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# Predictors of High Motivation Score for Performing Research Initiation Fellowship, Master 1, Research Master 2, and PhD Curricula During Medical Studies

## A Strobe-Compliant Article

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**Abstract:** Translational research plays a crucial role in bridging the gap between fundamental and clinical research. The importance of integrating research training into medical education has been emphasized. Predictive factors that help to identify the most motivated medical

students to perform academic research are unknown. In a cross-sectional study on a representative sample of 315 medical students, residents and attending physicians, using a comprehensive structured questionnaire we assessed motivations and obstacles to perform academic research curricula (ie, research initiation fellowship, Master 1, Research Master 2, and PhD). Independent predictive factors associated with high “motivation score” (top quartile on motivation score ranging from 0 to 10) to enroll in academic research curricula were derived using multivariate logistic regression analysis. Independent predictors of high motivation score for performing Master 1 curriculum were: “considering that the integration of translational research in medical curriculum is essential” (OR, 3.79; 95% CI, 1.49–9.59;  $P=0.005$ ) and “knowledge of at least 2 research units within the university” (OR, 3.60; 95% CI, 2.01–6.47;  $P<0.0001$ ). Independent predictors of high motivation score for performing Research Master 2 curriculum were: “attending physician” (OR, 4.60; 95% CI, 1.86–11.37;  $P=0.001$ ); “considering that the integration of translational research in medical curriculum is essential” (OR, 4.12; 95% CI, 1.51–11.23;  $P=0.006$ ); “knowledge of at least 2 research units within the university” (OR, 3.51; 95% CI, 1.91–6.46;  $P=0.0001$ ); and “male gender” (OR, 1.82; 95% CI, 1.02–3.25;  $P=0.04$ ). Independent predictors of high motivation score for performing PhD curriculum were: “considering that the integration of translational research in medical curriculum is essential” (OR, 5.94; 95% CI, 2.33–15.19;  $P=0.0002$ ) and “knowledge of at least 2 research units within the university” (OR, 2.63; 95% CI, 1.46–4.77;  $P=0.001$ ). This is the first study that has identified factors determining motivations and barriers to carry out academic research curricula among undergraduate and postgraduate medical students. Improving these 2 areas will certainly have an impact on a better involvement of the next generation of physicians in translational medicine.

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**Abbreviations:** 95% CI = 95% confidence intervals, ECTS = European Credit Transfer System, EHEA = European Higher Education Area, IQR = interquartile range, M1 = Master 1, M2 = Master 2, MEDINE 2 = Medical Education in Europe 2 project, OR = odds ratio.

## INTRODUCTION

Universities are naturally considered as key factors influencing knowledge production and dissemination. This is of particular importance in medical and scientific education. Indeed, an effective translation of scientific discoveries into clinical practice has a major impact on public health through improvement of medical care.<sup>1</sup> Translational research, traditionally described as a transfer of scientific knowledge to clinical practice “from bench to bedside,” is a multidirectional flow of knowledge between

basic research and patient-oriented research.<sup>2</sup> According to the Canadian Institutes of Health Research, patient-oriented research (also known as, patient-centered research) aims to support the development of new approaches to therapy and diagnosis, in order to promote greater quality, accountability, and accessibility of health care.<sup>3</sup> Translational research encompasses basic research, clinical research, epidemiology and public health, and concerns all professionals in the health sector. It is the expression of an essential need to accelerate the translation of discoveries from fundamental research into clinical application for the benefit of patients.<sup>4–6</sup> Translational research requires an early acquisition of collaborative skills to allow clinicians and scientists to work in effective multidisciplinary teams.<sup>2,7,8</sup>

Physicians are believed to be in the best position to identify a need for more scientific evidence in patient care and to incite new scientific questions. Indeed, physicians-scientists (MD-PhD) play a significant role in medical research, especially in shortening the time to translation between basic research and clinical medicine.<sup>9–12</sup> Even though MD-PhD alumni represent only 2.5% of medical school graduates each year in the USA, they have been shown to receive a third of the National Institutes of Health grants destined to physician-scientists.<sup>10</sup>

The importance of integrating the scientific training into medical studies has been suggested in the last decades.<sup>13–15</sup> Early exposure to compulsory research activities during undergraduate medical studies has been shown to play a significant role on motivation of medical students towards future involvement in research.<sup>16,17</sup> From among 126 U.S. medical schools and 17 Canadian medical schools only 19% and 24%, respectively, have been shown to require basic science as compulsory part of the medical curriculum.<sup>13</sup> Moreover, teaching methods presented a large diversity with a limited laboratory experience. Efforts have recently been undertaken in the United States and the United Kingdom aiming to integrate research modules in medical studies.<sup>2,18</sup> Similarly, in Europe the Medical Education in Europe 2 (MEDINE 2) project was created to raise the integration of research skills during medical studies.<sup>19</sup>

In a recent study performed on 338 residents and attending physicians across several residency programs in 2 French faculties of medicine, the enrolment of medical students in a Research Master (M2) and/or PhD curriculum was independently and strongly associated with several student-related information-seeking behaviors such as high skill in PubMed search, knowledge of the leading medical journals of the specialty, attending national and international academic conferences, and using academic theoretical learning supports several times a week.<sup>20</sup> Between 2000 and 2006, a nationwide study on US medical students aimed to identify factors associated with MD/PhD program graduation.<sup>21</sup> Compared with graduates of other MD degree programs, MD/PhD graduates (2.3% of the 79,104 respondents) tend to be less demographically diverse, have a substantial career involvement in research, a lower educational debt, and are more likely to be recipient of medical school scholarships or grants.<sup>21</sup> However, this study did not assess the motivation and potential obstacles of the remaining 97.7% of medical students without a PhD diploma for their potential enrollment in a scientific curriculum.<sup>21</sup>

Insufficient training in research methods during undergraduate studies has been shown to be an obstacle to student participation in academic research.<sup>16,22</sup> Recently, a self-reported survey on 327 Canadian medical students, identified that time constraints, inappropriate acknowledgment for research work and lack of mentors were the major barriers perceived by medical students to perform a research work during their undergraduate studies.<sup>16</sup>

In France, higher education is organized in 3 levels that correspond to those of other European countries as defined in the Bologna Process.<sup>23</sup> The overarching aim of this European reform is to create a European Higher Education Area (EHEA) based on international cooperation and academic exchange through the European Credit Transfer System (ECTS). The Bologna Process aims at creating European standards for university studies with 3 years allocated to the bachelor's degree ("licence" in French), 2 years for the Master's degree (Master 1 and Master 2), and 3 years for the doctorate (PhD). During the Master 1 curriculum, medical students perform a "Research Initiation Fellowship", which allows accumulating 12 ECTS.

To date, no study has reported motivation and potential obstacles to carry out research curricula (research initiation fellowship, Master 1, Research Master 2, and PhD) among medical students from both undergraduate and postgraduate academic levels. Furthermore, there is no available data regarding position and expectations of medical students towards scientific training in translational research during medical studies. We conducted a cross-sectional online survey in 2 French faculties of medicine, which aimed to comprehensively evaluate knowledge of medical students, residents, and attending physicians about academic research curricula and their active participation in biomedical research. We also assessed motivation and obstacles to enroll in academic research curricula during medical studies. Interestingly, this study allowed us to decipher independent predictors of high motivation score for enrolling research initiation fellowship, Master 1, Research Master 2, and PhD curricula during medical studies.

## METHODS

### Study Design and Questionnaire Construction

A cross-sectional anonymous survey was carried out among medical students, residents, and attending physicians from 2 medical faculties in France (Faculty of Medicine of Nancy, University of Lorraine; Faculty of Medicine of Poitiers, University of Poitiers). The instrument "Nancy-Poitiers Translational Research Study" was developed in the Faculty of Medicine of Nancy after an extensive literature review. Content validity of the questionnaire was endorsed by 2 experts in medical curriculum development (JPF, MB). The final version of the questionnaire encompassed 3 domains. The first domain provided information on the characteristics of respondents, the academic level, and orientation (13 items). The second domain concerned motivation for scientific training (4 items), research fellowships already accomplished by the respondents (4 items), possible constraints (9 items), knowledge on research structures within the home University of each respondent (3 items), and the scientific output of the respondent (3 items). The third domain of the questionnaire was focused on understanding of the concept of translational research (8 items) (Supplemental Digital Content: Questionnaire, <http://links.lww.com/MD/A659>). The questionnaire was created as an online survey using the Google Docs platform (<https://docs.google.com/>) and took ~10 min to complete. All responses were kept confidential. The study was approved by the Institutional Review Board of the University Hospital of Nancy and registered at French National Commission for Data Protection and Liberties (CNIL N°1797639).

### Details of Participants and Setting

In February 2015, a cover letter with a web link to the anonymous online survey was made available to the Informatics

and Communication departments of the medical faculties of Nancy and Poitiers. The questionnaire was distributed through the university e-mail to medical students, residents, and attending physicians. A second mailing was conducted in June 2015 using the same procedure.

**Statistical Analysis**

All quantitative variables are described as medians and percentiles [Interquartile range (IQR), 25–75th percentile]. All proportions are expressed as percentages with 95% confidence intervals (95% CI). The Cochran’s *Q* test was used for testing for differences between 3 or more matched sets of proportions within the same subgroup (eg, optimal academic level for performing a Master 1 curriculum among 11 levels). When the Cochran’s *Q* test was significant, posthoc multiple pairwise comparisons were performed. To look for independent predictors of high motivation score for performing research initiation fellowship, Master 1, Research Master 2, and PhD curricula, we performed multivariate analysis using stepwise multivariate logistic regression in order to identify independent predictors (age; gender; academic level; knowledge about the following academic research programs; Do you know any of the research structures of your University? Do you know whether your clinical department is affiliated to any of the research facilities of your University? Do you think that integrating translational research in medical curriculum) and to estimate their relative predictive weights (coefficients). All variables with *P* < 0.1 were initially included in the model and variables with *P* < 0.05 were retained in the model. Results were shown as odds ratios (OR) and 95% confidence intervals. We assessed the model discrimination using receiver-operating characteristic analysis and assessed model calibration using the Hosmer and Lemeshow goodness-of-fit test. All statistical analyses were conducted with MedCalc for Windows, version 14.8 (MedCalc Software, Ostend, Belgium), on the basis of a 2-sided type I error with an alpha level of 0.05.

**RESULTS**

**Characteristics of Survey Respondents**

Between February 2015 and June 2015, 315 subjects completed the questionnaire. Characteristics of the participants are detailed in Table 1. The median age of the respondents was 23 years and the majority being represented by medical students (68%). Medical students, resident physicians, and attending physicians represented 68% (n = 213), 24% (n = 76), and 8% (n = 26) of the respondents, respectively. The median year of enrollment in medical studies was 2011. The specialty mostly represented among resident and attending physicians was general medicine (39%; 37/96), followed by other medical specialties (33%; 32/96). Surgical specialties represented 17% (16/96), biological and radiological specialties 7% (7/96), and public health disciplines 4% (4/96) (Supplementary Table 1, <http://links.lww.com/MD/A659>).

**Knowledge of Medical Students, Residents, and Attending Physicians About Academic Research Curricula and Their Active Participation in Biomedical Research**

Sixty-five percent of the respondents are informed about research initiation fellowship, 53% and 35% of the participants have knowledge about Master 1 and Research Master 2, respectively, and 37% are informed about PhD curriculum

**TABLE 1.** Characteristics of Medical Students, Residents, and Attending Physicians Who Participated to the “Translational Research” Study

	N	Median	IQR, 25th–75th
Age (years)	315	23	21–26
Year of registration in the medical school	314	2011	2008–2013
Year of enrolment in Master 1	164	2012	2010–2013
Year of enrolment in Research Master 2	26	2013	2010–2014
Year of enrolment in PhD	13	2014	2008–2015
	<b>n/N</b>	<b>%</b>	<b>95% CI</b>
Gender			
Male	115/315	36.5	31.2–41.9
Female	200/315	63.5	58.1–68.8
Home university			
University of Lorraine	269/315	85.4	81.5–89.3
University of Poitiers	46/315	14.6	10.7–18.5

IQR = interquartile range, n = number of observations, N = number of respondents.

(Table 2). Nearly half of participants (46%) do not know any of the research structures within the university, 31% among them know at least 1 and 23% know 2 or more of the university research units. Only 25% of the respondents are informed about affiliation of their current training center to the university research structures. In order to optimize information access to academic research degree programs within the university the survey participants would suggest: organized tour of the university research units (40%), informative lecture (29%), information on the university website (27%), or notice-board information at the university office of educational affairs (3%). Interestingly, 86% of the respondents stated that they are interested to attend a conference addressing new research findings organized at the university.

Thirty-six percent of the respondents stated to understand the concept of translational research. The majority among them would define translational research, in descending order by frequency, as cooperation between clinicians and basic scientists (68%), transfer of new knowledge from the bench to the bedside (65%), increase in the quality of healthcare and improving public health (46%), faster realization and increased quality of clinical trials (28%), understanding of fundamental/molecular mechanisms in human biology (22%), cooperation between academic research centers and industry (15%), focus on frequent diseases (13%), and focus on rare diseases (5%).

Furthermore, to ensure that research findings will be used in the optimal way for the benefit of patients, the respondents think that new findings should be transferred to: healthcare professionals (79%), statutory education bodies (52%), researchers of a different scientific specialty (39%), health policy makers (35%), researchers of the same scientific specialty (29%), large public audience (26%), pharmaceutical companies (25%), and press release (17%). Interestingly, 88% of the participants consider that integrating translational research into medical curriculum is an added value and 7% of them consider it as essential.

When asked about active participation in biomedical research, 53% of the respondents reported being currently enrolled in Master 1, 8% in Research Master 2 and 4% in the PhD degree program. In total 11% (36/315) of all the survey

**TABLE 2.** Knowledge of Medical Students, Residents, and Attending Physicians About Academic Research Programs and Their Active Participation in Biomedical Research

	N	n	%	95% CI
Knowledge about the following academic research programs				
Do you know what does “Research Initiation Internship” refer to? (Yes)	315	204	64.8	59.5–70.1
Do you know what does “Master 1” refer to? (Yes)	315	166	52.7	47.2–58.2
Do you know what does “Research Master 2” refer to? (Yes)	315	110	34.9	29.6–40.2
Do you know what does “University thesis (PhD)” refer to? (Yes)	315	115	36.5	31.2–41.9
Do you know any of the research structures of your university?				
Yes, 2 and more	315	73	23.2	18.5–27.9
Yes, only 1	315	96	30.5	25.4–35.6
No	315	146	46.3	40.8–51.9
Do you know whether your clinical department is affiliated to any of the research facilities of your university?				
Yes	315	80	25.4	20.6–30.2
No	315	75	23.8	19.1–28.5
Do not know	315	160	50.8	45.2–56.3
Do you understand the concept of translational research? (Yes)	315	114	36.2	30.9–41.5
Which of the following best defines translational research?*				
Cooperation between clinicians and basic scientists	315	221	68.4	63.0–73.5
Transfer of new knowledge from the bench to the bedside	315	210	65.0	59.5–70.3
Increase in the quality of healthcare and improving public health	315	150	46.4	40.8–52.1
Faster realization and increased quality of clinical trials	315	90	27.9	23.0–33.2
Understanding of fundamental/molecular mechanisms in human biology	315	70	21.7	17.3–26.7
Cooperation between academic research centers and industry	315	49	15.2	11.4–19.7
Focus on frequent diseases (eg, diabetes, arterial hypertension, cancer)	315	42	13.0	9.5–17.2
Focus on rare diseases (eg, rare diseases of metabolism)	315	17	5.3	3.1–8.4
Do you think that integrating translational research in medical curriculum is:				
Added value	315	278	88.3	84.7–91.8
Essential	315	22	7.0	4.2–9.8
Waste of time	315	15	4.8	2.4–7.1
In your opinion, to whom should be transferred new research findings to ensure that they will be used in the optimal way for the benefit of patients?*				
Clinicians/healthcare professionals	315	256	79.3	74.4–83.6
Statutory education bodies	315	167	51.7	46.0–57.3
Researchers of a different scientific specialty	315	125	38.7	33.3–44.3
Health policy makers (eg, Ministry of Higher Education and Research)	315	113	35.0	29.7–40.5
Researchers of the same scientific specialty	315	92	28.5	23.6–33.8
Consumers/large public audience	315	84	26.0	21.2–31.2
Pharmaceutical company	315	81	25.1	20.4–30.3
Press release	315	56	17.3	13.3–21.9
Other	315	17	5.3	3.1–8.4
What would optimize information access to academic research degree programs in your university?*				
Organized tour of the university research units	315	130	40.2	34.7–45.8
Informative lecture organized by the university	315	95	29.4	24.4–34.8
Information on the university website	315	87	26.9	22.1–32.2
Notice-board information in the University’s Office of Educational Affairs	315	8	2.5	1.1–4.9
Would you attend conference addressing new research findings organized at your university? (Yes)	315	272	86.3	82.5–90.2
Enrolment in the following research curricula* (Yes)				
Enrolment in M1	315	166	52.7	47.2–58.2
Enrolment in Research M2	315	26	8.3	5.2–11.3
Enrolment in PhD	315	14	4.4	2.2–6.7
Are you a coauthor of at least 1 publication indexed in PubMed (Yes)	315	36	11.4	7.9–15.0

95% CI = 95% confidence interval, n = number of observations, N = total number of respondents.

\* Several answers are possible.

participants co-authored at least 1 publication indexed in PubMed. Among them the proportions of medical students, residents, and attendings were 17% (6/36), 31% (11/36), and 53% (19/36), respectively.

### Optimal Period for Performing Academic Research Curricula During Medical Studies

The majority of the respondents consider that the 2nd and the 3rd years of the medical studies are the optimal period for

**TABLE 3.** Respondents' Views on the Optimal Period for Performing Academic Research Curricula During Medical Studies

	Research Initiation Fellowship				Master 1				Research Master 2				PhD			
	N	n	%*	95% CI	N	n	%*	95% CI	N	n	%*	95% CI	N	n	%*	95% CI
General education in medical sciences 1 (2nd year)	315	192	61.0 <sup>†</sup>	55.5–66.4	315	171	54.3 <sup>†</sup>	48.8–59.8	315	32	10.2	6.8–13.5	315	18	5.7	3.1–8.3
General education in medical sciences 2 (3rd year)	315	94	29.8 <sup>†</sup>	24.8–34.9	315	94	29.8 <sup>†</sup>	24.8–34.9	315	56	17.8	13.5–22	315	8	2.5	0.8–4.3
Advanced training in medical sciences 1 (4th year)	315	11	3.5	1.5–5.5	315	23	7.3	4.4–10.2	315	39	12.4	8.7–16	315	8	2.5	0.8–4.3
Advanced training in medical sciences 2 (5th year)	315	2	0.6	0–1.5	315	2	0.6	0–1.5	315	12	3.8	1.7–5.9	315	4	1.3	0–2.5
Advanced training in medical sciences 3 (6th year)	315	1	0.3	0–0.9	315	0	0	—	315	1	0.3	0–0.9	315	1	0.3	0–0.9
Residency—1st year	315	8	2.5	0.8–4.3	315	12	3.8	1.7–5.9	315	63	20.0 <sup>†</sup>	15.6–24.4	315	56	17.8	13.5–22
Residency—2nd year	315	5	1.6	0.2–3	315	8	2.5	0.8–4.3	315	57	18.1	13.8–22.4	315	33	10.5	7.1–13.9
Residency—3rd year	315	1	0.3	0–0.9	315	4	1.3	0–2.5	315	32	10.2	6.8–13.5	315	39	12.4	8.7–16
Residency—4th year	315	0	0	—	315	0	0	—	315	12	3.8	1.7–5.9	315	41	13.0	9.3–16.8
Residency—5th year	315	0	0	—	315	0	0	—	315	1	0.3	0–0.9	315	20	6.3	3.6–9.1
Fellowship (attending physicians)	315	1	0.3	0–0.9	315	1	0.3	0–0.9	315	10	3.2	1.2–5.1	315	87	27.6 <sup>†</sup>	22.7–32.6

95% CI = 95% confidence interval, n = number of observations, N = total number of respondents.

\*  $P < 0.001$ , Cochran's  $Q$  test for comparison across all percentages.

†  $P < 0.05$  in post-hoc multiple comparisons with other academic levels.

performing research initiation fellowship (90.8%;  $P < 0.001$ , for comparison with other years) and Master 1 (84.1%,  $P < 0.001$ , for comparison with other years) (Table 3). Regarding Research Master 2, residency is considered as more appropriate for 52% of the respondents (Table 3). Residency and attending physician fellowship are considered as the optimal academic levels for performing a PhD curriculum by 60% ( $P < 0.001$ , for comparison with other years) and 28% ( $P < 0.001$ , for comparison with other years) of the respondents, respectively (Table 3).

### Obstacles to Enroll in Academic Research Curricula During Medical Studies

“Lack of time” was the main obstacle to perform academic research and was consistently reported for all the 4 research curricula: research initiation fellowship (63%), Master 1 (51%), Research Master 2 (47%), and PhD (55%). A lack of interest was perceived as obstacle to perform research curricula by around one-fifth of the respondents across the 4 research curricula. Other obstacles (incompatibility with medical studies, limited number of applicants accepted, lack of financial support, familiar obligations) were reported by <10% of participants (Table 4).

### Independent Predictors of High Motivation Score for Performing Research Initiation Fellowship, Master 1, Research Master 2, and PhD Curricula in Multivariate Logistic Regression Analysis

#### Research Initiation Fellowship

The median motivation score for performing a research initiation fellowship was 5 on a scale ranging from “0”

(absolutely not motivated) to “10” (extremely motivated) (IQR, 2–8). In multivariate logistic regression analysis, independent predictors for strong motivation (motivation score >8; 75th percentile) for performing research initiation fellowship were: knowledge of at least 2 research units within the university (OR, 9.75; 95% CI, 4.45–21.39;  $P < 0.0001$ ); residency, 2nd year (OR, 4.29; 95% CI, 1.14–16.13;  $P = 0.03$ ); and considering that the integration of translational research in medical curriculum is essential (OR, 3.48; 95% CI, 1.21–10.05;  $P = 0.02$ ) (Table 5).

#### Master 1 Curriculum

The median motivation score for performing a Master 1 curriculum was 6 (IQR, 3–8). In multivariate logistic regression analysis, 2 items were independently and positively associated with a strong motivation (motivation score >8; 75th percentile) for performing Master 1 curriculum: considering that the integration of translational research in medical curriculum is essential (OR, 3.79; 95% CI, 1.49–9.59;  $P = 0.005$ ) and knowledge of at least 2 research units within the university (OR, 3.60; 95% CI, 2.01–6.47;  $P < 0.0001$ ) (Table 5).

#### Research Master 2 Curriculum

The median motivation score for performing a Research Master 2 curriculum was 4 (IQR, 2–7). In multivariate logistic regression analysis, independent and positive predictors for strong motivation (motivation score >7; 75th percentile) for performing Research Master 2 curriculum were: attending physician (OR, 4.60; 95% CI, 1.86–11.37;  $P = 0.001$ ); considering that the integration of translational research in medical curriculum is essential (OR, 4.12; 95% CI, 1.51–11.23;  $P = 0.006$ ); knowledge of at least 2 research units within the university (OR, 3.51; 95% CI, 1.91–6.46;  $P = 0.0001$ ); and

**TABLE 4.** Obstacles for Performing Research Initiation Fellowship, Master 1, Research Master 2 and PhD Curricula During Medical Studies

	Research Initiation Fellowship				Master 1				Research Master 2				PhD			
	N	n	%*	95% CI	N	n	%*	95% CI	N	n	%*	95% CI	N	n	%*	95% CI
Lack of time	315	197	62.5 <sup>†</sup>	57.2–67.9	315	159	50.5 <sup>†</sup>	44.9–56	315	148	47.0 <sup>†</sup>	41.4–52.5	315	172	54.6 <sup>†</sup>	49.1–60.1
Lack of interest	315	64	20.3 <sup>†</sup>	15.8–24.8	315	73	23.2 <sup>†</sup>	18.5–27.9	315	73	23.2 <sup>†</sup>	18.5–27.9	315	59	18.7 <sup>†</sup>	14.4–23.1
Incompatibility with medical studies	315	25	7.9	4.9–10.9	315	29	9.2	6–12.4	315	36	11.4	7.9–15	315	25	7.9	4.9–10.9
Limited number of applicants accepted	315	14	4.4	2.2–6.7	315	31	9.8	6.5–13.1	315	18	5.7	3.1–8.3	315	7	2.2	0.6–3.9
Lack of financial support	315	12	3.8	1.7–5.9	315	19	6.0	3.4–8.7	315	27	8.6	5.5–11.7	315	26	8.3	5.2–11.3
Familiar obligations	315	2	0.6	0–1.5	315	3	1.0	0–2	315	12	3.8	1.7–5.9	315	25	7.9	4.9–10.9
Other	315	1	0.3	0–0.9	315	1	0.3	0–0.9	315	1	0.3	0–0.9	315	1	0.3	0–0.9

95% CI = 95% confidence interval, n = number of observations, N = total number of respondents, 95% confidence interval.

\*  $P < 0.001$ , Cochran's  $Q$  test for comparison across all percentages.

<sup>†</sup>  $P < 0.05$  in post-hoc multiple comparisons with other academic levels.

male gender (OR, 1.82; 95% CI, 1.02–3.25;  $P = 0.04$ ) (Table 5).

### PhD Curriculum

The median motivation score for performing a PhD curriculum was 5 (IQR, 2–8). In multivariate logistic regression analysis, independent predictors for strong motivation (motivation score  $> 8$ ; 75th percentile) for performing PhD curriculum were: considering that the integration of translational research in medical curriculum is essential (OR, 5.94; 95% CI, 2.33–15.19;  $P = 0.0002$ ) and knowledge of at least 2 research units within the university (OR, 2.63; 95% CI, 1.46–4.77;  $P = 0.001$ ) (Table 5).

## DISCUSSION

The present study highlights the significant role of knowledge of the research structures within the university as a strong and an independent predictor of high motivation score for enrolling in academic research curricula during medical studies. This emphasizes the importance of the university's scientific environment on student motivation toward academic research. Importantly, only 25% of the respondents had knowledge about affiliation of their current training department to research structures of their university. For the majority of the respondents the optimal time for performing research initiation fellowship and Master 1 curriculum would be during the 2nd and the 3rd years of the medical studies. On the other hand, residency and attending physician fellowship are considered as optimal periods for enrolling in Research Master 2 and PhD curricula.

Our results are in line with the MEDINE survey.<sup>24</sup> In this study, nearly 25% among 91 European medical schools in 26 participating countries were shown to promote insufficiently student research activities.<sup>24</sup> The lack of interest to carry out the research curricula, reported by 20% of the participants to our study, might be due to insufficient information delivered to students by the university educational bodies.

In our study, 11% of the respondents have coauthored at least 1 publication indexed in PubMed. Among medical students, this proportion falls to 3% (6/231). In the Netherlands,

among 2973 medical students who received their medical degree in 2006 or 2007, 15% published at least 1 scientific paper during the last 3 years of the medical studies.<sup>25</sup> Essential role of clinical-research training during medical studies has been emphasized in terms of publication output of medical students in Dutch medical schools.<sup>25</sup> In the Netherlands each medical school devotes between 50 and 80 European Credits on scientific education, of which nearly a half comprises a full time individual student research project of 14 to 27 weeks between 4th and 6th year.<sup>25</sup> Another study conducted among 318 medical students at the University of Groningen (Netherlands) has demonstrated that students performing extracurricular research during undergraduate medical studies have a significantly higher scientific output after graduation than students without undergraduate research experience and 50% of them published a scientific paper already before graduation.<sup>26</sup>

In our study, the lack of time was the most frequently reported obstacle by respondents to enroll in academic research curricula. In line with our results, a cross-sectional study performed on 327 students in Canada has identified time constraints as one of the major barriers perceived by students to participate in research activities during medical studies.<sup>16</sup> In Europe, the medical curriculum is defined by the EC directive 77/452/EEC and comprises 6 years or 5500 h of teaching with main orientation on clinical knowledge and on patient care. The inefficient integration of the research component into medical curriculum and absence of established learning outcomes have been evidenced. In France, the concept of research continuum is outlined in the guidelines for the biomedical research published in 2013 by the Ministry of Social Affairs and Health.<sup>27</sup> However, translational research is not an integral part of the medical curriculum in French medical faculties. It is represented by optional modules as a part of Master 1, doctoral or post-doctoral studies depending on a thematic orientation of the research laboratories. In Europe, strategies of integrating translational research modules to the actual curricular framework have been undertaken as part of the MEDINE 2 project which aims to raise the integration of research in the medical curriculum and strengthen the connections between medical education, research, and industry.<sup>19</sup>

**TABLE 5.** Independent Predictors of High Motivation Score ( $\geq$ IQR 75th) for Performing Research Initiation Fellowship, Master 1, Research Master 2, and PhD Curricula in Multivariate Logistic Regression Analysis

	OR	95% CI	Coef.	SE	P Value*	Percent Correct <sup>†</sup>	AUROC	95% CI
<b>High motivation score for performing research initiation curriculum (motivation score &gt;8; 75th IQR)</b>								
Model performance	—	—	—	—	—	81.9%	0.784	0.734–0.828
Do you know research units and facilities at your university: “yes, 2 and more”	9.75	4.45–21.39	2.277	0.401	<0.0001	—	—	—
Academic level: Residency, 2nd year	4.29	1.14–16.13	1.455	0.676	0.03	—	—	—
Do you think that integrating translational research in medical curriculum is: “essential”	3.48	1.21–10.05	1.248	0.541	0.02	—	—	—
Do you know research units and facilities at your university: “yes, only 1”	2.48	1.11–5.56	0.910	0.411	0.03	—	—	—
<b>High motivation score for performing Master 1 curriculum (motivation score &gt;8; 75th IQR)</b>								
Model performance	—	—	—	—	—	79.0%	0.657	0.602–0.709
Do you think that integrating translational research in medical curriculum is: “essential”	3.79	1.49–9.59	1.331	0.474	0.0050	—	—	—
Do you know research units and facilities at your university: “yes, 2 and more”	3.60	2.01–6.47	1.282	0.299	<0.0001	—	—	—
<b>High motivation score for performing Research Master 2 curriculum (motivation score &gt;7; 75th IQR)</b>								
Model performance	—	—	—	—	—	77.4%	0.750	0.698–0.797
Academic level: Attending physician	4.60	1.86–11.37	1.525	0.462	0.001	—	—	—
Do you think that integrating translational research in medical curriculum is: “essential”	4.12	1.51–11.23	1.415	0.512	0.006	—	—	—
Do you know research units and facilities at your university: “yes, 2 and more”	3.51	1.91–6.46	1.255	0.311	0.0001	—	—	—
Male gender	1.82	1.02–3.25	0.596	0.297	0.04	—	—	—
<b>High motivation score for performing PhD curriculum (motivation score &gt;7; 75th IQR)</b>								
Model performance	—	—	—	—	—	78.7%	0.664	0.609–0.716
Do you think that integrating translational research in medical curriculum is: “essential”	5.94	2.33–15.19	1.782	0.479	0.0002	—	—	—
Do you know research units and facilities at your university: “yes, 2 and more”	2.63	1.46–4.77	0.969	0.303	0.001	—	—	—

95% CI=95% confidence interval, AUROC=area under the receiver operating characteristic curve, Coef=coefficient, OR=odds ratio, SE=standard error.

\* Multivariate regression logistic model (stepwise method).

† Percent of cases correctly classified.

In the present survey, male gender was independently and positively associated with a high motivation score for performing Research Master 2 curriculum. Gender inequities in academic medicine with a slower professional advancement of women faculty have largely been documented in the literature, with female gender being underrepresented in the leadership positions and women being less likely to be promoted to full professors regardless age, experience, research productivity, specialty and parental status.<sup>28–31</sup> Among physicians with appointments to faculty positions at US medical schools, there were 60,609 men versus 30,464 women.<sup>31</sup> Of those, 3623 women (11.9%) versus 17,354 men (28.6%) had full-professor status.<sup>31</sup> Furthermore, junior faculty women have been shown to receive significantly less institutional support to carry out research projects than men irrespective degree or experience.<sup>32</sup>

Recently, attempts have been made to promote gender equality in academic medicine focusing on institutional framework strategies.<sup>33,34</sup>

Altogether our results suggest that motivation of medical students to perform academic research curricula is highly influenced by the scientific environment within the university. Our findings emphasize the need for implementing new curricular frameworks in order to provide research training to students.

We have to acknowledge several limitations of this study. First, it is a nonexhaustive data collection from all medical students, residents and fellows attending the 2 participating Universities. However, the aim of the study was to look for predictors of strong motivation to perform academic research curricula on a representative sample of medical students,



residents and attending physicians from 2 French medical faculties. Second, the study was designed as a statement-based survey. Nevertheless, most of the responders were still on their medical curriculum and report their real-life experience, hence reducing the risk of recall bias.

### CONCLUSION

This study identified factors determining medical student motivations and barriers they face in relation to carry out academic research curricula. Data analysis of this survey allowed us to extract predictive factors independently associated with a high motivation score for performing academic research. The present study highlights the deficiencies in the training dedicated to translational research in medical studies and potential barriers to training. Improving these 2 areas will certainly have an impact on a better involvement of the next generation of physicians in translational medicine.

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