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Medical students' perceptions and attitudes toward translational medicine education: a cross-sectional study in Paraguay

Percepción de estudiantes de Medicina sobre la integración de la medicina traslacional en la educación médica: estudio transversal en Paraguay

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ABSTRACT

Introduction: translational medicine seeks to bridge the gap between scientific discoveries and clinical practice, yet its integration in undergraduate medical education remains limited. Understanding students' perceptions of this field is key to designing curricula that foster translational competencies.
Method: a descriptive, cross-sectional study with a quantitative approach was conducted among 108 medical students from the Universidad María Auxiliadora (Paraguay, 2024 cohort). A validated 25-item questionnaire assessed three dimensions: understanding of translational medicine, perceived importance of including it in the curriculum, and expectations of its future applicability. Descriptive and bivariate analyses were performed.
Results: only 15 % of students reported good or complete understanding of translational medicine (mean self-perceived comprehension = 2,4/5), while 85 % agreed that it should be formally included in medical education. Most participants (≈80 %) anticipated that such training would enhance clinical reasoning, scientific updating, and professional innovation. The main barriers identified were lack of time (61 %), mentorship (52 %), and methodological knowledge (48 %). Nearly all students (93 %) expressed willingness to participate in translational research if supported institutionally.
Conclusions: although students' conceptual knowledge of translational medicine is limited, they recognize its relevance and express motivation to learn and apply it. Integrating translational content and mentorship programs into the curriculum could strengthen research culture and prepare future physicians to bridge science and clinical practice.

Keywords: Translational Medical Research; Education; Medical; Research Training; Educational Innovation; Paraguay.

RESUMEN

Introducción: la medicina traslacional busca conectar los descubrimientos científicos con la práctica clínica, aunque su integración en la educación médica de pregrado sigue siendo escasa. Conocer la percepción estudiantil sobre este campo es esencial para diseñar currículos que promuevan competencias traslacionales.
Método: estudio transversal, descriptivo y de enfoque cuantitativo realizado en 108 estudiantes de Medicina de la Universidad María Auxiliadora (cohorte 2024, Paraguay). Se aplicó un cuestionario validado de 25 ítems que evaluó comprensión del concepto, valoración de su importancia en el currículo y expectativas sobre su aplicación futura. Se efectuaron análisis descriptivos y bivariados.

Resultados: solo el 15 % manifestó comprender bien o totalmente la medicina traslacional (media de comprensión autopercibida = 2,4/5), mientras que el 85 % consideró importante incorporarla formalmente al currículo. Cerca del 80 % expresó que esta formación mejoraría su razonamiento clínico, actualización científica e innovación profesional. Las principales barreras identificadas fueron falta de tiempo (61 %), ausencia de mentorías (52 %) y escaso conocimiento metodológico (48 %). El 93 % mostró disposición a participar en investigación traslacional si contara con apoyo institucional.
Conclusiones: aunque el conocimiento conceptual sobre medicina traslacional es limitado, los estudiantes reconocen su relevancia y muestran alta motivación por formarse en este ámbito. Incluir contenidos y programas de mentoría traslacional fortalecería la cultura investigadora y prepararía médicos capaces de integrar ciencia y práctica clínica.

Palabras clave: Medicina Traslacional; Educación Médica; Capacitación en Investigación; Innovación Educativa; Paraguay.

INTRODUCTION

Translational medicine is an emerging interdisciplinary field that seeks to connect scientific discoveries with clinical practice, accelerating the application of new knowledge in healthcare. Essentially, it serves as a bridge "from the laboratory bench to the patient's bedside," narrowing the gap between basic research and its clinical use to improve patient outcomes. This discipline integrates knowledge from various areas (molecular biology, genetics, bioinformatics, etc.) to develop personalized and effective interventions, a central feature of precision medicine. Thanks to technological advances in genetic sequencing, multi-omic analysis, and computing, translational medicine has experienced rapid growth, enabling the identification of biomarkers and the development of safer, targeted treatments with fewer side effects, thereby improving patients' quality of life.[1,2]

However, historically, the incorporation of these advances into clinical practice has been slow, with estimates suggesting that it can take more than 15 years for an innovation to become standard practice.[3,4] This translational gap (known as *the "valley of death"*) reflects the difficulties in translating laboratory findings into concrete improvements in medical care. During the 20th century, the lack of integrative training structures perpetuated this disconnect, maintaining outdated and less effective clinical practices. In response to this problem, global initiatives such as the NIH's CTSA program emerged in recent decades to promote collaborative translational research, with support from government and private agencies, shortening the development time for new therapies.[5,6]

As a result, universities and academic centers in the US and Europe began to integrate translational medicine into their curricula in the 2000s. However, its adoption in regions such as Latin America has been more gradual. These strategic investments in infrastructure, funding, and training aim to eliminate the obstacles that hinder the transfer of discoveries to patients, thereby optimizing the translational process more efficiently.[7,8]

In this context, it is essential to investigate how medical students perceive the relevance of translational medicine in their academic training and future clinical practice. Students represent the physicians of tomorrow; their level of understanding and attitude toward translational medicine will determine how effectively they can apply new scientific findings to benefit their patients. Recent studies have highlighted that adequate translational training improves critical thinking and evidence-based practice in students.[9] Understanding student perceptions will allow us to identify training gaps and propose pedagogical strategies that strengthen medical education in this crucial domain. This will not only optimize academic programs but also foster a medical culture based on evidence and innovation, in response to the demands of modern medicine.[1,7]

Traditional medical education has paid scant attention to translational medicine, resulting in a disconnect between biomedical research and clinical practice. Many medical students finish their degrees without understanding how laboratory findings can be integrated into patient care. This training gap means that future physicians may not be adequately prepared to quickly capitalize on scientific advances, which could perpetuate outdated clinical practices. Failure to address this deficiency has several negative consequences: on the one hand, delays in the adoption of novel therapies (impacting the quality of care), and on the other, professionals who are less accustomed to critical-research thinking, limiting their ability to contribute to the generation of new knowledge. In a world of rapid advances, the lack of physicians with translational skills can translate into missed opportunities to improve health outcomes.[1,3,10]

In addition, it has been observed that evidence-based recommendations tend to be implemented slowly in medical practice, while scientific misinformation spreads rapidly.[3] This reinforces the urgency of training physicians who can accurately filter and apply evidence, thereby closing the gap between what is known and what is done in the clinic.

Investigating students' perceptions of translational medicine will provide valuable information for designing effective educational interventions. By identifying how they value this area and the barriers they perceive, medical schools will be able to adjust their curricula to incorporate applied research modules, practical experiences, or translational mentoring. Strengthening teaching in translational medicine will not only benefit individual training but will also result in more innovative and higher-quality health systems.[2]

METHOD

This study was designed as a cross-sectional, descriptive, quantitative study. A structured questionnaire was administered to a sample of 108 medical students at María Auxiliadora University (UMAX), spanning the first to tenth semesters of the 2024 cohort. The instrument was designed to assess three main dimensions: knowledge and understanding of the concept of translational medicine; assessment of its importance and the inclusion of translational content in the curriculum; and expectations regarding its applicability in future clinical practice. It also explored the barriers perceived by students, such as a lack of time, resources, or mentoring, which could hinder their participation in research during their studies.

The questionnaire was developed ad hoc based on the available scientific literature on translational training and validated by a panel of three experts in medical education. It consisted of 25 items structured on a five-point Likert scale (1 = strongly disagree, 5 = strongly agree) and dichotomous questions. Among the questions included were: "Do you understand the concept of translational medicine?", "Do you think that improving your training in translational medicine will better prepare you for your clinical practice?" and "How much do you agree that translational research should be incorporated into the compulsory curriculum?". Before its final application, the instrument was piloted with a group of 10 students who were not part of the final sample, to ensure clarity, comprehension, and appropriateness of language. The instrument demonstrated high internal consistency and adequate content validity as determined by expert evaluation.

Students were invited to participate voluntarily in the survey in June 2024. Data collection was conducted using an online form (Google Forms) after obtaining digital informed consent. In addition to the main variables, sociodemographic data such as age, gender, and semester of study were collected to characterize the sample. The data were then exported to SPSS version 25 for analysis. Descriptive statistics, including frequencies and measures of central tendency, were applied to summarize the responses.

From an ethical standpoint, participation was completely anonymous and voluntary, and the confidentiality of the information collected was guaranteed, which was used solely for academic purposes. The study posed no physical or psychological risks to the participants, and they were given the option to withdraw their consent at any time, which none of them exercised. The research was conducted in accordance with the ethical principles established in the Declaration of Helsinki.

RESULTS

Of the 108 students surveyed, 57 % were women and 43 % were men, with an average age of 24 (± 4,5). Representatives from the 1st to 10th semesters were included, with a predominance of 3rd-semester students (37 %). None reported having previously received specific education in translational medicine within the curriculum, beyond brief mentions in other subjects.

Table 1. Sociodemographic characteristics of participants (N = 108)		
Variable	**N**	**%**
Gender		
Female	62	57,4
Men	46	42,6
Average age (years)	24 ± 4,5 (range 18-40)	–
Semester taken		
1st semester	16	14,8
2nd semester	12	11,1
3rd semester	40	37,0
6th semester	20	18,5
Other semesters (4th, 5th, 8th, 10th)	20	18,5

Table 2 shows that only *16 of the students (15 %)* reported understanding the concept of translational medicine "well" or "completely," while the majority reported partial or no understanding. On a scale of 1 (none) to 5 (completely), the average self-perceived understanding was 2,4, indicating a low level. These data reveal that *most students lack clarity about what translational medicine is,* although they recognize some basic elements (e.g., "putting discoveries into practice"). Only 2 % (two students) indicated that they understood it completely.

Table 2. Level of understanding of the concept of translational medicine (N = 108)		
Level of understanding	**N**	**%**
I don't understand anything	22	20,4
I understand a little	38	35,2
Partial comprehension	32	29,6
I understand well	14	13
I understand completely	2	1,9

Despite their limited knowledge, students *do perceive the relevance* of translational medicine in their training. Table 2 shows that 85,2 % agreed or strongly agreed that *"it is important to include more translational medicine content in the medical degree program."* In fact, more than half (55,6 %) strongly agreed**.** No student expressed outright disagreement with its incorporation. This positive attitude suggests that, although they do not fully understand the concept, *they intuitively feel that translational training would be beneficial to them.*

These results underscore a generally favorable attitude toward strengthening translational teaching at the undergraduate level. No significant differences were found according to gender or semester in this assessment; both young students and those nearing graduation agree on its importance (which is consistent with international studies where students demand more research training during their degree program.[9,11] It should be noted that, although they value its inclusion, several admit to "not knowing exactly how it could be taught" or "in which courses to integrate it," which indicates that they trust in the potential benefits but with somewhat abstract expectations, given their lack of direct experience with the subject.

Table 3. Assessment of the importance of translational medicine in the curriculum (N = 108)		
Opinion	**N**	**%**
Strongly agree	60	55,6
Agree	32	29,6
Neutral	16	14,8
Disagree	0	0
Strongly disagree	0	0

Table 4 shows that most respondents believe that knowledge of translational medicine will be helpful to them as physicians. Some 79,6 % agree that *"knowing translational medicine will help me better face clinical challenges in the future."* Likewise, 70,4 % believe that this will enable them to stay up to date with the latest scientific advances throughout their professional career, reflecting the expectation that translational training will foster continuous learning in medical practice.

However, some uncertainty emerged, with a minority (~20 %) remaining *neutral*, possibly because they lacked a clear understanding of *how* this knowledge would be applied in daily practice. On the other hand, a small percentage (~5 %) expressed doubts or lack of confidence in their ability to apply translational medicine as physicians, attributing this to a "lack of practical experience" and "difficulty in transferring ideas from the laboratory to the patient." This finding aligns with reports from other institutions, where students. However, valuing research, *often do not feel fully equipped to conduct or implement it clinically due to a lack of practical training during their studies*.[9]

In summary, our respondents *anticipate concrete benefits* from translational medicine in their professional lives, mainly in terms of practicing medicine based on more solid and up-to-date evidence. For example, 81,5 % believe that it will allow them to offer more personalized and effective care to their patients (only 3,7 % disagree). Also, 88,9 % believe that improving their translational training would make them "more innovative physicians." These high expectations are accompanied, however, by the awareness that practical training and

institutional support will be required to realize them; otherwise, they run the risk of remaining good theoretical intentions that are not carried out.

Table 4. Expectations regarding the future application of translational medicine (N = 108)		
Expectation	**N**	**%**
Improves ability to address clinical challenges	86	79,6
Allows you to stay up to date with scientific advances	76	70,4
Improves personalized care	88	81,5
Promotes professional innovation	96	88,9

When asked about the difficulties of getting involved in translational research during their studies, the reasons most frequently cited in Table 5 were: lack of time due to academic overload (61 %), absence of accessible mentoring or research groups (52 %), and lack of methodological knowledge to start a project (48 %). These barriers are similar to those reported in other university contexts.[10,11] Forty-four percent also mentioned the lack of incentives or academic credits as a demotivating factor. On the other hand, virtually all students (93 %) stated that they would participate in translational research activities if given the opportunity, primarily if guided by faculty mentors and integrated into the curriculum.

Among the proposals suggested by the students themselves to improve the situation were: *including a mandatory practical module* on translational research, such as rotations in laboratories, workshops, or extracurricular seminars on translational medicine with guest researchers, and creating a program of "student researchers" with academic recognition (credits or mentions). It is worth noting the latent motivation: although they identify real barriers, students show interest in overcoming these obstacles if the faculty provides the means. This indicates that there is fertile ground for implementing translational educational interventions.

Table 5. Perceived barriers to participating in translational research (N = 108)		
Perceived barrier	**N**	**%**
Lack of time (academic overload)	66	61,1
Lack of accessible mentoring or groups	56	51,9
Lack of methodological knowledge	52	48,1
Lack of incentives or academic credits	48	44,4

DISCUSSION

The findings of our study highlight a significant training gap. Although medical students value translational medicine and consider it relevant to their professional development, *they currently lack sufficient knowledge and practical experience in this area*. This situation is not unique to this university; studies in different regions report similar difficulties in integrating translational research into undergraduate programs.[2]

However, our results offer valuable information for addressing the problem. First, the markedly positive attitude (85 %+ in favor of including it in the curriculum) indicates that there is an unmet student demand. In line with previous research, students desire training in research and translation because they perceive it as a necessary skill for modern medicine.[9] This receptivity is an encouraging starting point: any pro-translational curriculum reform is likely to have the support and active participation of students, provided it is implemented strategically and with adequate resources.

However, the limited conceptual understanding observed (only 15 % understand the term well) reflects that, until now, translational medicine has occupied a marginal or implicit place in the curriculum. Some content may be present in research or pharmacology courses, but *it has not been made visible or articulated as "translational medicine."* This suggests the need to formalize and institutionalize translational teaching. One strategy would be to develop a specific course (e.g., "Applied Translational Medicine") in the intermediate or advanced years of the degree program, where concepts, methodologies, and successful cases of translation are explicitly addressed. Another complementary tactic is to mainstream the translational approach into existing subjects, for example, by incorporating a discussion of how a molecular discovery led to an innovative drug into pathology or therapeutics classes.[1]

The latter can be achieved through the integration of translational case studies into the curriculum. The

literature reports successful experiences using this approach. In Canada and the US, discussions of recent scientific articles and their clinical correlates have been implemented as part of specific courses, which have significantly improved students' understanding and interest in applied research.[10,11]

Another noteworthy finding is the moderate but not complete confidence of students in their ability to apply translational medicine in practice without further training. While ~80 % believe it will help them in the future, around 5 % express doubts about their actual ability to do so. This perception is related to the barriers identified: students feel they lack practical experience and mentoring to translate knowledge into action. This highlights the importance of providing controlled practical opportunities during training. One recommendation would be to create *spaces for translational practice* for students, such as: Internships in translational research laboratories or clinical innovation departments (similar initiatives exist in Europe with positive results in student motivation);[11] Tutored research projects aimed at solving a clinical problem through basic science, so that students experience the complete cycle of translation on a small scale; and Translational simulations: exercises where a real clinical problem is presented and students are challenged to propose, in a multidisciplinary team, a plan that goes from the research hypothesis to a possible intervention (this *challenge-based learning* method has been shown to foster innovation and integrated thinking skills in the Netherlands).[1] The implementation of these strategies, although demanding, would cultivate in students the confidence and skills to apply what they have learned in theory to the real world.

It is pertinent to link the findings of this study with the competency models already described for translational science. Faupel-Badger *et al*. proposed integrating the competencies of the translational researcher, who is oriented toward conducting research, with those of the translational scientist, who is focused on managing the translation process. These competencies include effective scientific communication, teamwork, systemic thinking, and the ability to "cross disciplinary boundaries." Although students do not formally articulate these competencies, they perceive that translational medicine involves a unique set of skills. Consequently, when redesigning the medical curriculum, it is essential to consider the translational competency frameworks validated in the literature,[10,12] ensuring that training includes not only conceptual content, such as the phases of a translational clinical trial, but also skills and attitudes, such as collaborative leadership and resilience in the face of the so-called *"valley of death."*

The incorporation of specific training activities, such as scientific-clinical communication workshops and simulated multidisciplinary teamwork exercises, will enrich the comprehensive training of medical students and prepare them as translational physician-scientists capable of leading innovation processes in clinical practice. A particularly encouraging finding was the strong motivation of students to participate in translational research when barriers are reduced. Virtually all of them would be willing to get more involved if they had the time and support. This is in line with studies where, when undergraduate research programs were implemented, the student response was overwhelmingly enthusiastic.[9,12]

Therefore, our recommendations focus on removing structural obstacles. First, consider the workload: incorporating translational medicine *should not mean an overload* on the existing curriculum, but rather integrate harmoniously, possibly replacing redundant or less relevant content. Second, develop a mentoring system by assigning teacher-researchers to guide small groups of students through short projects. The literature highlights that active mentoring is crucial in helping students overcome their initial insecurity about research.[13] Third, create tangible academic incentives: elective credits, certificates of participation in translational research, and public recognition, which reinforce the value of research activity within the degree program (combating the perception of "wasted time" that some may have).

In terms of the impact on medical practice, strengthening translational education *promises to improve both the quality of care and the professional satisfaction of future physicians*. A physician trained in translational research will be better equipped to quickly adopt new evidence-based therapies, avoiding unjustified delays that could harm patients.[3] In addition, they will have the tools to lead or participate in continuous improvement projects within their hospital (designing and implementing protocols based on the latest findings, measuring results, and providing feedback to the system). This is especially relevant in the post-COVID-19 pandemic era, where the importance of quickly translating evidence into clinical guidelines to save lives has become clear.

On the other hand, from the perspective of professional well-being, engaging in these activities can increase physicians' sense of purpose and accomplishment, as they feel like active agents in generating knowledge, rather than just passive users of guidelines. Studies on physician *burnout* suggest that cultivating academic and research interests protects against the demoralizing routine of practice.[3]

We acknowledge that the sample size was small and comprised data from a single private institution, which limits the generalizability of the findings. It would be valuable to expand the study to include more universities (including public ones) and a larger number of participants to confirm whether these perceptions are replicated in other contexts. In addition, the use of a self-reported questionnaire carries potential biases (students may have expressed high ratings because they know they "should" appreciate research, even if they are not involved in practice). We attempted to mitigate this by ensuring anonymity and emphasizing that there

were no right or wrong answers.

Another limitation is that we did not explore qualitative methods that could have shed light on *why* some students are hesitant or *how* they envision integrating translational medicine into their profession. Future studies could incorporate interviews or focus groups to explore these dimensions. Despite these limitations, the data obtained provide a reliable initial diagnosis of the situation in our faculty, consistent with the literature, and they serve as a basis for action.

CONCLUSIONS

This research demonstrated that students, even those with limited knowledge of the field, recognize the importance of translational medicine and *appear eager to incorporate it* into their learning. This represents a valuable opportunity for medical schools to align their curriculum with the demands of modern science and the expectations of their students. We recommend explicitly incorporating translational medicine content and experiences into the curriculum in an integrated and practical way (through clinical-translational cases, elective modules, research internships); Establish mentoring programs and facilitate student participation in real translational projects, breaking down perceived barriers of time, guidance, and resources; and adopt a competency-based approach, drawing on internationally developed frameworks (translational researcher and scientist competencies) to guide both teaching and assessment of learning in this area.

We suggest that future evaluations measure the impact of translational educational interventions on *concrete outcomes*, such as verifying whether, after introducing a translational medicine module, students' self-reported confidence in reading scientific articles improves or whether student participation in research projects increases. In addition, it would be enriching to follow up with graduates to see how this training influences their performance during their internship or residency (do they apply evidence more? Do they initiate improvement projects?).

Translational medicine has the potential to transform medical practice and patient care; however, to achieve this, it must first transform the way we train our doctors. Our study shows that the first step, recognizing the need and willingness to change, has already been taken in the minds of our students. It is the responsibility of institutions to respond to this call, closing the virtuous circle between the generation of knowledge and its use in everyday medicine.

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CONFLICT OF INTEREST
The authors declare that there is no conflict of interest.

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