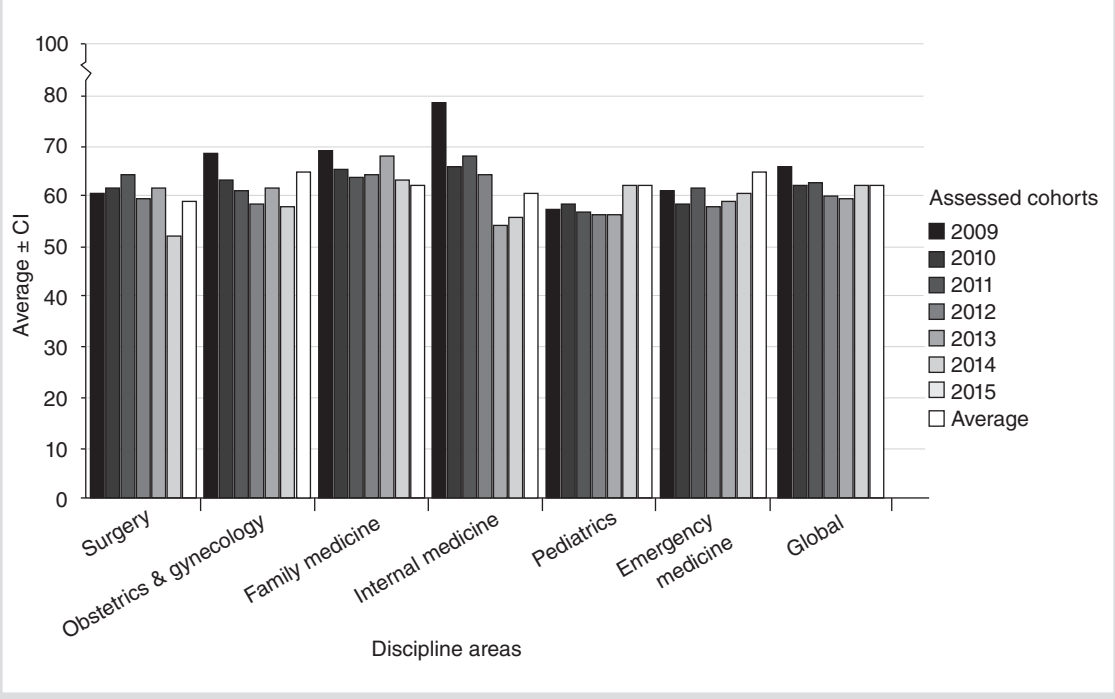

Figure 3. *Results obtained by each cohort of examinees at each discipline area.*

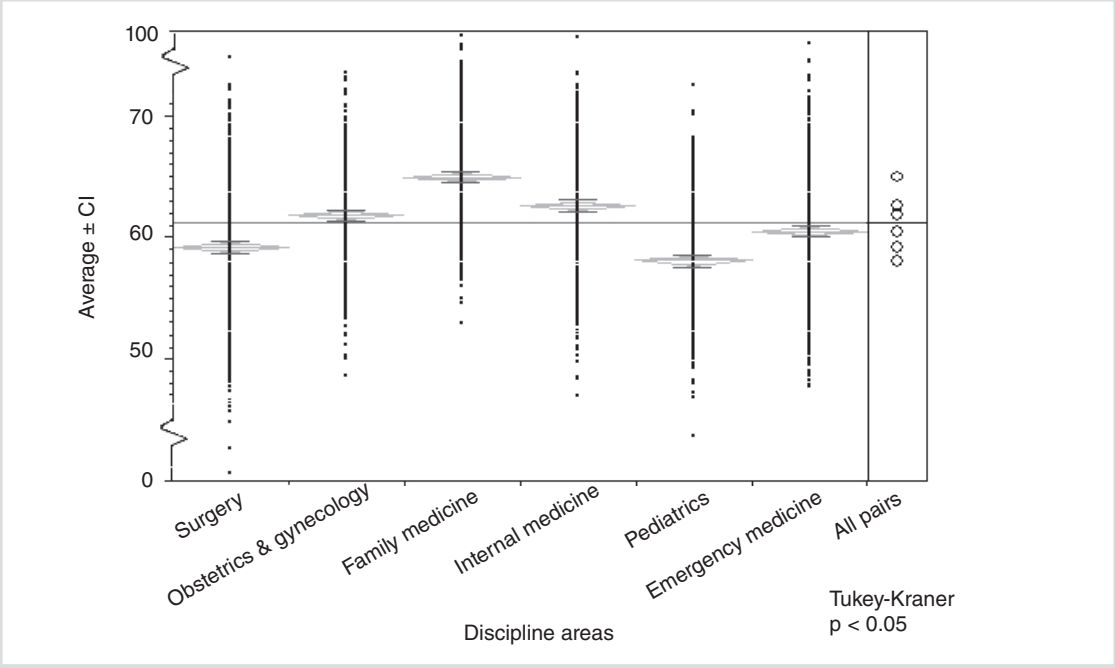

Figure 4. *Global results obtained by the students of the seven cohorts in the OSCE by discipline area. The abscissas indicate the discipline area, and the ordinates, the scores average. The horizontal lines above and below the means represent the 95% confidence intervals (CI). The highest discipline area was family medicine, and the lowest, pediatrics. With the post hoc Tukey-Kramer test, significant differences ($p \leq 0.0001$) were found between family medicine, surgery and pediatrics individually with the other areas.*

One of the limitations of this study is the fact that it was carried out in a single medicine school, with a particular context and characteristics, which limits the generalization of the results to other national or international institutions, although it can be argued that the Faculty of Medicine of the UNAM, with public nature, is the largest medical school in the country, and its students represent a broad sample of all economic and social strata of the Mexican population, which suggests that our results are applicable to the majority of national medical schools.

The present study is one of the few of its kind investigating clinical competence assessment in Mexico, and thereby it can serve as a basis to design other studies that help to improve the quality of medical education in our country, particularly comparative studies with 2010 curriculum currently in use, in order to evaluate its strengths and weaknesses.

In Mexico, there are few faculties of medicine that know and apply the OSCE, and for this reason it is recommendable to continuously diffuse this evaluation strategy. Assuming the challenge to improve medical education at the UNAM Faculty of Medicine enables to advance in the training of general practitioners, since it provides evidence-based information and feedback, in an attempt to help students and teachers to increase the quality of the healthcare educational and clinical process. The OSCE results should guide the changes in academic programs and decision making, towards the development of the competences that are wanted to be acquired.

This study contributes to increase the culture of clinical competence evaluation in our setting and provides valid and reliable results obtained with a rigorous methodology. It is deemed to be desirable to formally generalize the use of the OSCE, in order for all students to be assessed by means of this strategy, since it is one of the most objective existing instruments to assess and improve clinical competence aiming to offer patients greater safety[20-22].

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