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Perception of Biostatistics by Lebanese Medical Students: A Cross-Sectional Study

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ABSTRACT

Background: Inadequate use of statistics in biomedical research might not only affect science but also harm human beings if applied in medical practice. Biostatistics is fundamental to improve understanding and appraising of evidence-based medicine (EBM); yet, it is still not well understood and appreciated by medical students. Therefore, early exposure of medical students and physicians-in-training to research tools including Biostatistics is of utmost importance.

Objective: The aim of this study is to determine the perception of Biostatistics by medical students at a private medical school in Beirut, Lebanon, and to identify its best implementation time in the medical curriculum.

Methods: This is a cross-sectional study based on a self-administered questionnaire distributed among medical students in their pre-clerkship years (first three years of a 6-year program) who undertook Biostatistics. The assessment of perception was based on the 5-point Likert scale anchored by Strongly disagree = 1 and Strongly agree = 5 including 36 questions distributed into four domains to assess the course value, difficulty, behavioral, and expectations.

Results: 186 of 269 students responded to the questionnaire, yielding a response rate of 69.14%. Around 60% of students declared that the knowledge gained from biostatistics courses is useful to their future career, and almost 70% understood the main concepts of biostatistics. 57.7% of students perceived that lack of practicing exercises might contribute to making the course more difficult. The mean score of domains was higher in females but did not significantly differ within the three academic years. Only 35.1% of the students positively perceived the importance of biostatistics modules, mostly third-year students.

Conclusion: Although the majority of medical students perceived biostatistics modules negatively, they were aware of the relevance of biostatistics to their medical career and real-life health issues.

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KEYWORDS

Biostatistics; medical students; perception

1. BACKGROUND

Medical knowledge has witnessed enormous advances due to healthcare technology revolution, leading to increasing controversies, extensive bias, and diversity of medical information [1]. As such, physicians must seek the best evidence in order to make decision about their patients' care, and this is indeed best accomplished by evidence-based medicine (EBM). Thus, EBM has become essential for reducing information complexity and diversity [2].

In medicine, decision making includes interpreting clinical evidence, comparing results, and linking patient information to medical literature in order to achieve the best quality of patient care. Henceforth, early exposure of medical students and physicians-in-training to research tools including Biostatistics is of utmost importance [3]. Physicians' understanding of basic biostatistics knowledge is necessary not only to be able to critically appraise literature and identify the

flow in the information, but also to judge the authenticity of the literature and to reduce diagnostic errors [4–7]. Unfortunately, despite curricular integration of EBM, studies have demonstrated that clerkship-level medical students were only able to execute half of the steps of EBM with difficulties especially pertaining to critical appraisal [8,9].

Inadequate use of statistics in biomedical research and its subsequent false results can lead to serious consequences that might not only affect science but also harm human beings [10,11]. This is why learning biostatistics is crucial early in the educational journey [9]. It has been postulated that graduates should be able to “integrate and critically evaluate scientific evidence” and “analyze and use numerical data” [12]. In reality, clinicians and medical students show unsatisfactory knowledge in Biostatistics and poor ability to apply its concepts in medical research [13]. This leads to

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difficulty in understanding the statistics of published articles and medical guidelines and reduce their ability to critically appraised literature [10,14]. In a study by Gore *et al.*, results showed that only 2.9% of participants – including faculty members and final year postgraduates – gave the correct meaning of p -value and more than three quarters of participants asked for help of a biostatistician to present their data [15].

It is assumed that appropriate teaching approaches are essential to help medical students understand and make the best out of the delivered information. Biostatistics, as a part of an updated medical curricula, becomes useless with the absence of a proper curricular design to deliver it. Biostatistics modules are indeed challenging as they need to be taught using unique learning methods and they require different style of thinking. The teaching modality, content, and timing of this module vary widely among medical schools worldwide [16]. Most schools in the United States, for example, teach biostatistics during first or second years. At Mayo Clinic's School of Medicine, biostatistics is taught during the third year as part of two courses: Research and Public Health [17,18]. However, in John Hopkin's School of Medicine, it is taught in the first medical year [19]. In the Imperial College London, where medical school program is 6 years long, biostatistics is given as part of "Clinical Research and Innovation" course in the second year and includes statistics, critical appraisal, and data analysis [19]. Similarly, in South Africa, Biostatistics is taught in the first and the second years with further reinforcement practiced in years 3 and 4 [13].

Despite being important for their future careers, biostatistics modules are still perceived negatively by medical students [17–22]. Nonetheless, perception of biostatistics has developed greatly overtime, where students nowadays are at least aware of the importance of biostatistics in medical practice [21,23,24], which was not viewed back in mid-eighties.

After remodeling the research curriculum in 2015 at our universities, it was decided to divide the research project module topic among the first three years of pre-clerkship, and give Biostatistics topics among this module during the second, fourth, and sixth semester of medical school simultaneously in order to implement it later in the second semester. The amended research project module now involves an epidemiological and translational research project that starts in the third semester and extends over to the sixth semester ending with a manuscript.

In our study, we aimed at assessing the perception of Biostatistics by Lebanese medical students who are in their pre-clerkship phase of medical education and

to identify the best implementation time among the first three years of education.

2. METHODS

2.1. Study design

This is a cross-sectional study conducted at Beirut Arab University based on a self-administrated survey. The Faculty of Medicine adopts a six-years module-based program on a scholar-year basis. Previously, biostatistics topics used to be given by the end of the pre-clerkship phase of medical education (specifically in the sixth semester of a 12-semesters medical curriculum) and included: types of data and data collection, numerical and graphical presentation of data, measurement of dispersion, normal distribution curve and correlation, and data analysis.

2.2. Study participants

The response rate in our study was 69.14% with 186 students out of 269 responding.

Students were invited to participate in the study at the end of their Biostatistics teaching in each year, and 186 were enrolled as follows: 61 students from the first year (32.8%), 66 from the second year (35.5%), and 59 from the third year (31.7%). Students who had been previously exposed to Biostatistics courses or had a scientific educational background including mathematics or related topics were excluded.

2.3. Instruments and procedure

A previously constructed and validated survey was adjusted and used in our study [23]. The survey included 36 questions allocated to four domains namely: (A) course value, (B) difficulties, (C) behavioral, and (D) expectations. The course value domain targeted the usefulness and worthiness of the material included in the biostatistics module. The difficulties domain tackled the difficulties that students faced and the factors that might have influenced their interest in the subject. The behavior domain encompassed the perception of the student to the lecturer's behavior toward them. The expectation domain took into consideration some actions that might have influenced the material outcome. A Likert scale (5 points) anchored by Strongly disagree = 1 and Strongly agree = 5 was used to evaluate the perception of the medical students.

2.4. Statistical analysis

Data were entered and analyzed using IBM SPSS Statistics for Windows, version 22.0 (Armonk, NY, USA). Response to questions and perception were

described in frequencies and percentages, while scores were described in terms of means and standard deviation. Chi square test was used for comparing qualitative data. The scores were obtained by adding the response to all questions in each domain separately and for all domains collectively according to Likert-scale. One-way ANOVA test (+LSD: Least significant difference) was used to pairwise comparison between every two groups, whereas independent student's *t*-test was used to compare among gender. *p*-value of less than 0.05 was considered significant.

In order to categorize the scores as positive or negative perception, a formula was followed such that the domain score of each individual student was considered indicating a positive perception if it was above 70% of the maximum possible score [23]. The formula used was: domain score = number of domain variables \times 5; and domain cutoff = domain score \times 0.7. For example, if domain A included nine variables, the maximum score expected will be 45 (9×5) and the cutoff will be 31.5 ($9 \times 5 \times 0.7$). Any score above 31.5 was considered an indicator of positive perception. Likert-scale scoring was reversed in domains B and D, where strongly disagree = 5 and strongly agree = 1 since, unlike other domains, a "strongly disagree" to a question about difficulties indicates positive perception of the course and should result in a higher score.

3. RESULTS

The response rate in our study was 69.14% with 186 students out of 269 responding. Participants were distributed as 61, 66, and 59 students from the first, second, and third academic years, respectively. Regarding the gender, 56.1% of students were females and 43.9% were males.

Regarding the course value domain, 59.1% of students declared that the knowledge and experience they gained are useful to their future career as doctors, 71.7% understood the main concepts of biostatistics and 52.8% felt that they gained skills in designing a research paper (Table 1). Regarding difficulties domain, 57.7% of students thought that lack of practicing exercise in Biostatistics rendered it more difficult and only 29.5% found biostatistics lectures not interesting. Besides, 34.1% of students could not relate biostatistics to medicine at their current level (Table 1). With respect to the behavioral domain, 82.6% of students pointed up the lecturer as the only source of knowledge. Concerning the expectations domain, 47.8% of students declared that carrying out a quiz prior to the progress test is important to evaluate their understanding of the subject, whereas 50.3% disagreed about establishing a separate biostatistics-epidemiology module. Moreover, 61.6% of students asked for more time for the whole course, noticing an agreement among the three years (Table 1).

The main difference in the students' responses according to their academic year was in the difficulties' domain and, to a lesser extent, in the behavioral and expectations domains. A significant difference was observed among students when asked about their perception regarding dealing with numbers and the lectures (Table 2). Third-year students found that Biostatistics is more about dealing with numbers and that lectures were not interesting and intensive (Table 2). Moreover, they were the least interested in Biostatistics in comparison with first-year students who are the most interested in biostatistics lectures (Table 2). Third-year students also significantly disagree that their works and efforts are acknowledged and requested to have more practical session significantly more than first- and second-year students. However, first-year students had to study at home significantly more comparing to others (Table 2).

When comparing the mean scores of the different domains with students responses across academic years, the course value and the behavioral domain were comparably perceived by students with no significant difference; however, difficulties and expectations domains showed significant differences with the lowest perceived difficulties and highest expectations being scored by students in third year (Table 3). Gender was significantly associated only with course value domain, where it was perceived positively by females more than males (Table 3). In general, the total mean score of domains was not significantly associated with academic years but with gender where females scored higher than males (Table 3).

Regarding Biostatistics perception, only 35.1% of students across academic years had positive perception of Biostatistics, with third-year students perceiving Biostatistics significantly more positively than the others. This is mainly reflected in the expectation of students toward biostatistics. Alternatively, 56.3% and 77% of students positively perceived the course value and the behavior of the lecturer, respectively; however, only 15.7% found Biostatistics not difficult with no significant difference across the academic years (Table 4).

4. DISCUSSION

The importance of biostatistics is acknowledged in different medical schools curricula in both developed and developing countries [25]. However, certain variability exists from school to school regarding the allocated time, scope, and depth of topics covered.

In this study, the perception of medical students regarding Biostatistics is assessed and compared among the first three academic years of a 6-year medical curriculum. Contrary to previous studies that showed an overall positive perception [22,23,25], more than half of the students in this study had

Table 1. General Response of participants by domains questions. n and % represent the number and the percentage of participant respectively.

| Question (n) | Strongly disagree/ Disagree n (%) | Neutral n (%) | Strongly agree/ Agree n (%) |
|--|---|------------------|-----------------------------------|
| Domain A: Course Value | | | |
| 1. The course focuses on the concept of interpretation more than calculation (185) | 12 (6.5) | 40 (21.6) | 133 (71.9) |
| 2. The gained knowledge and experience is useful to my career as a doctor (186) | 29 (15.6) | 47 (25.3) | 110 (59.1) |
| 3. Sequence of topics was logical (186) | 13 (7) | 34 (18.3) | 139 (74.7) |
| 4. I understood the main concepts of Statistics (180) | 12 (6.7) | 39 (21.7) | 129 (71.7) |
| 5. I realized the relevance of biostatistics to the real health issues (179) | 28 (15.6) | 46 (25.7) | 105 (58.7) |
| 6. I gained confidence in my ability to do basic statistical studies (180) | 35 (19.4) | 75 (41.7) | 70 (38.9) |
| 7. My skills improved in solving problems (178) | 29 (16.3) | 79 (44.4) | 70 (39.4) |
| 8. I gained skills to read scientific papers (180) | 26 (14.4) | 43 (23.9) | 111 (61.6) |
| 9. I gained skills to design research (180) | 33 (18.3) | 52 (28.9) | 95 (52.8) |
| Domain B: Difficulties | | | |
| 1. I have to deal with numbers (186) | 63 (33.8) | 52 (28) | 71 (38.2) |
| 2. Subjects need creative thinking (185) | 80 (43.2) | 52 (28.1) | 53 (28.3) |
| 3. Lack of practicing exercise for these topics (182) | 39 (21.4) | 38 (20.9) | 105 (57.7) |
| 4. I like clinical studies more than biostatistics (186) | 13 (7) | 33 (17.7) | 140 (75.2) |
| 5. Lectures were not interesting (183) | 71 (38.8) | 58 (31.7) | 54 (29.5) |
| 6. Lectures were lengthy (185) | 37 (20) | 51 (27.6) | 97 (52.4) |
| 7. Lectures were difficult to understand (184) | 84 (45.7) | 62 (33.7) | 38 (20.6) |
| 8. Too many lectures for one day (182) | 72 (39.5) | 52 (28.6) | 58 (31.8) |
| 9. There were no specific references (183) | 41 (22.4) | 46 (25.1) | 96 (52.4) |
| 10. I could not see the relation between biostatistics and medicine at this level (185) | 78 (42.2) | 44 (23.8) | 63 (34.1) |
| 11. Simply I am not interested in the subject (181) | 70 (38.7) | 56 (30.9) | 55 (30.4) |
| Domain C: Behavioral | | | |
| 1. I was treated with respect (186) | 8 (4.9) | 32 (27.9) | 146 (67.2) |
| 2. Works and efforts were acknowledged (185) | 9 (4.9) | 55 (29.7) | 121 (65.4) |
| 3. Lecturer is the source of knowledge (184) | 3 (1.6) | 29 (15.8) | 152 (82.6) |
| 4. Lecturer is the facilitator of instruction and guiding students (185) | 3 (1.6) | 27 (14.6) | 155 (83.8) |
| 5. It is the responsibility of student to initiate debate/question during lectures (182) | 41 (22.5) | 78 (42.9) | 63 (34.6) |
| Domain D: Expectations | | | |
| 1. Give more time for the whole course (182) | 32 (17.6) | 36 (19.8) | 114 (61.6) |
| 2. The lecture should be followed by small group session (181) | 69 (38.2) | 35 (19.3) | 77 (42.6) |
| 3. Carry out short exam (quiz) before the progress test to evaluate the understanding of the student (182) | 53 (29.1) | 42 (23.1) | 87 (47.8) |
| 4. Need More practical, workshop for planning and data collection to have real experience in dealing with data (179) | 9 (5) | 31 (17.3) | 139 (77.7) |
| 5. Attendance to be strictly taken during the computer lab session (179) | 48 (26.8) | 58 (32.4) | 73 (40.8) |
| 6. Make the module pure for biostatistics and epidemiology, so the attention will not be withdrawn to other subjects (179) | 90 (50.3) | 32 (17.9) | 57 (31.8) |
| 7. Emphasize on using biostatistics in elective courses (180) | 44 (24.4) | 57 (31.7) | 79 (43.9) |
| 8. Provide specific textbooks for biostatistics (180) | 36 (20) | 40 (22.2) | 104 (57.8) |
| 9. I have to study at home before class meetings (180) | 50 (27.8) | 65 (36.1) | 65 (36.1) |

Table 2. Questions showed significant difference in responses between students in different academic years. Chi square was used to compare between groups. $p < 0.05$ is considered significant and marked with a star (*).

| Domain | Questions | Academic Years | Strongly Disagree/ Disagree | Neutral | Agree/ Strongly Agree | p-value |
|---|---|----------------|-----------------------------|-----------|-----------------------|---------------|
| B | I have to deal with numbers | 1 | 31 (43.7) | 11 (21.2) | 19 (30.2) | 0.01* |
| | | 2 | 26 (36.6) | 22 (42.3) | 18 (28.6) | |
| | | 3 | 14 (19.7) | 19 (36.5) | 26 (41.3) | |
| | Lectures were not interesting | 1 | 26 (48.1) | 18 (31) | 15 (21.1) | 0.03* |
| | | 2 | 15 (27.8) | 22 (37.9) | 29 (4.8) | |
| | | 3 | 13 (24.1) | 18 (31) | 27 (38) | |
| | Too many lectures for one day | 1 | 18 (31) | 25 (48.1) | 18 (25) | 0.006* |
| | | 2 | 28 (48.3) | 11 (21.2) | 25 (34.7) | |
| | | 3 | 12 (20.7) | 16 (30.8) | 29 (40.3) | |
| Simply I am not interested in the subject | 1 | 25 (45.5) | 20 (35.7) | 15 (21.4) | 0.01* | |
| | 2 | 16 (29.1) | 23 (41.1) | 24 (34.3) | | |
| | 3 | 14 (25.5) | 13 (23.2) | 31 (44.3) | | |
| C | Works and effort are acknowledged | 1 | 1 (11.1) | 30 (54.5) | 30 (24.8) | 0.002* |
| | | 2 | 4 (44.4) | 14 (25.5) | 47 (38.8) | |
| | | 3 | 4 (44.4) | 11 (20) | 44 (36.4) | |
| D | Need more practical, workshop for planning and data collection to have real experience in dealing with data | 1 | 2 (22) | 18 (58.1) | 39 (28.1) | 0.006* |
| | | 2 | 5 (55.6) | 10 (32.3) | 49 (35.3) | |
| | | 3 | 2 (22.2) | 3 (9.7) | 51 (36.7) | |
| | I have to study at home before class meetings | 1 | 8 (22.2) | 8 (20) | 44 (42.3) | 0.001* |
| | | 2 | 21 (58.3) | 12 (30) | 31 (29.8) | |
| | | 3 | 7 (19.4) | 20 (50) | 29 (27.9) | |

Table 3. Mean Difference in responses between students. SD represents the standard deviation of the sample. $p < 0.05$ is considered significant and marked with a star (*).

| Characteristic | Domains (mean \pm SD) | | | | Total score (mean \pm SD) |
|----------------------|-------------------------|-------------------------|-------------------------|-------------------------|-----------------------------|
| | Domain A | Domain B | Domain C | Domain D | |
| Academic Year | | | | | |
| 1 | 31.5 \pm 5.3 (N = 59) | 28.9 \pm 6.5 (N = 56) | 19 \pm 2.7 (N = 57) | 29.9 \pm 4.5 (N = 56) | 109.8 \pm 12.7 (N = 48) |
| 2 | 32.1 \pm 5.6 (N = 62) | 30.8 \pm 8.6 (N = 56) | 19.2 \pm 2.1 (N = 62) | 27.4 \pm 5.1 (N = 64) | 110.3 \pm 15.7 (N = 52) |
| 3 | 32.6 \pm 4.6 (N = 55) | 33 \pm 6.3 (N = 54) | 19.5 \pm 3 (N = 58) | 31.3 \pm 4.2 (N = 55) | 116 \pm 13 (N = 48) |
| p-value | 0.53 | 0.01* | 0.57 | 0.00* | 0.053 |
| Gender | | | | | |
| Male | 31.3 \pm 5.2 (N = 63) | 30.2 \pm 7 (N = 63) | 18.8 \pm 2.6 (N = 68) | 29.8 \pm 4.9 (N = 64) | 109.5 \pm 13.7 (N = 57) |
| Female | 33 \pm 5 (N = 85) | 32.2 \pm 7.6 (N = 78) | 19.6 \pm 2.5 (N = 84) | 29.2 \pm 5.1 (N = 84) | 114.9 \pm 14 (N = 69) |
| p value | 0.04* | 0.1 | 0.08 | 0.47 | 0.03* |

a negative perception toward Biostatistics which can be attributed to the fact that students in their first three medical years might be more oriented toward basic medical sciences courses such as anatomy, pathology, physiology, and pharmacology. A study published in 2007 concluded that it is common for medical students to dislike and underperform in courses involving mathematics, numeracy, or statistics [26]. Moreover, biostatistics was delivered as lecture series which neither engages the students nor meets their needs and this is reflected in their responses where more than 50% found that lectures were lengthy and emphasize on the absence of practical sessions.

Regardless of the negative perception, more than half of students positively perceived the course value. This may be ascribed to the fact that the course was focused, and the topics were instantly related to real health issues and delivered by medical doctors specialized in epidemiology and biostatistics, which was reflected in the students' agreement with the behavior of the lecturer. Such results defy the viewpoint that the relevance of Biostatistics in real health issues is only appreciated by medical practitioners [27–29]. Similarly, in Pakistan and in Croatia, studies showed that most students surveyed had a positive attitude toward the relevance of Biostatistics to the

Table 4. Positive perception of students regarding biostatistics. Independent student's *t*-test is used to compare the mean between groups. $p < 0.05$ is considered significant and marked with a star (*).

| Academic Year | Positive perception N (%) | | | | |
|-----------------------|---------------------------|-----------|------------|---------------|--------------|
| | Domain A | Domain B | Domain C | Domain D | All Domains |
| 1 | 30 (50.8) | 4 (7.1) | 43 (75.4) | 20 (35.7) | 10 (20.8) |
| 2 | 35 (56.5) | 12 (21.4) | 53 (82.2) | 13 (20.3) | 19 (36.5) |
| 3 | 34 (61.8) | 10 (18.5) | 43 (74.1) | 24 (43.6) | 23 (47.9) |
| All years | 99 (56.3) | 26 (15.7) | 139 (77.7) | 57 (32.6) | 52 (35.1) |
| <i>p</i>-value | 0.498 | 0.09 | 0.459 | 0.021* | 0.02* |

medical curriculum 28, 29]. A meta-analysis study also concluded that students were aware of the importance of statistics to their future careers, but apprehensive about learning it [22]. When comparing the different academic years in our study, students of the third year had the highest percentage of positive answers regarding the course value compared to other years which further anchors the point that biostatistics is a subject best perceived when coupled with clinical examples and searching the literature.

Regarding the difficulties of Biostatistics, students realized that the main point of Biostatistics is the interpretation of the calculated results and thus it is not about mere numbers. Half of the students of the first-year perceived dealing with numbers as a problem, while such problem was not obvious in students of the second and third years. This may be because the course was observed from a mathematical orientation with much theory and formulae with no obvious correlation; however, senior students focus less on the numerical and mathematical aspects of Biostatistics and thus they are more inclined to view Biostatistics as a tool for reviewing the literature and understanding research.

Most students across years perceived that the lectures or information provided by the lecturer were the main source of information. This may be due to the absence of textbooks that deliver Biostatistics in an easy and understandable way and the shortage of time to prepare for biostatistics. Biostatistics lectures were condensed and given as a subject in modules, rather than being given as a core biostatistics module on its own. Therefore, students had to deal with the limited time given to Biostatistics sessions which may have prevented them from searching for further information. This point was further emphasized upon as many students stated a longer biostatistics course was needed.

Moreover, students conceded that the Biostatistics delivery method must emphasize more on practical approaches. Delivering Biostatistics through small group discussions that focus on critical appraisal and problem solving may have shifted the learning process toward student-based approach and provided, at least,

part of the necessary practical skills the students asked for.

While comparing the mean score and the perception of students, although no significant differences were observed in the mean of total score between academic years, students in the third-year perceived Biostatistics as being less difficult and had higher expectation than the first-year students. In addition, third-year students had more positive perception when compared with the first years. However, no significant difference was observed between second- and third-year students.

As mentioned previously, Biostatistics is considered essential to enhance undergraduates' medical education. Second-year students are more incorporated in the field of medicine than first-year students, and hence they can link biostatistics to medicine. Nevertheless, implementing the course in the third year might be too late since students usually necessitate judging and appraising of scientific publications earlier in their pre-clerkship phase.

4.1. Limitations

Some limitations can be pointed in this study. Importantly, biostatistics topics were given throughout different modules in each medical year. This could have affected the perception of students toward Biostatistics taking into consideration the difficulty and content of each module. Also, no open comments were provided which may have limited students' complaints or solutions. However, this is the first study to assess the perception of medical students to Biostatistics across three academic medical years, and more importantly it discusses when such material should be implemented in the six-year medical curriculum.

4.2. Conclusion

In this study, although most medical students perceived Biostatistics negatively, they were aware enough of the relevance of this subject to their medical career and real-life health issues. The main difficulties encountered were lack of practical applications and specific reference textbooks that may have affected their comprehension of the material, imparting a negative perception among most of them. Biostatistics was much more difficult for students of the first year in comparison to their peers in the second and third year. This study suggests implementing biostatistics later in the pre-clerkship phase and points out the necessity of including variety of delivery methods such as flipped classes and practical sessions.

Disclosure statement

The authors declare no conflict of interest or financial interests.

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