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AEROSPACE MEDICINE: FUTURE DOCTORS IN A NEW SPACE ERA

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Abstract

Currently there is a growing interest in Aerospace Medicine, a field focused on the physiology of the human body in outer-atmosphere and space environments. What interest exists in the specialty and whether medical students are capable of approaching common challenges in this area remains to be seen. A multiple-choice test along with a survey was structured and distributed to TSMU medical students. Year 1 and Year 2-6 students' scores were compiled and compared. Data collected from results revealed there is surprisingly great interest in Aerospace Medicine in the medical student community, as well as the lack of statistical significance between experienced students' performance and understanding of first-year students. Though the study confirms the existence of an interest in Aerospace Medicine, the lack of statistical significance when comparing students is most likely due to inadequate data and the ineffectiveness of the test.

Introduction

Aerospace medicine is a field focused on the health and physiology of humans in high altitudes and space, as well as how to overcome the challenges the human body tolerates while traversing these environments. Today there is a growing interest in this specialty, especially for space flight [1-3], as many are claiming the modern world is entering a 'new Space era' [4].

The possible future of a renewed space flight era is approaching at an alarming rate, garnering much interest from the scientific community as well as the international populace. Despite robust certification processes and medical guidelines [5,6], the ability and opportunity to fly suborbital is possible within the next decade [4]. In the following years, high-altitude flights and space travel will become more readily available to the general public. This will change the identity of the average patient subjected to the numerous consequences of high and outer atmosphere traversal- that of a fit individual, usually male and military, to patients with preexisting medical conditions and varying overall health [7,8]. Individualized preventive measures and treatment plans will need to be considered for each traveler. In order to ensure the well-being of individuals in this rising tide, collaboration and communication between medical personnel and aerospace specialists are warranted with a focus on teaching future generations [4].

The opportunities for medical students to receive exposure and an increased understanding of Aerospace Medicine are rare. What training does exist is limited to areas where such programs are offered as part of an elective or clerkship, therefore the true level of interest and clinical knowledge in medical institutions remains to be seen. Through gauging modern medical curricula's ability to train as well as identify future doctors and researchers skilled in the field of Aerospace medicine, one can better distinguish the state of ongoing educational programs and anticipate areas of improvement.

Though many researchers have explored the implementation of electives and programs amongst students, most medical students have yet to encounter the challenges faced in Aerospace Medicine or recognize it as a field of study [7]. Medical students, current healthcare professionals, and fellow researchers are often a subject in research projects because of their involvement in the community. The novelty of this experiment is based on its area of study during the time of newfound interest in spaceflight.

The purpose of this study was to observe how syllabi and modules in medical education are preparing students for such an esoteric specialty. Also, this study investigated the students' current level of interest in Aerospace Medicine and determined what factors influenced their opinions. Subsequently, the purpose of this study is twofold. Namely, are medical students capable of approaching common challenges familiar to Aerospace Medicine, and what level of interest exists for it presently amongst the medical student bodies.

In lieu of the former, evaluating how present-day medical curriculums are preparing medical students is always invaluable. The rigorous demands and challenges of the medical field are often scrutinized and analyzed in order to identify possible areas of correction, clarification, and/or

investigation. Though not alone, Aerospace Medicine is one of these highly specialized, uncommon fields and its complexity is only becoming more formidable from the constant updating of contemporary discovery and research. Awareness of the domain is likely to be heightened from greater attention and scrutiny as civilians take part in higher-altitude and spaceflight traversal, however enigmatic it may presently be. As such, discerning the true level of scientific knowledge amongst existing students could be enlightening. This can be achieved through a common standardized assessment to determine knowledge by presenting questions, scenarios, and/or cases in a logical and clinical manner. Students of various career paths are more than familiar with this type of examination as they often promote critical thinking and problem-solving skills. Utilizing the objective and targeted data from the study can then establish how thoroughly prepared potential candidates are from their studies and extrapolate if adaptation of these programs is necessary.

At the same time, the opinions and thoughts of a rising generation are integral in interpreting what interest already exists in the student bodies of medical universities. Several articles have hypothesized the potential effects of adapting qualifications for aerospace travelers, its impact, and the difficulties of Aerospace Medicine faced by experts and laymen. However, our investigation was unable to locate the prevalence of curiosity amongst the medical community. Each student understandably has a disparate background, perspective, outlook, and goals. Though subjective, distinguishing what motivates and drives a person can piece together observable patterns and trends. By collecting individual responses through a structured survey, this data will provide information about what kind of enthusiasm and passion for Aerospace Medicine exists and demonstrate a future in which the world and space travel communities would benefit.

This study hypothesizes that when presented with simulated cases and questions pertinent to Aerospace Medicine through a standardized test, students will be found insufficiently prepared by current medical school curricula. This study also hypothesizes that there is ample interest in Aerospace Medicine amongst the medical student community. If our hypothesis is correct, these findings will prove that enhancing current medical university education is paramount if indeed there is a future demand of clinicians and researchers for Aerospace Medicine.

Methods

This project relied on constructing scientific and clinical-based scenarios in order to assay a student's prior knowledge, problem-solving, and critical thinking in the sphere of Aerospace Medicine. Therefore, a thorough approach to the multidisciplinary aspects of Aerospace Medicine was necessary in order to identify key basics with which to test the student's knowledge. These may include an awareness of the challenges of high and outer atmosphere traversal, the physiological effects of gravity on the human body, diagnostic approaches to the common pathologies, modern management plans in isolated environments, and the real documentation of appropriate cases. These questions are the main device by which this study's objective data was collected, requiring each of the problems to be realistic enough to warrant scientific consideration or clinical approach while also being framed in a multiple-choice format familiar to students. Ergo, the goal is to present an applicable case to engage the subject and evaluate knowledge and understanding of the material. Constructed cases were to also vary from the sciences of human physiology, correct diagnosis of an ailing patient's condition, as well as correct 'next step' approaches for the treatment of the patient.

In order to fulfill this aspiration, questions were based on published medical journals and academia pertaining to Aerospace Medicine. Despite the abstruse nature of the field, a surprisingly great number of articles were found which provided notable cases and thought-provoking results [9-22]. Their topics ranged from inflight emergencies while aboard an airline vessel to the myriad of genetic, immune and physiological effects of microgravity and cosmic radiation upon the human body. What's more, resources like the International Space Station's 'Integrated Medical Group (IMG) Medical Checklist' provided insightful walkthroughs for emergency situations outside Earth's atmosphere. This plethora of reports and materials were distilled and implemented to form realistic questions that could potentially be canon to the field of Aerospace Medicine. All the relevant articles, in addition to resources associated with the topic, have been included in the bibliography of this study and deserve accreditation.

As previously mentioned, the test was enriched with a questionnaire that will allow students to express their thoughts and personal opinions on Aerospace Medicine. Simple questions were easy enough to include following the test portion for this very purpose in the hopes of gathering subjective information on each subject's own insights about the research's topic. Other information (student's nationality, prior knowledge on Aerospace Medicine, chosen career paths, personal experience with the test) were also enclosed in the hopes of revealing underlying influences and similarities.

Once finalized, the finished project was distributed with permission to the International and American Programs at TSMU. A test of 15 multiple-choice questions along with a survey about the individuals' general knowledge of Aerospace Medicine was compiled and structured in a Google form. A forward prefacing of the test and survey sections was also introduced, in order to ask for consent and verify students' intentions of taking the test with honesty and integrity. The Google Form was then attached to an email inviting medical students of both programs to participate as well as announcing the objective of the study. No time limit was incorporated for completing the survey in order to promote involvement, along with respecting and honoring students' time.

During the conduction period, multiple emails were sent in the ensuing weeks leading up to the deadline to politely remind willing students of the impending completion of the research. Responses were gathered and evaluated on a Google Sheet to filter out responses where consent was withheld, dishonesty was intended, and/or otherwise was ladened with errors. Test results and answers of the survey were analyzed in order to format the data for patterns between the objective test scores and subjective data.

At the end of the study, all scores were accumulated and averaged in order to address the central aim of this study and evaluate the beginning hypothesis. This was done by first establishing the mean test scores of Year 1 students from both programs as a baseline, which was then compared to the averages of the following class Years 2 through 6 in an effort to see if there is a significant difference between both groups. If the average score of Years 2-6 was higher than that of those in Year 1 student's average score, the null hypothesis would be rejected and the study would conclude that current medical curricula are suitable in preparing medical students for a greater, future incidence of common challenges seen in Aerospace Medicine. However, if the average score of students from Years 2-6 was not statistically significant, the null hypothesis would be accepted and conclude that current medical education programs are not preparing students for a greater incidence of common challenges seen in Aerospace Medicine.

Results

A total of 138 responses were received from both the International and American Programs of TSMU, with 98 and 28 responses from each. Of those, 12 subjects were excluded from the study due to either not consenting to be included in the research or stating they would use outside resources in order to complete the test. The remaining responses of 126 stated they were from a variety of countries (**Figure 1**).

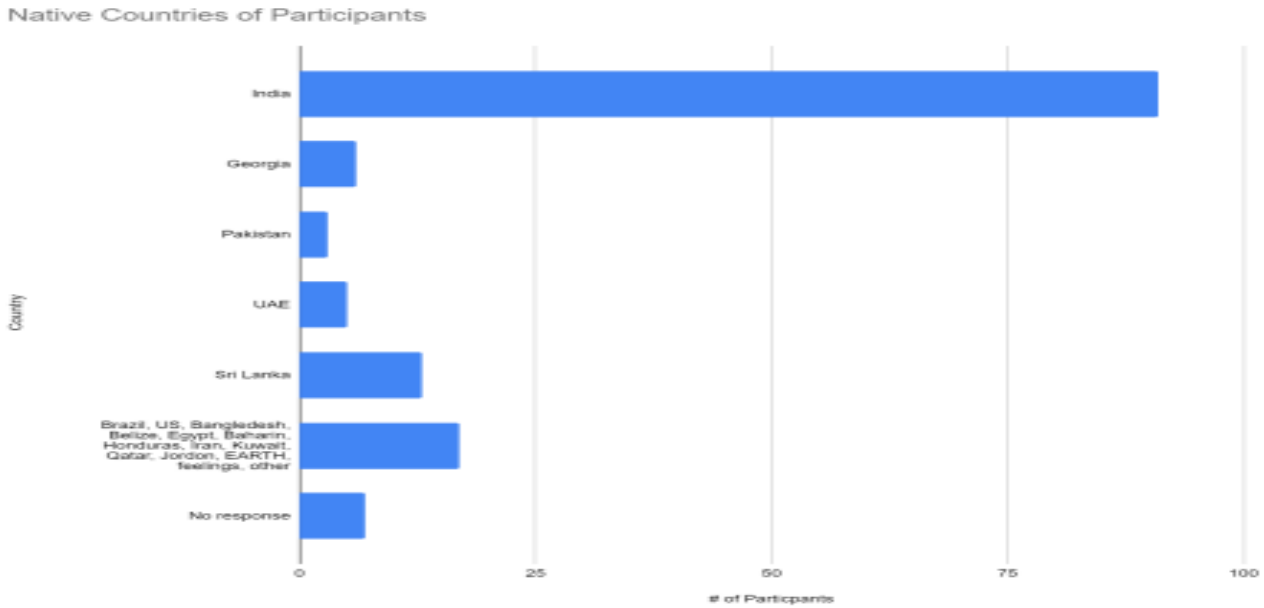

Figure 1. Native Countries of Participant

64 of these students have never heard of Aerospace Medicine before participating in this research (**Figure 2**). Despite this, 53 candidates expressed great interest in Aerospace topics (**Figure 3**), and 118 responses agreed with the statement 'We are entering a new Space era.' (**Figure 4**). Though 76 participants considered the test portion of the study to be very interesting (**Figure 5**) and 96 responses expressed they would like to learn more about the field in the future (**Figure 6**), a similar number of 69 students considered the quiz to be quite challenging (**Figure 7**).

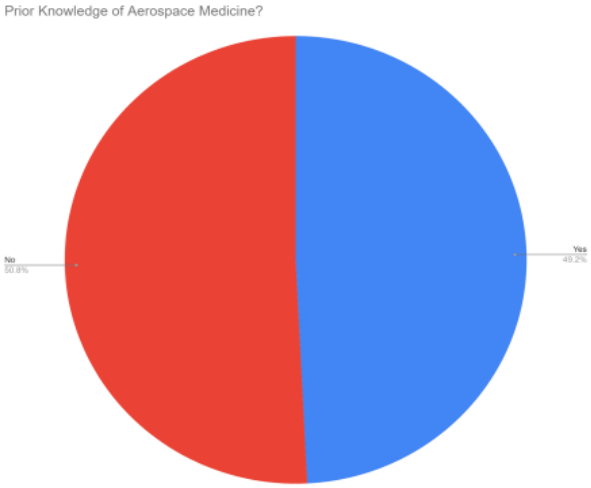

Figure 2. Prior Awareness of Aerospace Medicine.

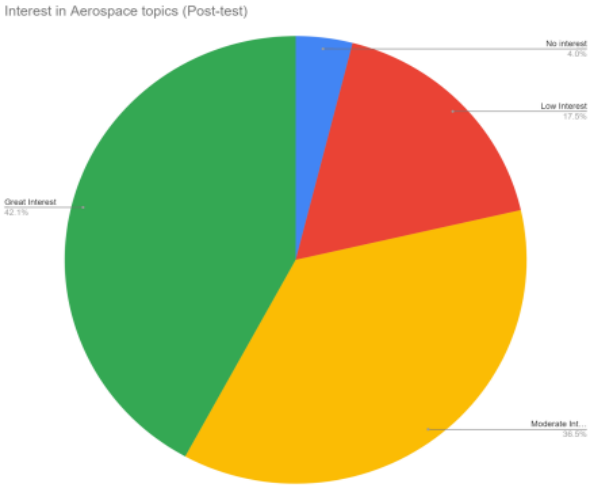

Figure 3. Interest in Aerospace topics (Post-test).

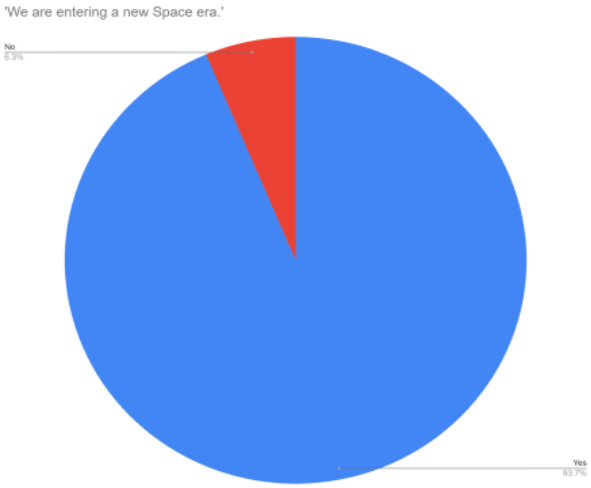

Figure 4. 'We are entering a new Space era.'

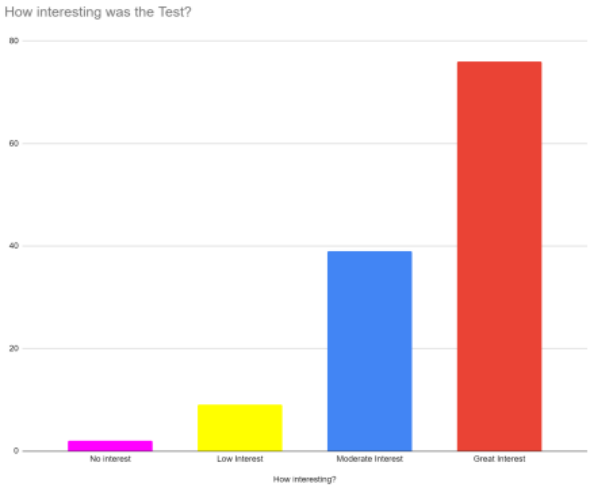

Figure 5. How interesting was the test?

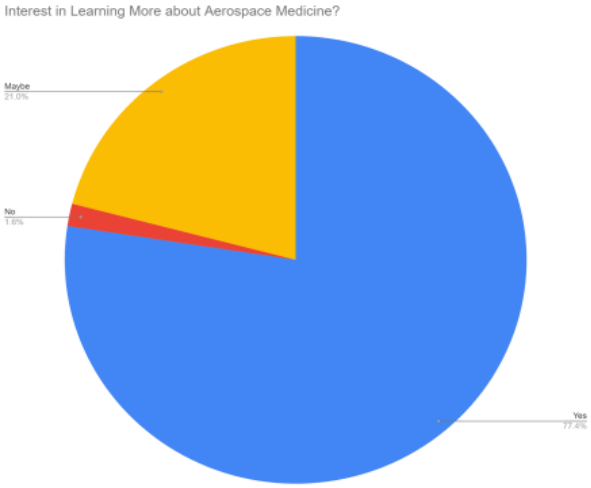

Figure 6. Interest in learning more about aerospace

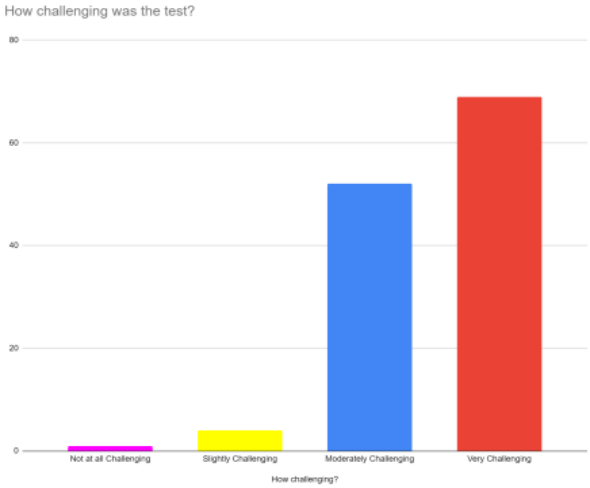

Figure 7. How challenging was the test?

medicine?

From the survey data, it can be inferred that there was a large number of students who were aware of Aerospace Medicine, were interested in topics related to the subject, and wanted to learn more about it in the future. This was greater than expected, seeing as how obscure Aerospace Medicine appears to be and how few medical professionals are involved in the field today. Also, surprising was the near-total confirmation from participants of the statement, 'We are entering a new Space era.'. This statement was coined from a 2019 article about how different regulations in the process of becoming an astronaut have eased somewhat, to the point of allowing civilians to qualify for space travel [4]. Most likely being unaware of this published article, similar influences and events would have had to impact these medical students in order for them to agree with the statement. If nothing else, this hallmark as well as the other aforementioned data provides evidence for the current existence of an interest in Aerospace Medicine amongst medical students.

From the test portion of the included 126 responses (**Figure 8**), there was an overall average score of 5.91 from all participants, a median of 6, and a range of 0-12. When separating by class year, 21 and 105 responses were from Year 1 and Years 2-6 students respectively. Year 1 student scores' mean was 5.86 (SD 2.29), while the average of the Years 2-6 students was 5.92 (SD 2.41). Using these values, a right-tailed T-score of equal variances for the study was calculated to be .454 (pooled SD 2.39), from which a p-value was derived to be 0.325. At a 95% CI, the study demonstrated a lack of statistical significance and summarily fails to reject the null hypothesis. This outcome indicates medical students are not adequately prepared by modern medical curricula for challenges in Aerospace Medicine, establishing the original hypothesis is correct with the current data and power of this study. The study's analysis ventures to conclude that improvements and adaptations will need to be integrated in order to prepare future doctors and researchers for challenges that may arise in the future.

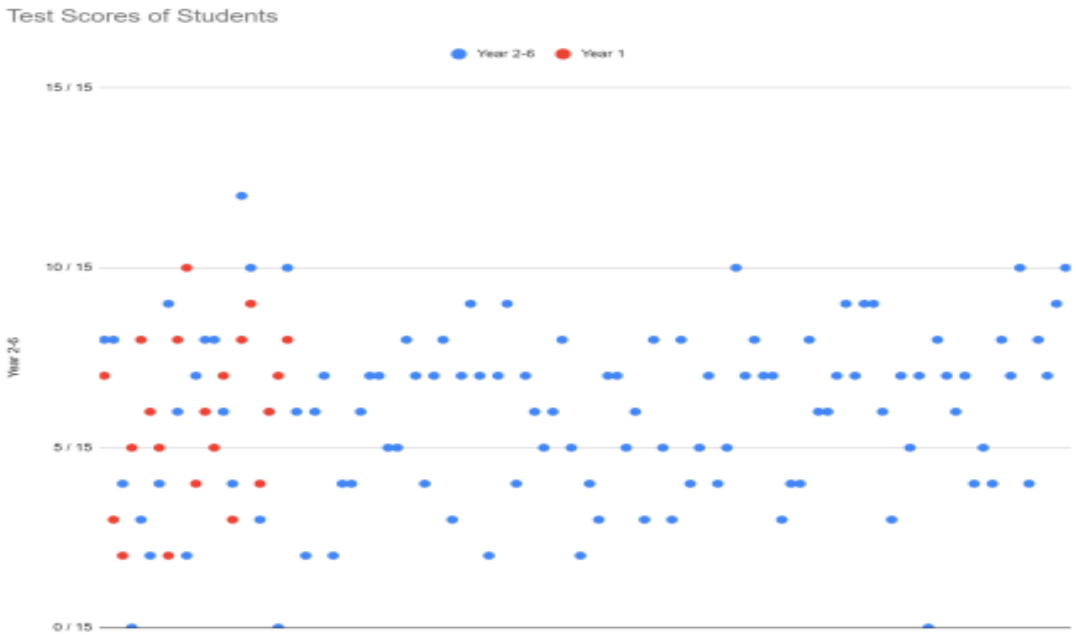

Figure 8. Test scores of students.

Discussion

According to survey results, approximately half of the participants were aware or had heard of the field of Aerospace Medicine, with a surprising percentage agreeing the world is entering a new space era. Also, 77.3% expressed interest in learning more about the subject. Further extrapolation from these results validates the theory that a more substantial number of candidates are interested in furthering their knowledge and understanding of Aerospace medicine. They are also aware of events related to aerospace which may carry over to future achievements and developments in the field. Nevertheless, the supposition from this study assumes some potential preference of causing a Pygmalion effect or observer-expectancy

bias, thereby impacting these findings. Therefore, the findings of this study acknowledge the existence of an interest in Aerospace Medicine amongst medical students and its subsequent future effects.

The test portion of this study concludes the lack of statistical significance when comparing the average scores of Year 1 students to Years 2-6 students with a 95% CI. This outcome fails to reject the null hypothesis, establishing medical students are not being prepared by modern medical curricula for challenges in Aerospace Medicine. However, due to the recognizing inherent shortcomings of this study, there is the possibility that inadequate power handicapped the true conclusion of this study. Were this power increased, the resulting data may have demonstrated a suspected different outcome from the study.

Reasons of Insufficient Power must be acknowledged. These ensuant flaws may have restricted the study's capability to reject the null hypothesis, which warrants careful consideration for future similar research: 1. There is the possibility that the number of participants was not numberable enough to produce a reliable study. Although a greater than expected number of students from both programs of TSMU were involved, 126 responses are not likely to be reflective of the rising medical community that competes globally. Furthermore, programs from only one medical school can do little to properly represent the variety of educational institutions and their unique programs' capacities in preparing medical students. For a future study, an exceedingly greater number of medical students from diverse universities around the world would increase the data, and therefore the power, in determining the results of our study. 2. The 15 questions test, which was essential in gathering informational data, is somewhat lacking in amount and quality. The final values emerged in stark proximity to each other with their individual standard deviations completely overlapping each other. Perhaps a greater number of questions could have been included, notwithstanding the complexity of Aerospace Medicine or the respect for students' time in order to advocate participation. 3. The test relied heavily on the honesty and integrity of the student to participate without searching the internet and/or confiding in a friend. Although versatile and potent as a survey, Google Form is limited when being implemented as a testing medium in that the ability to tell if the student was answering questions based on their own knowledge or through internet assistance was inconclusive. In order to mitigate this factor, preliminary questions included a direct interrogative as to a student's honorable intentions. Those who answered in the negative were excluded from the final study. However, this measure can be easily circumvented. For a future study, competent means of delivering and recording student responses while ensuring veracity will immeasurably affect performance and results.

Besides the possible insufficient power, there were also biases identified within the study. One of these was the bias of a willing subject. By announcing the research area of focus, those previously interested would be more likely to participate in the study compared to those who have never heard of it before or were otherwise uninterested. This could have conflated the results and skewed the outcome of the study. Questions were implemented to mollify this effect; however, it is a bias nonetheless and hard to avoid in consenting participants. Another was confirmation bias; the hypothesis depended on the assumption that medical universities weren't properly outfitted with the means to teach students on this material. This may have led to more difficult than necessary topics and scenarios for question creation, again misrepresenting the reality of medical education programs. To overcome this bias, the study constituted a familiar test apparatus with multiple choice answers, relying solely upon the basics and common elements of Aerospace Medicine, and allowed subjective answers for the survey. Alas, despite best efforts, there isn't the possibility of fully removing confirmation bias from the study in consideration of individual performances and the intricacy of the field.

If the present study can be considered reliable despite these flaws, there are a couple of inferences of the future to be made. As technological advancements improve and a lower threshold of qualifications allows a greater number of citizens to span upper and outer atmospheres, this will undoubtedly increase the expansion and value of the Aerospace Sciences (including engineering, physics, medicine, etc). This will increase the demand for researchers skilled in this area of medicine, predictably happening in the short term and possibly within the decade. Years later, as this situation accelerates at an exponential rate, general physicians will also need to be aware and trained to diagnose as well as manage patients' ailments commonly seen in Aerospace Medicine. Implementations will have to be considered in medical universities in order to expedite a student's education and skill, beckoning institutions to include this specialty in their curricula. If this possibility has been accentuated by this study, planning and starting

early to enhance modern education before this necessity is likely to alleviate the hassle of performing under stress and streamline the process.

In conclusion, this study confirms the existence of an interest in Aerospace Medicine amongst medical students and its future possible effects. Additionally, the conclusion demonstrates the lack of statistical significance when comparing the average scores of Year 1 students to Years 2-6 students with a 95% CI. This outcome fails to reject the null hypothesis, establishing medical students are not being prepared by modern medical curricula for challenges in Aerospace Medicine.

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