Assessment of Global Health Education: The Role of Multiple-Choice Questions

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Introduction: The standardization of global health education and assessment remains a significant issue among global health educators. This paper explores the role of multiple choice questions (MCQs) in global health education: whether MCQs are appropriate in written assessment of what may be perceived to be a broad curriculum packed with fewer facts than biomedical science curricula; what form the MCQs might take; what we want to test; how to select the most appropriate question format; the challenge of quality item-writing; and, which aspects of the curriculum MCQs may be used to assess.

Materials and Methods: The Medical School for International Health (MSIH) global health curriculum was blue-printed by content experts and course teachers. A 30-question, 1-h examination was produced after exhaustive item writing and revision by teachers of the course. Reliability, difficulty index and discrimination were calculated and examination results were analyzed using SPSS software.

Results: Twenty-nine students sat the 1-h examination. All students passed (scores above 67% - in accordance with University criteria). Twenty-three (77%) questions were found to be easy, 4 (14%) of moderate difficulty, and 3 (9%) difficult (using examinations department difficulty index calculations). Eight question (27%) were considered discriminatory and 20 (67%) were non-discriminatory according to examinations department calculations and criteria. The reliability score was 0.27.

Discussion: Our experience shows that there may be a role for single-best-option (SBO) MCQ assessment in global health education. MCQs may be written that cover the majority of the curriculum. Aspects of the curriculum may be better addressed by non-SBO format MCQs. MCQ assessment might usefully complement other forms
INTRODUCTION

Multiple Choice Questions (MCQs) are the most commonly used tool for assessment in medical education (1, 2). While other tools including short answer questions, long answer questions, oral examinations, and written reports also have an important role in assessment, the vast majority of summative examinations a medical student takes are based on MCQs (1, 3, 4). The popularity of MCQs rests on the ease of testing a breadth of knowledge, standard setting and production of statistical data necessary for quality control of institutional question banks (4–6). Common criticisms of standard MCQs include their failure to engage higher order thinking, test attitude, behaviors or the application of clinical skills, and their failure to take into account gender and cultural biases in question response. Thus, standard MCQs are not generally associated with transformational learning (4, 5, 7). There are, however, a multitude of MCQ styles that may, to varying degrees, test knowledge, skills, attitudes, judgement and even behavior, especially when questions are context-based.

Examples of MCQ style are given in Table 1 below which summarizes the features of each type of question: single best option (SBO); true/false statements; extended matching; situational judgement; and, script concordance questions (8–11). For the most part, SBO style MCQs are used to assess the biomedical curriculum. This is the case in national licensing exams such as the United States Medical Licensing Examination (12).

In comparison to the techniques used for the assessment of the basic sciences, assessment of global health learning is more problematic. While lectures and written learning resources may be rich in factual content, there is a perception among students, and perhaps even faculty, that these facts are not immediately relevant to a scientific medical curriculum, and that a grasp of global health concepts does not necessarily require a recall of facts (13, 14). Thus, many global health programs rely exclusively on reflective essays as assessment tools—focusing on cultural and anthropological exploration, and ethics and overseas medical experience, or on a project thesis that seeks to address a distinct research question in line with Master of Public Health programs (15–17). This is at odds with standard assessment of the biomedical curriculum which substantially requires the demonstration of recall and understanding of specific facts in order to demonstrate competence to practice.

While many medical schools describe their global health learning programs in detail, there is a paucity of research into what students actually learn on these courses. There is evidence that students know far less than they think they do (13, 14, 18, 19). Eichbaum (20) writes of a frenzied growth in global health education programs with poorly defined goals and objectives, describing the need for competency-based programs. Over the last 10 years there have been calls

| Topic | Examples of application to Global Health |
|-------|----------------------------------------|
| Definitions | Difference between people trafficking and people smuggling |
| International organizations | The world bank, IMF and international aid programs |
| SPHERE standards | Millennium and sustainable development goals |
| Biostatistics | Testing potable water |
| Infectious Disease | Standards in hygiene and sanitation |
| Health policy | Diseases contributing to mortality in children under the age of 5 years |
| | Trauma and burns in school children |
| | Parasite infestation and steps in eradication |
| | Universal Health Coverage |
| | AIDS pandemic |
| | Age-friendly cities |

| Question type | Components | Adjustments | Instructions |
|---------------|------------|-------------|--------------|
| Single best option | A question stem with multiple distractors | Although distractors may be plausible, there is a single best answer to the stem | Choose the single best answer |
| True or false | A statement | Each statement is either true or false | Mark whether each statement is true or false |
| Extended matching | Stem, lead in question, options, multiple distractors | The same answer may apply to multiple questions | Select one answer to each question |
| Situational judgement | Scenario, variety of responses | Each response is rated by the student | Rate the appropriateness of each response |
| Script concordance | Case, relevant diagnostic/management options and findings, options | The options assess the direction and intensity of new findings on the student's reasoning | Indicate whether the new finding has a positive or negative effect on the hypothesis |

| TABLE 2 | Topics routinely tested by MCQ assessment and their relevance in global health. |
|---------|--------------------------------------------------------------------------------|
| Topic | Examples of application to Global Health |
|-------|----------------------------------------|
| Definitions | Difference between people trafficking and people smuggling |
| International organizations | The world bank, IMF and international aid programs |
| SPHERE standards | Millennium and sustainable development goals |
| Biostatistics | Testing potable water |
| Infectious Disease | Standards in hygiene and sanitation |
| Health policy | Diseases contributing to mortality in children under the age of 5 years |
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Keywords: global health, medical education, multiple-choice questions, assessment, single-best option
for an agreement on undergraduate global health education frameworks and competencies (21–28). These competencies are similar to those developed by the Joint US/Canadian Committee on Global Health Core Competencies and those discussed in the 2008 Bellagio conference on global health education and include learning about: the global burden of disease; health implications of travel, migration and displacement; social and economic determinants of health; population resources and environment; globalization of health and health care; health care in low-resource settings; and, human rights in global health. The global health competencies of the Medical School for International Health (MSIH), Ben-Gurion University in Be’er Sheva, Israel, mirror these international standards.

Reflective essays alone cannot test the breadth of such curricula and do not reflect the broad range of global health competencies. Moreover, this style of assessment encourages students to view global health as a “soft” science, less of a priority in learning than the traditional disciplines usually covered in the biomedical curriculum, and to overestimate how much they actually know about global health (13, 14, 29).

Table 2 gives examples of factual learning outcomes in the global health curriculum. Just as the breadth of the biomedical curriculum may be assessed through a SBO MCQ, we propose that for substantial areas of the global health curriculum SBO MCQs may be a useful assessment tool. Table 3 gives examples of how these learning outcomes might be assessed using different MCQ formats.

In this research we describe the challenges and limitations of devising MCQs for the assessment of knowledge across the global health curriculum and report our experience of SBOs.

### MATERIALS AND METHODS

#### Context

The Medical School for International Health (MSIH) was founded in 1996 as a collaborative effort between the Ben-Gurion University of the Negev in Be’er Sheva, Israel, and the Columbia University Medical Center in New York. The goal of the medical school is to produce physicians who are competent international health practitioners (30, 31). Students are mainly from the USA, some are from Canada and a few from outside North America. Teaching and assessment are conducted in English.

As part of a first year global health teaching program review at MSIH we sought to assess global health learning: looking specifically to see how many of the curricular learning outcomes may be taught and learned over a two-semester global health course; and how to assess what has been learned. Changes to the course and assessment were gradual—over, at least, 14 months (spanning two taught courses). The number of guest lectures was reduced from previous iterations of the course and student involvement in local community programs and patient interaction increased on practical placements. Material from practical placements was incorporated into lectures so that, in principle, all students had exposure to the same learning objectives within the curriculum. Learning objectives from published global health competencies were mapped to the teaching curriculum. MCQs were chosen as they were already in widespread use across the biomedical curriculum. A 30-question SBO MCQ examination was designed and administered to students at the end of the course.

#### Blue Printing the Curriculum

Learning objectives within each section of the global health curriculum were defined and teaching faculty agreed on

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**TABLE 3 | Examples of global health MCQ assessment questions.**

| Example | Question | Answers | Analysis |
|---------|----------|---------|----------|
| 1. Local context-linked: public health program in Israel | You have been working with a team of Family Medicine practitioners on a program to reduce the risk of diabetes in a Bedouin community in the Negev. The program aims to educate families in a healthy diet and to measure blood sugar and weight and encourage physical exercise. After 6 months it becomes obvious that the program is failing and that there is very little interest from the community in engaging with the program. Which ONE of the following factors is most likely to be the reason for failure of the program? | A. Advising all women to cook bread with brown whole meal flour  
B. Dialogue only with Bedouin women  
C. Failure of your team to perform blood sugar and weight checks more than once in 6 months  
D. Insufficient and non-transparent funding  
E. Too many aims to achieve in the program | Analysis of examination results shows that 59% selected the correct answer, 31% option B, 7% option A and 1% option E (discrimination 0.83), none of the MSIH control group selected the correct answer, 40% selected option B, 40% option E, 12% option D and 2 option A (discrimination 0). |
| 2. Global Context linked-disaster response abroad | In the aftermath of a disaster in an agricultural village, SPHERE standards are to supply a minimum of 15 liters of water per person per day as part of the disaster response. According to SPHERE standards which ONE of the following is the most urgent initial priority in water supply? | A. Ensuring that drinking water is free of coliforms  
B. Producing sufficient water sources in order to avoid queuing for longer than 1 h  
C. Providing sufficient water for essential livestock  
D. Reducing the environmental impact of the water sources identified and used  
E. Reducing the distance of all households to the nearest water point to 5 m | Analysis of examination results shows that all of the study group answered this question correctly (discrimination 0), 64% of the MSIH control group answered correctly, 16% selected option C, 12% option B, 4% option D and 4% option D (discrimination –0.12) |
### TABLE 4 | MCQ Blueprint for global health learning objectives.

| GH Organizations (5%) | Number of Questions |
|-----------------------|---------------------|
| History               | 0–1                 |
| Current role          | 1–2                 |
| Health Systems 5%     |                     |
| Structures of healthcare systems | 1–3         |
| Application of health services management to lower and middle income countries | 1–2 |
| Concept and dimensions of health system performance | 1–2 |
| National, inter-organizational, community and patient level interventions to improve health systems | 1–4 |
| Health Economics 4%   |                     |
| Major financing methods for health care and global health efforts | 1–2 |
| Key factors in choosing the type of health care financing system | 1–2 |
| Major sources of funding in global health and how resources are allotted | 1–2 |
| Health Policy 5%      |                     |
| How health policies are made and implemented | 1–2 |
| How data on global health measures affect policy change and development | 1–3 |
| Politics 1%           |                     |
| Importance of local and international politics in the delivery and efficacy of global health and medicine | 1–2 |
| Different methods and tools that healthcare providers can utilize for political advocacy | 1–2 |
| Environmental Health 5% |                   |
| Understand how geography and climate of a region can impact human health | 1–2 |
| Understand the importance of environmental issues such as pollution, natural disasters and climate change and the impact they have on health | 1–2 |
| Cross Cultural Medicine |                 |
| Cultural Sensitivity 1% |                   |
| Role that culture plays in the practice of medicine and global health | 0–1 |
| Culturally distinct beliefs, attitudes and practices relating to health and medicine | 0–1 |
| Medical Anthropology 4% |                   |
| Practice and theory of medical anthropology and its role in global health and medicine | 2–3 |
| Vulnerable Populations |                   |
| Maternal and Child Health 4% |                 |
| Social and economic context of maternal and child health | 1–2 |
| Basic terms and definitions of indicators specific to these populations | 1–2 |
| Main causes of morbidity and mortality for mothers, neonates, infants, and children | 1–2 |
| Maternal health issues and interventions as distinct from other women’s health issues | 1–2 |
| Low-cost, effective, community-based approaches to intervention | 1–2 |
| Disasters, Displaced Persons, Refugees 4% |                 |
| Principles and laws governing international humanitarian assistance | 1–2 |
| Basic needs for human survival including water, food, sanitation and safety | 1–2 |
| Most common causes of morbidity and mortality in populations affected by conflict, disaster | 1–2 |
| Key assessment strategies and public health interventions in disaster management | 1–2 |
| Human rights legislation and enforcement | 1–3 |
| Aging Populations 4% |                     |
| Demography of global aging and its relationship to non-communicable diseases | 1–2 |
| How the expanding elderly population will influence global health in the future | 1–2 |
| Mental Health 4%      |                     |
| Epidemiology and impact of mental health issues or populations | 1–2 |
| Economic and social costs of mental illness on populations | 1–2 |
| Relationship between mental health and chronic illness | 1–2 |
| Barriers to effective treatment of mental illness | 1–2 |
| Poverty 4%            |                     |
| How poverty can affect health and how health problems can result in poverty | 1–2 |

(Continued)
TABLE 4 | Continued

| Vulnerable Populations | Number of Questions |
|------------------------|---------------------|
| How both absolute and relative poverty act as key determinants of health | 1–2 |

Primary Care Medicine

| Number of Questions |
|---------------------|
| Primary care in global health 4% |
| Define primary care and understand the way it is defined and practiced in different cultures and health systems | 1–2 |
| Understand the history of primary care and its global importance today | 1–2 |
| Recognize how countries with inadequate primary healthcare are adversely affected and how stressors are manifest on primary healthcare providers | 1–2 |
| Identify the various ways in which access to primary care can be blocked or facilitated | 1–2 |

Preventative Medicine 4%

| Number of Questions |
|---------------------|
| Identify strategies and goals of health systems to prevent illness, including education, screening, vaccination and prophylaxis | 1–2 |
| Be familiar with current trends in national and international prevention programs for infectious and chronic illness. | 1–2 |

Global Pediatrics 4%

| Number of Questions |
|---------------------|
| Understand the unique health needs of infants, children and adolescents | 1–2 |
| Be familiar with organizations and programs geared toward child health | 1–2 |
| Be familiar with global pediatric vaccination recommendations | 1–2 |

Sexual and Reproductive Health 4%

| Number of Questions |
|---------------------|
| Understand the unique health needs of infants, children and adolescents | 1–2 |
| Be familiar with organizations and programs geared toward child health | 1–2 |
| Be familiar with global pediatric vaccination recommendations | 1–2 |

Access to Essential Medicines 4%

| Number of Questions |
|---------------------|
| Understand the current definition and suggested list of essential medications as defined by the WHO and Doctors Without Borders | 1–2 |
| Be familiar with current efforts and limitations to increase global access to essential medications | 1–2 |

Global Health Ethics

| Number of Questions |
|---------------------|
| Global Health Equity 2% |
| Describe the meaning of the right to health and understand the concept of social justice | 0–1 |
| Describe the difference between equity and equality | 0–1 |
| Describe the major factors in global health disparities | 0–1 |

Equity in knowledge sharing 2%

| Number of Questions |
|---------------------|
| Understand the ethical reasoning for open source resources | 0–1 |
| Understand the concept and rationale for open-source journals | 0–1 |
| Understand the technical aspects of open-access technology including mobile data collection and medical records | 0–1 |

TABLE 5 | Statistics of administered global health examinations.

| Examination statistics from 30-question MCQ paper |
|-------------------------------------------------|
| Average | 84 |
| Median | 85 |
| Standard Deviation | 6.3 |
| Reliability | 0.27 |
| Number of questions | 30 |
| Number of students | 29 |
| Students passing (>65) | 29 |
| Excellent scores (>90) | 0 |
| Failed (<65) | 0 |
| Minimum–maximum score | 70–97 |

Difficulty of Questions

| Difficulty of Questions |
|-------------------------|
| Easy (90–100) | 20 (67%) |
| Easy (80–89) | 2 (7%) |
| Easy (70–79) | 1 (3%) |
| Moderate (60–69) | 3 (10%) |
| Moderate (50–59) | 1 (3%) |
| Difficult (40–49) | 1 (3%) |
| Difficult (30–39) | 1 (3%) |
| Difficult (<29) | 1 (3%) |

Distribution of Discrimination

| Distribution of Discrimination |
|-------------------------------|
| High (>0.35) | 3 (10%) |
| Medium (0.25–0.34) | 2 (7%) |
| Low (0.15–0.24) | 3 (10%) |
| Non-discriminating (<0.14) | 20 (67%) |
| Negative (<0) | 2 (7%) |

The weighting of topics within the curriculum in terms of MCQ assessment (Table 4). Teachers prepared learning materials (lectures and discussion topics) with these learning objectives in mind and prepared MCQs based on these objectives.

Item Writing and Testing

MCQs were written by all (four) teachers of the course who taught distinct parts of the curriculum. The SBO format was chosen over the other MCQ styles as there was only one correct answer per question, there was broader agreement on a single correct answer, and questions were deemed less susceptible to guessing. Each question focused on a single learning objective. The final 30 questions chosen out of 100 authored by all teachers of the course were agreed to represent a broad representation of the course material.

The 30 questions were chosen after exhaustive item review. Items were discussed and tested with the faculty (seven teachers from MSIH and four teachers from other faculties), independently (forty medical students in the United Kingdom and seven students in Israel at a different medical school). Criteria for agreement on the final 30 questions comprising the examination were that each question had a meaningful stem free of irrelevant detail, the stem ended with a question, negative phrasing was not used, and that distractors were clear, concise, roughly the same number of words, mutually exclusive and independent of each other. Distractors included common
misconceptions discussed in class and were plausible alternatives unless students’ precise knowledge of the topics was tested. Any questions with “all/none of the above” or non-heterogeneous distractors were omitted or rewritten. Distractors were listed in alphabetical order.

**Data Analysis**

Item analysis and exam statistics provided information about the quality of MCQs and difficulty and discrimination index. The aim was to develop questions that would principally test the recall of facts (in particular definitions, criteria and structural frameworks used in global health as in Table 2).

Reliability was based on Kuder-Richardson 21 (testing reliability of binary variables—where an answer is right or wrong when questions do not vary widely in their level of difficulty). We assumed all questions were equal in difficulty and the binary variable was a correct or incorrect answer. Difficulty-index was calculated as follows:

\[
\text{Difficulty Index} = \frac{\text{Number of students who answered correctly}}{\text{Number of students who answered}} \times 100
\]

Discrimination was computed by comparing students with the highest score to students with the lowest score.

\[
\text{Discrimination} = 2 \times \left( \frac{\text{Number of students in highest group with correct answer} - \text{number of students in lowest group with correct answer}}{\text{Total number of students in both groups}} \right)
\]

**RESULTS**

Examples of multiple-choice questions used in the 30-question examination are seen in Table 3. The MSH Examinations Department administered and analyzed student performance in the examination using their standard statistical tools and WHO guidelines. One-way ANOVA was applied to detect differences between the student scores using Statistical Product and Service Solutions (SPSS) software. This software was also used to determine discrimination, difficulty and reliability.

Table 5 shows the examination statistics for the 30-question examination. Twenty-nine students sat the 1-h examination. All students passed (scores above 67% as determined by MSHI examinations criteria). Twenty-three (77%) questions were found to be easy, 4 (14%) of moderate difficulty, and 3 (9%) difficult according to the examinations office statistical criteria. Eight questions (27%) were considered discriminatory and 20 (67%) were non-discriminatory. The reliability score was 0.27.

**DISCUSSION**

**The Role of MCQ in Global Health Assessment**

The function of assessment has been described as maximizing student competence while guiding subsequent learning. Multiple assessment methods are needed to test all aspects of competence (32). Assessment (or practice for assessment) drives learning.

Our experience indicates that identifying ‘factual’ aspects of the global health curriculum is possible and that SBO MCQs may be tailored to assess recall and application of these facts. As factual aspects are spread across the curriculum (Table 4), global health MCQs may be employed to assess learning of the breadth of the curriculum just as in the basic sciences. Particular “facts” include definitions, roles of organizations, epidemiological trends in disease prevalence and agreed global standards or health-related goals (Table 2).

We believe that introducing MCQ assessment into a global health curriculum may introduce students to the perception of global health learning as a “hard” science with knowledge and skill competencies in common with the rest of the standard biomedical curriculum. Further, we believe that self-assessment using MCQs may assist students in defining their own learning needs and identify deficiencies in knowledge and competency for practice.

In combination with other assessment modalities based on patient-focused assessment tools such as the global health case report, the MCQ may have a role to play in global health education (33–35). Indeed, MCQs may focus learning in what some students may perceive a rather nebulous and unfocused subject. According to Bloom’s taxonomy (Figure 1) MCQ-based assessment may overly emphasize the bottom two phases, “remember,” and “understand,” while neglecting higher orders of learning. Topic selection and item writing, therefore, require careful thought that encourages critical (and reflective) thinking, where possible—using diverse MCQ formats (Table 3) (4, 37–39).

**Topics Suitable for MCQ**

The suitability of SBO MCQs in assessing breadth of knowledge is relevant in global health assessment (4, 40). Few medical fields require as broad a knowledge base as global health. Topics suitable for MCQ assessment must be identified with clear learning and assessment objectives in mind. The process of defining learning objectives, blueprinting, developing the practical course and putting together a final examination to review took 14 months. We were at pains to ensure that we had taught what we planned to assess and assessed what we knew we had taught. Particular emphasis was placed on understanding why distinct definitions exist to describe vulnerable populations and the rights and entitlements these entail, for example (Table 2). While students may feel that they have a grasp of these topics, choosing only one option from a list of distractors forces the student to accept that precise knowledge and understanding of the topics is required to practice safely and access the care their patients require. Table 6 offers an example of a question that we believe tests the application of knowledge and understanding of the social determinants of health.
Item Writing and Quality Control

Writing “good” global health questions is a challenge that requires multiple contributors of questions, exhaustive criticism and review. MCQs should be based on a blueprint of the curriculum and test topics most suited to MCQ-style assessment. We emphasized context as students were encouraged to learn global health on practical placements as well as lectures (41). Our aim is to better engage students (providing real-life experience of global health problems patients experience) and make assessment relevant to future clinical practice. Epstein (6) explains that “questions with rich descriptions of the clinical context invite the more complex cognitive processes that are characteristic of clinical practice. Conversely, context-poor questions can test basic factual knowledge but not its transferability to real clinical problems.” Thus, we believe that context-based questions may place potentially abstract global health concepts in practical, realistic settings relevant to students, easier to identify, recall, and apply knowledge.

Although reliability may have been improved by increasing the number of test items in the exam, we opted for a 30-question examination so that the assessment would be completed within 1 h. We selected 30 questions that represented the breadth of the curriculum and our blueprint. A greater spread of scores with more moderately difficult questions (Difficulty Index 0.4–0.8) and discriminatory questions, would also have been preferable.

Limitations

The most obvious deficiency in this research is that the examination was run only once, and exam questions subjected to statistical analysis only once. This substantially limits any conclusion regarding reliability and validity. Clearly testing needs to be repeated. The research period (a 3-year PhD program that included the running of the global health course) precluded repeated testing. Also important is the development of other styles of MCQs to evaluate their role in the assessment of attitudes and behaviors expected of global health practitioners. We have since increased our bank of questions and written MCQs in other formats better suited to testing judgement, decision making and situational awareness. Examples are given in Table 7. Further

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**TABLE 6 | MCQ example testing understanding and application.**

| Question | Answer |
|----------|--------|
| Israel’s National Health Insurance Law came into effect in 1995. This entitles refugees, migrants and asylum seekers to emergency health care. The influence of this legislation on public health is an example of a/an __________ impacting a __________ of health inequality. | A. Downstream social determinant of health; structural determinant |
| | B. Downstream social determinant of health; intermediary determinant |
| | C. Upstream social determinant of health; structural determinant |
| | D. Upstream social determinant of health; intermediary determinant |
| | E. Upstream social determinant of health; exceptional determinant |
testing and analysis of all formats of MCQs for global health teaching and learning is planned.

**Conclusion**

Global health curricula now have internationally agreed defined competencies and learning objectives (42). As medical teaching worldwide becomes increasingly standardized, there is a need to define precise measures of assessment of student learning that may be used in combination with existing assessment tools such as reflective essays or case reports. We propose further development of MCQs in their diverse formats and testing so that we may determine, not simply their utility in testing what
has been learned, but how this knowledge may be applied in the practice of doctors who study global health.

**DATA AVAILABILITY STATEMENT**

The raw data supporting the conclusions of this article will be made available by the authors without undue reservation.

**ETHICS STATEMENT**

The studies involving human participants were reviewed and approved by Ben Gurion University IRB. The patients/participants provided their written informed consent to participate in this study.

**AUTHOR CONTRIBUTIONS**

SB designed and researched the material. SB and ND wrote the article. SB, KM, MA, and M-TF wrote the questions.

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Conflict of Interest: SB is editor-in-chief of BMJ Case Reports which publishes Global health case reports. ND is an associate editor of BMJ Case Reports.

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