

## Characteristics and opinions of MD-PhD students and graduates from different European countries: a study from the European MD-PhD Association

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### Summary

**BACKGROUND:** MD-PhD programmes throughout the world provide a platform for medical trainees to commit to a physician-scientist career, qualifying with both a medical degree (MD or equivalent) and Doctor of Philosophy (PhD). However, there are limited studies assessing the characteristics of MD-PhD programmes in Europe and the outcomes of MD-PhD students and graduates.

**PURPOSE:** This study aims at a first country-wise exploration of characteristics, opinions, and academic outcomes of MD-PhD students and graduates in Europe.

**METHODS:** Two questionnaires were developed to assess the demographics, MD-PhD programme characteristics, opinions, future career paths and academic outcomes of European MD-PhD students and graduates. An online survey of 278 MD-PhD students and 121 MD-PhD graduates from nine and six European countries, respectively, was completed between April 2016 and December 2017. The country-wise categorical responses were then compared through chi-square analysis followed by multiple logistic regression.

**RESULTS:** Responses from 266 MD-PhD students and 117 MD-PhD graduates were considered valid. Significant country-wise differences ( $p < 0.05$ ) were observed for age group, resident status, clinical time allocation, duration of studies, sources of funding, publications, average impact factor of the journals in which the research was published, satisfaction with the duration of MD-PhD studies and future career choices of MD-PhD students. Responses related to self-perception about clinical and research competence and challenges faced during MD-PhD training did not show a significant country-wise difference.

**CONCLUSION:** The MD-PhD workforce in Europe is highly diverse in their demographics, programme characteristics and career paths but does not differ in opinions related to the challenges faced. The results of this study may be helpful for implementation and improvement of MD-PhD programmes.

**Keywords:** MD-PhD, physician-scientist, translational, outcome

### Introduction

A number of medical faculties around the world implement programmes that allow the combination of medical studies with a Doctor of Philosophy (PhD). These dual degree programmes, generally termed as MD-PhD, lead to a unique career path and development of physician-scientists. Physician-scientists are health professionals who have undergone substantial training in research, typically a PhD, in addition to the conventional clinical training. The aim of this training is to prepare the medical community for the increasing complexity of academic medicine and to accelerate the translation of basic research into clinical therapies. Such training programmes are most suited to medical students and physicians who wish to dedicate a substantial amount of effort to academic research [1].

The origin of physician-scientist education is in the USA, where the first organised MD-PhD programme was established in 1956. Currently, around 90 such programmes exist in the US [1]. However, there have been recent concerns about a steady decline in physicians opting for career paths with a primary focus on research [2, 3]. As a result, concerted efforts are being made to ascertain the opinions and academic outcomes of MD-PhD students and graduates to optimise the structure of existing and future MD-PhD programmes in the US [1, 4–15]. A recent such study ( $n = 6876$  MD-PhD alumni) by the Association of American Medical Colleges identified that the number of MD-PhD graduates in the US remains less than desired and they comprise a very small proportion of medical school graduates [4]. Nevertheless, MDPhDs are rendering a remarkable service to biomedical research and academic medicine and roughly three quarters of the MD-PhD graduates stay engaged in long-term research [4, 16].

Owing to the very pluralistic higher education system in Europe, MD-PhD/physician-scientist programmes in Europe are highly diverse in their curricular framework. First, the terminology for physician-scientist education is not consistent in Europe, with such programmes being labelled

**Author Contributions**  
FS, MK, VTB, RB, and AJ conceived the study and developed the survey tool with additional help from LF. ASR lead the data collection with significant contributions from JDK, MS, AJ and AN. ASR and AJ performed data mining and data analysis with additional help from DMAM. MS and LO collected and verified the data related to MD-PhD programme structures in different European countries. AJ, MS and ASR wrote the manuscript. JDK and AJ coordinated the study and helped in interpretation of the results. All the authors have read and approved the final manuscript.

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as *MD-PhD* in a majority of countries, such as in Switzerland, France and the Netherlands; *MB-PhD* in the United Kingdom (UK); and *Dr. med. Dr. rer. nat.* in Germany. In the context of this study, an MD-PhD graduate is defined as someone who has successfully obtained both the medical diploma and the PhD degree. Second, the programmes are extremely variable with regards to the timing of PhD studies. In France and the UK, the PhD thesis is integrated as a fulltime research period during medical school training. In the Netherlands, students alternate between periods of clinical and research placements during medical school. In Germany and Switzerland, the structures are inconsistent between institutions with some programmes incorporating PhD studies parallel to medical school studies, whereas others require a medical degree for enrolment of students to 80-100% research-commitment for the PhD (fig. 1).

This diversity of MD-PhD curricula in Europe allows a unique opportunity to study the effects of different MD-PhD training frameworks on the attitudes and challenges of MD-PhD students and graduates. To the best of our knowledge, the only assessments of MD-PhD students and graduates in Europe have been on students from single programmes or countries [17–20]. The European MD-PhD Association (EMPA), officially formed in 2015 as a networking platform of physician-scientists across Europe, is

uniquely placed to comprehensively assess the characteristics and outcomes of MD-PhD students and graduates in Europe because of its representation in different European countries [21]. The aim of the current study was to explore the demographics, career paths, and opinions regarding satisfaction and challenges of MD-PhD students and graduates from different European countries. Additionally, we outline the MD-PhD programme structures of the major countries where the study was performed. We note that differences in structure may influence the demographics and characteristics of the MD-PhD students and graduates. The results of this study may help as a direct feedback to the MD-PhD programme coordinators and policy makers to optimise MD-PhD curricula suitable to the preferences and challenges of the MD-PhD workforce, thus ensuring a greater commitment to stay engaged in a physician-scientist career. Finally, by giving insights in the structure and importance of MD-PhD programmes in Europe, this study could promote a better dissemination of such programmes.

## Methods

### Study design

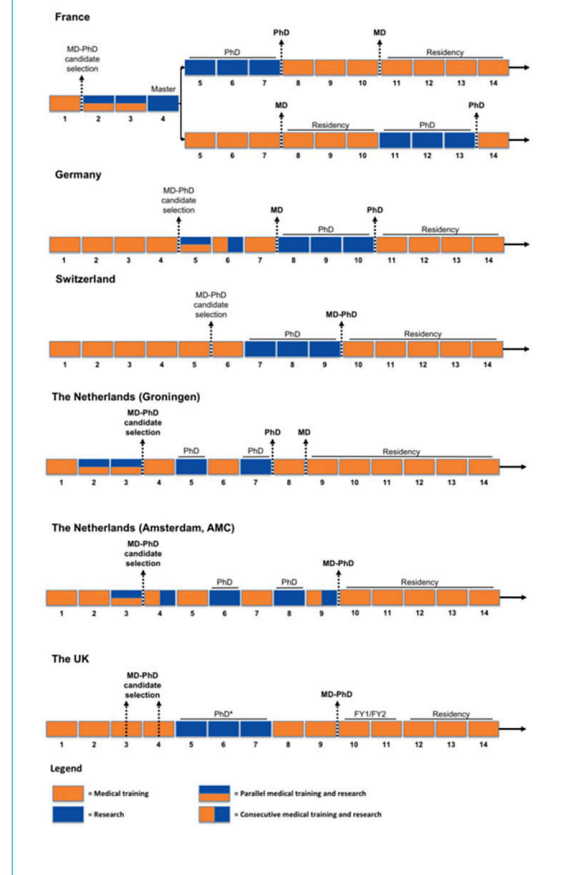
This study comprised a cross-sectional survey-based assessment of MD-PhD students and graduates from nine European countries overall. The anonymous survey was conducted amongst attendees of MD-PhD programmes: those who were currently enrolled in MD-PhD programmes (students) and those who had already graduated (graduates) at the time of completing the survey (April 2016 to December 2017). Students and graduates were invited to fill in the appropriate questionnaire (uploaded on a Google survey platform) based on their status. After initial contact, two more reminders were sent 6 and 12 months after the initial approach. The anonymity of participants was maintained throughout the process of data sampling and analysis. For countries with fewer than 10 responses, where the anonymity of the respondents could be compromised, the responses were pooled together in an arbitrary category “others”.

### Questionnaire development

The questionnaires were developed based on previously published studies [14, 18]. They included questions that assessed training characteristics, opinions, and outcomes of MD-PhD students and graduates and were adjusted from original resources (questionnaires are available in appendices 1 and 2). The feasibility of the surveys was tested through a pilot study on five MD-PhD students and graduates each from Switzerland and the Netherlands prior to the full data collection.

Two separate questionnaires were used for MD-PhD students and graduates. The questionnaire for students comprised closed-ended questions, which collected information regarding their demographics, training characteristics, current position and activity, career path, career goals, opinions about the utility of MD-PhD studies, publications, and their satisfaction with their MD-PhD studies. The questionnaire for graduates included questions related to the academic standing of MD-PhD graduates and their opinions related to the obstacles they have faced in pursuing a physician-scientist career, besides demographics. In addition, there was an opportunity for MD-PhD students

**Figure 1:** Representative structures of MD-PhD programmes in five European countries. Each block represents one year. Blue blocks represent research time; Orange blocks represent medical/clinical education. Both activities can also be done in parallel or consecutively. In the UK, MD-PhD students continue their clinical training throughout the research period. FY = foundation year; AMC = Academic Medical Centre



and graduates to give comments at the end of each survey. The opinion questions employed a Likert-like scale and showed a consistent clustering of responses, hence, precluding the need for a factor analysis.

### Ethical considerations

Informed consent was obtained from each participant to allow the use of their answers for anonymous recording, analysis and publication. The confidentiality of the participants was maintained through all phases of the study. An institutional review board (IRB) approval was not obtained for the study as the study was conducted solely from the EMPA platform.

### Data collection

Using a nonrandomised referral sampling (snow-ball sampling) method, study participants were contacted by members of the EMPA Executive Board and EMPA Board of Representatives, either personally or via institutional communication channels. For Switzerland and the Netherlands, MD-PhD student and graduate mailing lists were acquired by EMPA. In France, the French National MD/PharmD-PhD Association (Association Médecine/Pharmacie Sciences) relayed the survey to its members. In the UK, universities with official MD-PhD programmes were contacted to ask if surveys could be circulated to their MD-PhD students and graduates, inviting them to participate. For the remaining countries, social networks and personal contacts were used to recruit participants. Sampling did not follow a balanced European or country-wise distribution since the number of recipients was not known. Wherever possible, multiple institutes within a country were approached to participate. However, as a result of the referral sampling method, the exact affiliations of the participants is not clear in all the cases. Furthermore, confidentiality reasons precluded us from having access to participant lists of individual MD-PhD programmes. Thus, we were not able to calculate the response rate. A total of 278 surveys were completed by current MD-PhD students, out of whom 12 participants were excluded because of ambiguous or incomplete answers. Similarly, a total of 121 surveys were completed by MD-PhD graduates and 4 participants were excluded because of ambiguous answers. Only fully filled questionnaires were considered valid and included in the final analysis.

### Statistical analysis

Statistical analyses were performed using IBM SPSS Statistics version 25 [22]. Categorical variables were compared between MD-PhD students and graduates from different countries using the chi-square test. For questions assessing the future career choices of MD-PhD students, predictors with significant p-values on univariate analyses were further assessed through multivariate logistic regression to adjust for the effect of confounders. The confounders were individual predictors that showed significant differences ( $p < 0.05$ ) in univariate analysis and were used as reference points in multivariate modelling. Significant predictors were expressed by odds ratios (ORs) using specified reference categories. All results with a p-value less than 0.05 were considered significant.

## Results

### Structures of MD-PhD programmes

To have a clear overview of the differences in the structural frameworks of MD-PhD programmes in the countries assessed, the MD-PhD programme structures were verified through reliable resources (referenced articles and official websites) [18, 23–26]. As expected, country-wise differences are prominent in terms of the timings of MD-PhD candidate selection and periods of research during the MD-PhD studies in the most-represented countries. Furthermore, the programme structures are not always uniform within the same country (fig. 1).

### Demographics of MD-PhD students

The valid responses ( $n = 266$ ) were from France ( $n = 93$ ), Switzerland ( $n = 77$ ), the Netherlands ( $n = 45$ ), UK ( $n = 23$ ), Germany ( $n = 15$ ), Italy ( $n = 8$ ), Portugal ( $n = 3$ ), Georgia ( $n = 1$ ) and Norway ( $n = 1$ ). Responses from the countries with fewer than 10 participants (Italy, Portugal, Georgia, Norway) were grouped together in the “others” category ( $n = 13$ ). The gender distribution did not differ significantly ( $p > 0.05$ ) between different countries. Overall, 45 MD-PhD students were not citizens of the countries of their MD-PhD training. Eighteen MD-PhD students had non-European citizenship, including five participants from China, three from Morocco, two from Pakistan, and one each from Bangladesh, Brazil, Egypt, Indonesia, Iran, Mauritius, Mexico, Saudi Arabia, and South Korea. Germany (40%) and Switzerland (31.1%) had the highest proportion of foreign MD-PhD students. The majority of MD-PhD students from France (62.4%) and the UK (52.2%) were in the age group of 20–24 years, whereas the majority of students from Switzerland (64.9%) and the Netherlands (60.0%) were in the 25–29 years old category (table 1).

Significant differences ( $p < 0.05$ ) between countries were observed in the MD-PhD curricular track followed by MD-PhD students. A majority of MD-PhD students were medical students in France (83.9%), Germany (60.0%), the Netherlands (66.7%) and the UK (100.0%) compared with Switzerland where the majority (77.9%) of MD-PhD students were already medical graduates.

Similarly, there was diversity between European countries regarding the clinical time during MD-PhD studies, with a vast majority of MD-PhD students in France, Germany, Switzerland and the UK having less than 20% time allocated to clinics. Further, the duration of MD-PhD studies was significantly shorter in the Netherlands (60% less than 3 years) and the Netherlands was unique in terms of having a vast majority (93.3%) of their MD-PhD students being funded through MD-PhD scholarships (table 1).

### Attitudes and academic outcomes of MD-PhD students

A significant country-wise difference ( $p < 0.05$ ) was observed between MD-PhD students in terms of peer-reviewed publications that they had published or expected to publish during their MD-PhD studies, with the Netherlands being the only country where a majority of students (66.7%) expected to publish more than five articles.

When queried about the utility of MD-PhD studies, MD-PhD students from all countries agreed that MD-PhDs are

not better than non-clinician graduates with PhDs in terms of their competence as researchers. Similarly, a majority of MD-PhD students, irrespective of the country, were of the opinion that MD-PhDs are not better clinicians than MDs without PhDs. However, with regards to satisfaction with the duration of studies, there was a country-wise difference as a substantial proportion (31.1%) of the MD-PhD students from the Netherlands found it to be too short (table 2).

### Determinants of future career choices of MD-PhD students

To ascertain which factors influence the future career choices of MD-PhD students, a multivariate logistic regression model was built including all factors queried, which turned out to be significantly different ( $p < 0.05$ ) among students from different countries. These factors included: age group, resident status, clinical time during MD-PhD studies, duration of MD-PhD studies, provision of funding for MD-PhD by the host laboratory or through an MD-PhD scholarship, publications during MD-PhD studies, average impact factor of the journals in which students published in or aimed to publish in, satisfaction with the duration of MD-PhD studies and the importance of different factors when deciding on a future career. Based on the model, a strong preference (OR 8.28, 95% confidence interval [CI] 2.09–32.79) for not doing basic science research was found among MD-PhD students from the Netherlands. A similar preference for not doing basic science research was also observed for MD-PhD students who had not published or expected to publish during their studies (OR 6.94, 95% CI 1.31–36.81). Similarly, not per-

forming clinical duties during MD-PhD studies was associated with a lack of interest in doing clinical research (OR 2.11, 95% CI 1.12–3.99) or considering a 100% clinical career (OR 0.01, 95% CI 0.00–0.23) in the future. On the contrary, students who did not consider opportunities for patient care or financial security as important factors in deciding their future showed an inclination towards a 100% research career (table 3).

### Demographics, outcomes and opinions of MD-PhD graduates

The valid responses ( $n = 117$ ) were from graduates who completed MD-PhD programmes in six different European countries: Switzerland ( $n = 54$ ), the Netherlands ( $n = 45$ ), France ( $n = 7$ ), the UK ( $n = 6$ ), Germany ( $n = 3$ ) and Romania ( $n = 2$ ). Responses from countries with fewer than 10 responses were grouped together as the “other” category ( $n = 18$ ). A significantly higher proportion (66.7%) of females were present in the group of MD-PhD graduates from the Netherlands. A majority (60%) of the MD-PhD graduates from the Netherlands were engaged in clinical research, compared with the graduates from Switzerland who were involved in basic science or translational research (55.6%). The graduates from these countries also differed in terms of publication outcomes after their MD-PhD studies: whereas the majority (75.6%) of graduates from the Netherlands did not publish after their MD-PhD, the majority of graduates from Switzerland reported either between one and five (40.7%) or six or more (35.2%) publications (table 4). It is noteworthy that, despite these differences, MD-PhD graduates from different countries were in consensus when asked about major obstacles they

**Table 1:** Demographic and curricular details of current MD-PhD students according to the country of training. Data are percentages of MD-PhD students.

|  |                    | France<br>(n = 93) | Germany<br>(n = 15) | Switzerland<br>(n = 77) | The<br>Netherlands<br>(n = 45) | UK<br>(n = 23) | Others<br>(n = 13) | Total<br>(n = 266) | p-value<br>( $\chi^2$ ) |
|--|--------------------|--------------------|---------------------|-------------------------|--------------------------------|----------------|--------------------|--------------------|-------------------------|
| Gender (%)   | Females            | 44.1               | 46.7                | 35.1                    | 53.3                           | 21.7           | 46.2               | 41.4               | ns                      |
|  | Males              | 55.9               | 53.3                | 64.9                    | 46.7                           | 78.3           | 53.8               | 58.6               |                         |
| Resident status (%)  | Foreigners         | 7.5                | 40.0                | 31.2                    | 2.2                            | 17.4           | 23.0               | 20.4               | ***                     |
|  | Natives            | 92.5               | 60.0                | 68.8                    | 97.8                           | 82.6           | 77.0               | 79.6               |                         |
| Age group (%)  | <24                | 68.9               | 33.3                | 3.9                     | 33.3                           | 52.2           | 46.2               | 39.5               | ***                     |
|  | 25–29              | 18.3               | 26.7                | 64.9                    | 60.0                           | 43.5           | 46.2               | 42.9               |                         |
|  | >30                | 12.8               | 40.0                | 31.2                    | 6.7                            | 4.3            | 7.6                | 17.6               |                         |
| Current status (%)   | Medical student    | 83.9               | 66.7                | 20.8                    | 66.7                           | 100.0          | 100.0              | 63.2               | ***                     |
|  | Medical graduate   | 9.7                | 33.3                | 77.9                    | 33.3                           | –              | –                  | 34.2               |                         |
|  | Other†             | 6.4                | –                   | 1.3                     | –                              | –              | –                  | 2.6                |                         |
| Clinical time during MD-PhD studies (%)                        | None               | 32.3               | 60.0                | 41.6                    | 8.9                            | 43.5           | 23.1               | 33.1               | ***                     |
|  | <20%               | 25.8               | 26.7                | 50.6                    | 42.2                           | 43.5           | 23.1               | 37.2               |                         |
|  | 20–39%             | 8.6                | 6.7                 | 6.5                     | 1.1                            | –              | 17.4               | 8.8                |                         |
|  | 40–59%             | 11.8               | –                   | 1.3                     | 31.1                           | –              | 15.4               | 10.5               |                         |
|  | ≥60%               | 21.5               | 6.6                 | –                       | 6.7                            | 13             | 4.2                | 10.5               |                         |
| Duration of MD-PhD studies (%)                                 | <3 years           | 7.5                | 20.0                | 3.9                     | 60.0                           | –              | –                  | 15.0               | ***                     |
|  | 3–3.5 years        | 23.7               | 46.7                | 70.1                    | 11.1                           | 43.5           | 69.2               | 40.2               |                         |
|  | 4–4.5 years        | 11.8               | 20.0                | 24.7                    | 24.4                           | 4.3            | –                  | 16.9               |                         |
|  | ≥5 years           | 57.0               | 13.3                | 1.3                     | 4.5                            | 52.2           | 31.8               | 27.9               |                         |
| Possibility of training in a foreign country during MD-PhD (%) | Yes                | 31.2               | 26.7                | 27.3                    | 31.1                           | 21.7           | 61.5               | 30.5               | ns                      |
|  | No                 | 68.8               | 73.3                | 73.7                    | 68.9                           | 78.3           | 38.5               | 69.5               |                         |
| Funding for MD-PhD provided by (%)‡                            | Host laboratory    | 49.5               | 53.3                | 63.6                    | 8.9                            | 43.5           | 43.5               | 45.5               | ***                     |
|  | MD-PhD scholarship | 40.1               | 53.3                | 37.7                    | 93.3                           | 56.5           | 69.2               | 51.9               |                         |

† Students doing a PhD in addition to a degree in veterinary or dental medicine; ‡ other sources of funding are not shown. \*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$ , ns = non-significant

have faced in pursuing a physician-scientist career. Approximately half of the MD-PhD graduates across different countries identified lack of opportunity (range 42.6–61.1%), lack of funding (range 42.6–66.7%) and lack of work-personal life balance (range 38.9–53.7%) as the major challenges. However, the majority of MD-PhD graduates agreed that not finding a position in the desired location, discrimination or under-compensation were not major obstacles in this regard (table 5).

## Discussion

This study outlines the structure of MD-PhD programmes in six countries in Europe, highlighting differences in their timing, duration and curricular framework. Concurrently, a survey of European MD-PhD students and graduates reveals significant country-wise differences in terms of the type of research performed and future career choices but no differences in terms of the challenges faced during the training.

The importance of physician-scientist education is increasingly emphasised in the scientific community to bridge the gap between the laboratory bench and the patient bedside. A number of world-renowned universities have now in-

**Table 2:** Academic outcomes and attitudes of current MD-PhD students according to the country of training. Data are percentages of MD-PhD students.

|   |                                  | France<br>(n = 93) | Germany<br>(n = 15) | Switzerland<br>(n = 77) | The Netherlands<br>(n = 45) | UK<br>(n = 23) | Others<br>(n = 13) | Total<br>(n = 266) | p-value<br>( $\chi^2$ ) |
|---|----------------------------------|--------------------|---------------------|-------------------------|-----------------------------|----------------|--------------------|--------------------|-------------------------|
| Publications and/or expected publications during MD-PhD studies (%) | <2                               | 44.1               | 46.7                | 36.4                    | 8.9                         | 43.5           | 76.9               | 37.2               | ***                     |
|   | 3–4                              | 31.2               | 20.0                | 41.6                    | 24.4                        | 21.7           | 15.3               | 31.2               |                         |
|   | ≥5                               | 24.7               | 33.3                | 22.0                    | 66.7                        | 34.8           | 7.8                | 31.6               |                         |
| Average impact factor of the journals (%)                           | <5                               | 20.4               | 33.3                | 48.1                    | 51.2                        | 26.1           | 30.8               | 35.3               | ***                     |
|   | ≥5                               | 17.2               | 20.0                | 14.3                    | 37.7                        | 21.7           | 7.7                | 19.9               |                         |
|   | N/A, would not like to disclose  | 62.4               | 46.7                | 37.6                    | 11.1                        | 52.2           | 61.5               | 44.8               |                         |
| Do you think MD-PhDs are better researchers than PhDs? (%)          | Yes                              | 17.2               | 20.0                | 15.6                    | 13.3                        | 13.0           | 23.3               | 18.5               | ns                      |
|   | No                               | 82.8               | 80.0                | 84.4                    | 86.7                        | 87.0           | 76.7               | 81.5               |                         |
| Do you think MD-PhDs are better researchers than MDs? (%)           | Yes                              | 78.5               | 80.0                | 87.0                    | 80.0                        | 78.3           | 53.8               | 80.1               | ns                      |
|   | No                               | 21.5               | 20.0                | 13.0                    | 20.0                        | 21.7           | 46.2               | 19.9               |                         |
| Do you think MD-PhDs are better clinicians than MDs? (%)            | Yes                              | 29.0               | 6.7                 | 18.2                    | 26.7                        | 17.4           | 30.8               | 23.3               | ns                      |
|   | No                               | 71.0               | 93.3                | 81.8                    | 73.3                        | 82.6           | 69.2               | 76.7               |                         |
| Are you satisfied with the duration of your MD-PhD? (%)             | Just right                       | 73.1               | 63.6                | 72.7                    | 66.7                        | 87.0           | 76.9               | 72.9               | ***                     |
|   | Too little                       | 4.3                | 13.3                | 3.9                     | 31.1                        | 13.0           | 23.1               | 10.9               |                         |
|   | Too much                         | 22.6               | 23.1                | 23.4                    | 2.2                         | –              | –                  | 16.2               |                         |
| An important factor in deciding your future career path would be:§  | Opportunity for research (%)     | 83.9               | 80.0                | 77.9                    | 68.9                        | 87.0           | 76.9               | 79.3               | ns                      |
|   | Opportunity for patient care (%) | 59.1               | 53.3                | 50.6                    | 88.9                        | 52.2           | 61.5               | 60.9               | ***                     |
|   | Financial security (%)           | 32.2               | 60.0                | 27.2                    | 26.7                        | 43.5           | 23.0               | 32.0               | ns                      |
|   | Work-personal life balance (%)   | 47.3               | 53.3                | 44.2                    | 68.9                        | 60.1           | 69.2               | 51.1               | ns                      |

† PhDs = non-clinician graduates with PhDs; ‡ = clinicians without a PhD; § Data on other potentially important factors in selecting future careers are not shown: opportunities for teaching, community service, travel or international work, ability to balance work and personal life, and prestige \* p < 0.05, \*\* p < 0.01, \*\*\* p < 0.001, ns = non-significant

**Table 3:** Significant determinants of future career choices of current MD-PhD students established through multiple logistic regression. Independent associations of variables that are different in MD-PhDs from different countries are assessed against questions related to their future career paths.

| Future career path  | Potential predictors   | Odds ratio   | p-value (95% confidence interval) |                 |
|---|--|--|-----------------------------------|-----------------|
| Will not do basic research in future                      | MD-PhD training in the Netherlands compared to other countries                                     | 8.28   | * (2.09–32.79)                    |                 |
|   | Zero articles during MD-PhD studies compared to having one or more publications                    | 6.94   | * (1.31–36.81)                    |                 |
| Will not do clinical research in future                   | No clinical duties during MD-PhD studies compared to 20% or more time allocated to clinical duties | 2.11   | * (1.12–3.99)                     |                 |
| Allocation for research/clinical time in an ideal career† | 100% clinical  | No clinical duties during MD-PhD studies compared to 20% or more time allocated to clinical duties | 0.01                              | *** (0.00–0.23) |
|   | 100% research  | Opportunity for patient care is not an important factor for deciding future career                 | 9.63                              | ** (1.93–47.95) |
|   |  | Financial security is not an important factor for deciding future career                           | 6.56                              | * (1.11–38.92)  |
|   | 75% clinical, 25% research   | MD-PhD training in the Netherlands compared to other countries                                     | 8.49                              | * (1.09–66.26)  |

† No significant factors were identified related to “25% clinical, 75% research” or “50% clinical, 50% research” options. \* p < 0.05, \*\* p < 0.01, \*\*\* p < 0.001

tegrated clinical medicine into their biology programmes [27]. Moreover, MD-PhD programmes are now successfully in place around the world, including in Asia and Australia [1, 21, 28–30]. With the rapid expansion of such programmes in different European countries [18–20], it is important that the structure of MD-PhD training is dynamically adapted to alleviate the challenges for current MD-PhD students and to attract the best talents among medical students for MD-PhD training. The heterogeneity of MD-PhD curricula in Europe allows a unique opportunity to ascertain the effects of these inter-curricular variations on the programme characteristics, career choices and academic outcomes of MD-PhDs. The results of this study suggest that variation in the curricular structure does indeed influence the career choices and academic outcomes of MD-PhD students in different European countries.

Major differences were observed between different countries among MD-PhD students, as well as, MD-PhD graduates. These included age group, clinical time during MD-PhD studies and engagement of graduates with basic and clinical research, and could be explained by the curricular differences. However, it is unknown whether students interpreted clinical time during their MD-PhD studies as clinical time during the PhD or throughout the MD-PhD training. Reasonably, the majority of graduates from the

Netherlands, where MD-PhD studies have a clear focus on clinical research, are also more engaged in clinical research. For instance, the MD-PhD curriculum in the medical university of Groningen, which had a substantial representation in the responses from the Netherlands, has some unique characteristics. It is an accelerated MD-PhD programme with a usual allocation of 2 years as dedicated research time. It is important to consider that this provision also influences the type of research performed, with a preference for clinically oriented research. Furthermore, the students from the Netherlands considered an opportunity for patient care as an important factor in deciding their future career path, highlighting a greater emphasis on clinical care in the Dutch MD-PhD curriculum.

Interestingly, across the different European countries, the majority of MD-PhD students believed that their research competence is not better than non-clinician graduates holding a PhD and that their clinical acumen and skills are not better than clinicians without a PhD. To the best of our knowledge, there is no clear evidence that the quality of academic or clinical performance differs between MD-PhDs and PhDs and MDs.

A comparison of our study with previous similar studies indicates some disparities in the opinions of MD-PhD students and graduates. Whereas MD-PhD graduates in our

**Table 4:** Demographic and academic outcomes of MD-PhD graduates according to the country of training. Data are percentages of MD-PhD graduates.

|  |  | Switzerland<br>(n = 54) | The Netherlands<br>(n = 45) | Others<br>(n = 18) | Total<br>(n = 117) | p value<br>( $\chi^2$ ) |
|--|--|-------------------------|-----------------------------|--------------------|--------------------|-------------------------|
| Gender (%)                             | Females  | 33.3                    | 66.7                        | 33.3               | 46.2               | **                      |
|  | Males  | 66.7                    | 33.3                        | 66.7               | 53.8               |                         |
| Resident status (%)                    | Foreigners   | 18.5                    | 6.7                         | 28.6               | 14.5               | ns                      |
|  | Natives  | 81.5                    | 93.3                        | 71.4               | 85.5               |                         |
| Age group (%)                          | <30  | 7.4                     | 66.7                        | 22.2               | 32.5               | **                      |
|  | ≥30  | 92.6                    | 33.3                        | 77.8               | 67.5               |                         |
| Duration of MD-PhD studies (%)         | ≤3 years   | 22.2                    | 40.0                        | 22.2               | 29.1               | **                      |
|  | 4 years  | 68.5                    | 33.3                        | 44.4               | 51.3               |                         |
|  | ≥5 years   | 9.3                     | 26.7                        | 33.4               | 19.6               |                         |
| Nature of current research (%)         | Basic science or translational                     | 55.6                    | 28.9                        | 61.1               | 46.2               | *                       |
|  | Clinical   | 25.9                    | 60.0                        | 16.7               | 36.8               |                         |
|  | Public health / policy making / not doing research | 18.5                    | 11.1                        | 22.9               | 17.0               |                         |
| Publications during MD-PhD studies (%) | <2   | 24.1                    | 51.1                        | 38.9               | 36.8               | *                       |
|  | 3–4  | 48.1                    | 11.1                        | 33.3               | 31.6               |                         |
|  | ≥5   | 27.8                    | 37.8                        | 27.8               | 31.6               |                         |
| Publications after MD-PhD studies (%)  | None   | 24.1                    | 75.6                        | 22.2               | 43.6               | **                      |
|  | 1–5  | 40.7                    | 22.2                        | 38.9               | 33.3               |                         |
|  | ≥6   | 35.2                    | 2.2                         | 38.9               | 23.1               |                         |

\* p < 0.05, \*\* p < 0.01, \*\*\* p < 0.001, ns = non-significant

**Table 5:** Challenges faced by MD-PhD graduates according to the country of training. Percentages of MD-PhD graduates who considered each factor to be an obstacle in pursuing a physician-scientist career are shown.

| A major obstacle in pursuing a physician-scientist career has been: (%)              | Switzerland<br>(n = 54) | The Netherlands<br>(n = 45) | Others<br>(n = 18) | Total<br>(n = 117) | p-value<br>( $\chi^2$ ) |
|--|-------------------------|-----------------------------|--------------------|--------------------|-------------------------|
| Lack of opportunity/funding  | 42.6                    | 66.7                        | 61.1               | 44.4               | ns                      |
| Not finding position in the desired location   | 13.0                    | 31.1                        | 27.8               | 22.2               | ns                      |
| Lack of mentoring  | 46.3                    | 33.3                        | 33.3               | 39.3               | ns                      |
| Under-compensation   | 20.4                    | 20.0                        | 38.9               | 23.1               | ns                      |
| Discrimination against your gender / ethnicity / sexual orientation / any other bias | 7.4                     | 0                           | 11.1               | 5.1                | ns                      |
| Work-personal life balance   | 53.7                    | 40.0                        | 38.9               | 46.2               | ns                      |
| Unsatisfactory professional advancement  | 44.4                    | 35.6                        | 27.8               | 38.5               | ns                      |

ns = non-significant

study identified lack of opportunity, funding and work-personal life balance as major obstacles in pursuing a physician-scientist career, a previous study from Switzerland in 2009 had identified lack of mentoring as the major obstacle in combining a physician-scientist career amongst MD-PhD students and graduates [18]. However, this issue seems to have been addressed, as only one third of the Swiss MD-PhD graduates identified lack of mentoring as a challenge in the current study. Furthermore, while the US physician-scientist workforce has in the past considered lower salary as a critical problem [1], only 23% of European MD-PhD graduates identified it as a challenge in our study. However, the range of responses here is broad (20% in Switzerland to 39% in “others”), which raises the possibility that this could be a challenge in some countries that may be underrepresented in the current study. In accordance with our findings, an Australian study also identified time and work-personal life balance as key problems faced by MD-PhD students [31].

The current study has several strengths. First, there are limited number of studies exploring the MD-PhD programme characteristics, opinions, career choices and outcomes of MD-PhD students and graduates. No such studies exist for some countries included in our analysis. Hence, results of this survey could serve as critical feedback to universities running MD-PhD programmes in these countries. Second, the diversity of MD-PhD programmes in Europe offers an opportunity to study the influence of diverse curricula on the opinions, career choices and outcomes of MD-PhD students and graduates. Third, a parallel analysis of students and graduates provides some insight, albeit limited, into how the opinions of MD-PhDs are shaped during and after their training, although this warrants a prospective investigation.

However, limitations of the study must be considered when interpreting the results. First, owing to the sampling strategy, a response bias cannot be eliminated. For example, there was an over-representation of the responses from the University of Groningen among the students from the Netherlands compared with the students from other universities. Second, the number of participants from different countries was not equal. However, use of nonparametric tests (chi-square) precludes any major bias resulting from these differences. Third, there is a disparity in the country-wise representation of MD-PhD students and graduates, and it is recognised that not all European MD-PhD students and graduates completed the surveys because, for example, of contact details being unavailable or out of date. Fourth, as a result of curricular differences, students’ and graduates’ interpretation of the survey may have been different. Fifth, the responses of the MD-PhD students are from nine different countries, whereas the responses of the graduates are from six different countries. It would have been ideal to have a consistent country-wise representation for students and graduates, but systematic access to MD-PhD graduates was not achieved. Finally, the sample size for the graduates was limited, warranting caution in generalising the results of this study.

In conclusion, this first survey of MD-PhD students and graduates across Europe shows strong effects of curricular frameworks on opinions, career choices and outcomes of MD-PhD students. Surprisingly, despite a huge diversity

in MD-PhD training, perceptions about their clinical and research competence and challenges faced by MD-PhDs are similar. This up-to-date summary of European physician-scientists’ early career paths can serve as an invaluable source for medical universities when implementing new MD-PhD programmes or optimising current ones.

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Appendix 1

**Questionnaire for students**

Appendix 2

**Questionnaire for graduates**

The appendices are available in separate files at <https://smw.ch/article/doi/smw.2020.20205>.