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Cultural and academic barriers toward physician-scientist (MD-PhD) careers: A mixed methods study

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Abstract: In Saudi Arabia, there is yet to be a single MD-PhD program established despite calls for its implementation. Herein, we assess students' and stakeholders' perceived barriers and opinions towards the implementation of such a program. A mixed-method design was used. For the quantitative part, a sample of 190 medical students completed a pre-validated survey that addressed procedural, bureaucratic, and environmental challenges to the implementation of the program. In addition, three semi-structured interviews with stakeholders had been carried out to address the implementation of an MD-PhD track. While the semi-structured interviews resulted in a wide array of responses, most students indicated that limited funding (55.7%) and predicted high workload (63.2%) were amongst the most significant hurdles to enrolling in an MD-PhD if offered to do so. In addition, first-generation students and female students were less likely to encourage the establishment of such a program. This study reported multiple significant barriers to pursuing an MD-PhD track in the Kingdom of Saudi Arabia. The findings of this study reflect the complexity of implementing an MD-PhD program in the country and can be useful for concerning bodies to holistically consider predicted barriers that students may face when establishing an MD-PhD.

Subjects: Educational Research; Education Studies; Higher Education Management; Study of Higher Education; Teaching & Learning; Education & Development; Medicine; Allied Health

Keywords: MD-PhD; academia; physician-scientist; medical education

1. Introduction

Research plays a major role in the advancement of health within a community. An MD-PhD is a program first established in the 1950's at Johns Hopkins University in the United States. The program was then adopted by Europe in the late 80's and early 90's. MD-PhD programs combine completion of an undergraduate (or graduate) MD degree integrated with a PhD degree. It is structured such that the first two years are dedicated toward the pre-clinical studies of a candidate's MD degree, followed by 3–4 years dedicated towards their PhD and the last two years being dedicated toward their final clinical years of their MD degree.

MD-PhD programs provide for multifaceted physician-scientists equipped with training that allows them to translate research from the bench-to-bedside in their communities and elsewhere(Bonham, 2014). A survey of all MD-PhD graduates from the University of Geneva between 2010–2019 revealed

that almost all graduates were satisfied with the program, considered it beneficial to their career, and if given the same choice, would do it again(Santos Rocha et al., 2020).

Such programs still are not widely adopted, despite the calls for their implementation(Abu-Zaid et al. 2016). While innovative ideas have been developed to ensure the integration of research into the undergraduate medical education panorama by targeted programs, such as the undergraduate research committee at Alfaisal University(Alamodi et al., 2014), little has been done elsewhere. (Eley et al., 2017) conducted a study in 2017 to assess the Australian medical students' perspective on the program. They found that the majority of negative perceptions concerned time, funding, and pathway. If those issues were solved, most students indicated that they would choose the program because it would improve their resume; allow some to pursue a strong interest in a particular research area; help others become better physicians; and add up to developing some research skills, pursuing an academic career, or publishing a paper in a respected journal. Similarly, perceptions toward such careers have been reported to be positive among the medical student population in Saudi Arabia, despite the lack of such programs in the country, with many misconceptions that need to be addressed (Althubaiti & Althubaiti, 2018).

Herein, we aimed to evaluate the opinions and perceived barriers toward implementing such a program in the Kingdom of Saudi Arabia by surveying medical students and interviewing physicians, stakeholders, as well as university professors within the medical community for in hope to decipher the barriers and help draft educational policies that may contribute to the implementation of an MD-PhD program in the Kingdom.

2. Materials and methods

We conducted a cross-sectional sequential, explanatory, mixed-methods study at King Saud bin Abdulaziz University for Health Sciences (KSAU-HS) in Jeddah, Kingdom of Saudi Arabia. The purpose of this study was to assess perceived cultural and academic barriers quantitatively and qualitatively among medical students and stakeholders toward physician-scientist careers (MD-PhD) at a public medical college in Jeddah. The subjects of this study include medical students in their final 5th and 6th years. First to fourth-year medical students were excluded from the study because they have not yet transitioned into their clinical practice as well as for the fact that they are more likely not to have a complete, well-informed input toward future career prospects for medical graduates. Quantitative data was collected using an electronic survey that was sent to medical students, and qualitative data was collected by conducting in-depth interviews with the stakeholders.

The used questionnaire was self-built based on a comprehensive literature review, and both content validity and face validity were done using three experts' opinions and four medical students to ensure the quality and clarity of the questions. The questionnaire entailed three subsections, each corresponding to a specific area of our study. Questions included were of multiple choice and dichotomous style. The first section of the survey aimed to collect demographic information from participants, including sex, marital status, academic year, and specialty of interest in addition to grade point average (GPA), family income, and whether participants identified as first-generation medical students. This section ensured complete confidentiality and privacy. Thus, no names, phone numbers, email contacts, or any other information that could possibly reveal the identity of participants enrolled in the study were collected. The second section of the questionnaire included questions corresponding to perceptions toward physician-scientist careers and its barriers. Questions pertaining to pay and individual characteristics were addressed here using a 5-point Likert scale. The third and final section contains two questions that assess the students' willingness to encourage the establishment of an MD-PhD program, and also if they would encourage aspiring students to join such a program if it exists. For the qualitative data, in-depth interviews with selected physicians and stakeholders helped us to collect information about decision makers' perceptions regarding cultural and academic barriers towards a professional

Table 1. Interview questions

No.	Question
1.	What should be the entry requirements for an MD-PhD (i.e., previous qualification)?
2.	What aspects of an MD-PhD program will be interesting compared to the MD program, considering its impact on patients, educators, university, and competencies of graduates?
3.	Can you list the top 3 resources needed to implement an MD-PhD program?
4.	What are the current career pathways for MD-PhD graduates?
5.	From your perspective, what are the challenges of implementing an MD-PhD nowadays?
6.	Overall, do you support the implementation of an MD-PhD program track?

physician-scientist career. The questions were prepared based on literature review and three experts' opinions (see, Table 1).

Three interviews and one pre-test interview were conducted. Each interview was conducted by an interviewer and was later reviewed and transcribed by two independent authors of this study (IO, AA), except for one interview where the interviewee refused recording due to their sensitive position and the interview was actively transcribed by its interviewee. Initially, six potential interviewees were identified with variation of background from different sectors and authorities having been considered. Only three interviewees accepted our invitation to join this study whom they were 1) the dean of one of the top three colleges of medicine in Saudi Arabia, 2) the Chief Executive Officer of a commission responsible for all regulatory rules concerning medical colleges and healthcare dynamics in Saudi Arabia, and 3) a physician-scientist at a leading research hospital in Saudi Arabia. Because of interviewee confidentiality, their names were replaced by an abbreviation that indicated their position. The DEan, CEO in the COMmission, and REsearcher are shown later on respectively as DE, COM, and RE.

3. Data analysis

Data management and analyses were carried out using JMP®, Version 15. SAS Institute Inc., Cary, NC, 1989–2021. Results were presented in frequencies and percentages, mean and standard deviation (SD), and median (maximum, minimum). Chi-square test and Fisher's exact test were performed to test for any association between participants' characteristics and opinions\perceived barriers about establishing MD-PhD program. These associations were declared significant by a two-sided p-value of less than 5%. As this was a mixed methods study, findings and discussion are presented together in the following section.

4. Results and discussion

4.1. Demographics

This study included a total of 190 medical students. The mean ± SD age of the students was around 23 ± 1.5 years and the majority of them were males (n = 122, 64.2%). This is in accordance with the proportion of male-to-female students in their fifth and sixth years attending the college (i.e., 6:4). Most participants were 5th year medical students (n = 120, 63.2%) followed by 6th year medical students (n = 70, 36.8%), of which the majority had a GPA of above 4.5 out of 5 (n = 140, 73.7%). Out of all those students, only 8.4% (n = 16) have obtained a previous bachelor's degree before enrolling in medical school. Job satisfaction and work-life balance had been reported elsewhere as influential factors in medical student career intention in the general practice (Lane et al. 2014), we expect a similar theme in pursuing academic and clinical research duties, which could best explain the students' reported future career intentions whom when asked about career intention, approximately 94.2% (n = 179) reported that they intended to pursue clinical duties, followed by academia (n = 78, 41.1%) and clinical research (n = 64, 33.7%). Further details about participants' characteristics are presented in Table 2.

Table 2. Participants' characteristics	
Age, years	Mean ± SD
	23 ± 1.5
GPA (out of 5)	Median (max, min)
	4.79 (3.70, 4.97)
Sex	n (%)
Female	68 (35.8)
Male	122 (64.2)
Educational level	n (%)
5th year	120 (63.2)
6th year	70 (36.8)
Prior bachelor's degree	n (%)
Yes	16 (8.4)
No	174 (91.6)
First-in-family to attend medical school	n (%)
Yes	95 (50)
No	95 (50)
Family income	n (%)
<15,000 SAR	35 (18.4)
15,001–20,000 SAR	27 (14.2)
20,001–25,000 SAR	31 (16.3)
25,001–30,000 SAR	22 (11.6)
>30,000 SAR	75 (39.5)
Career intention (pick whichever applies)	n (%)
Clinical duties	179 (94.2)
Clinical research	64 (33.7)
Academia	78 (41.1)
Administration	27 (14.2)
Basic medical science research	9 (4.7)

Total number of participants = 190.
Abbreviation: GPA, Grade Point Average; SAR, Saudi Arabia Riyals

4.2. Barriers toward physician-scientist careers (MD-PhD)

Unlike in the United States, where the Medical Scientist Training Program (MSTP)(National Institute of General Medical Sciences | National Institutes of Health, 2021) exists, a dedicated program to fund physician-scientist (MD-PhD) students remains to be established in Saudi Arabia. Nonetheless, a study by Kwan and colleagues(Kwan et al., 2017) has reported that medical students with intense research career intentions (MD-RI) listed research funding as a major concern in pursuing research. Likewise, the majority of the students in our survey "agreed" (n = 70, 36.8%) or "strongly agreed" (n = 36, 18.9%) about having concerns regarding locating funds for their future research. Additionally, only a minority of students (n = 65, 34.2%) "disagreed" or "strongly disagreed" that the substandard conditions at their institution limited their interest in pursuing a PhD and 40% (n = 76) were concerned about the unavailability of samples or patients. This is in accordance with one study at Taibah University(Noorelahi et al., 2015), Saudi Arabia where medical students had reported inadequate facilities, samples, and patients as major obstacles in pursuing research. This phenomenon could be better explained by the fact that research laboratories at Saudi medical colleges are established with the intention of conducting basic science-level experiments, not graduate-level research. Students also "agreed" (n = 68, 35.8%) or "strongly agreed" (n = 52,

27.4%) that they would only be able to contribute a minority of their time to clinical duties if they were to pursue a physician-scientist career, and approximately 65.7% (n = 125) reported concerns about dedicating enough time to raising their families. This comes as no surprise as many studies in the literature had reported similar outcomes among medical students, citing work-life balance as the main barrier, among others, in pursuing a PhD or a research-scientist career(Kwan et al., 2017; Kwan et al., 2020). About 58.4% (n = 111) of the participants either "disagreed" or "strongly disagreed" about having sufficient exposure to MD-PhD physician scientists in medical school. This lack of mentors has been reported elsewhere (Andriole & Jeffe, 2016) as a major predictor that deters MD/PhD graduates from pursuing academic careers post-graduation, especially among underrepresented students, and could be a re-emerging theme in our Saudi community. Overall, 70% (n = 133) of students reported that MD-PhD physician scientists are much needed in our local community, which reflects appropriate understanding of our participants of the vital role MD-PhD physicians play in their communities and beyond. Results related to perceived challenges towards pursuing a physician scientist career are presented in Table 3.

4.3. Supporting the establishment of an MD-PhD program

When asked about their opinion regarding the establishment of an MD-PhD program in the Kingdom of Saudi Arabia, 82.6% (n = 157) reported that they do encourage the establishment of such a program (Table 2). Furthermore, 70.5% (n = 134) stated that they would encourage incoming students to apply to an MD-PhD program if a well-structured program gets established in the future.

Table 4 and Table 5 showed that significant differences were found when comparing sex and educational level with the willingness of a student to encourage the establishment of an MD-PhD program. For instance, males (p-value = 0.013) and 6th year students (p-value = 0.014) were more likely to encourage the establishment of such a program. We suspect that 6th-year students were more likely to encourage the establishment of such a program as they were more aware of the need to increase career pathways for medical students post-graduation, especially considering the fact that the Saudi match has a 47% un-match rate according to statistics published by the Saudi Commission for Health Specialties in 2019 (Saudi Commission for Health Specialties, 2019). It was found that educational level was also significantly associated with the students' likelihood to encourage incoming students to apply to an MD-PhD program (p-value = 0.001). Surprisingly, having a previous bachelor's degree was not significantly associated with neither the encouragement of developing an MD-PhD program (p-value = 0.59), nor the likelihood of encouraging future students to apply to an MD-PhD program (p-value = 0.68). This could be best explained by the limitation that this study had only included 16 (8.4%) students who had previously pursued a bachelor's degree. An interesting finding was that students with a higher GPA (i.e. >4.5) were less likely to encourage incoming students to join an MD-PhD program (p-value = 0.002), and could be further explained by the fact that these students may already deem the current curriculum challenging and time-consuming, with no available time to pursue further research interests, and/or could be related to institution-specific barriers that had been reported earlier in our survey. Finally, students who were the first in their family to ever attend medical school were less likely to encourage establishing an MD-PhD program (p-value<0.001). This comes as no surprise as under-represented students in medicine tend to be less aware of available research careers pre-entry to medical school, which could explain their opposition to establishing such an instrumental program during medical school, as they may consider it too late to join such a program (Blish, 2018). Additional data regarding the students' willingness to support the MD-PhD program is presented in Table 4 and Table 5.

4.4. Semi-structured interviews

Please see, Table A1 for a summary of all interview responses.

Question 1: *Entry Requirements*

Table 3. Survey responses, n (%)

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
If I were to pursue an MD-PhD, I will be concerned about locating funds for my research	12 (6.3)	23 (12.1)	49 (25.8)	70 (36.8)	36 (18.9)
The substandard conditions of the research facilities at my institution limit my interest in pursuing a PhD	23 (12.1)	42 (22.1)	57 (30.0)	33 (17.4)	35 (18.4)
If I were to pursue a PhD, I will only be able to contribute a minority of my time to clinical duties in the future	7 (3.7)	23 (12.1)	40 (21.1)	68 (35.8)	52 (27.4)
An MD-PhD track is not limited to basic science research but can also include clinical research	8 (4.2)	15 (7.9)	36 (18.9)	65 (34.2)	66 (34.7)
If I were to pursue an PhD, I will be able to achieve work-life balance during my future career	20 (10.5)	30 (15.8)	75 (39.5)	39 (20.5)	26 (13.7)
If I were to pursue an MD-PhD, I will be concerned about dedicating enough time to raising my family	8 (4.2)	21 (11.1)	36 (18.9)	51 (26.8)	74 (38.9)
I have had sufficient exposure to MD-PhD physician-scientists while in medical school until now	47 (24.7)	64 (33.7)	41 (21.6)	18 (9.5)	20 (10.5)

(*Continued*)

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
If I were to pursue an MD-PhD, I will be concerned about the unavailability of samples or patients required for my PhD research	7 (3.7)	39 (20.5)	68 (35.8)	34 (17.9)	42 (22.1)
MD-PhD physician scientists are much needed in our local community	2 (1.1)	13 (6.8)	42 (22.1)	53 (27.9)	80 (42.1)
	Yes		Unsure		No
Do you encourage establishing such a program in the Kingdom?	157 (82.6)		27 (14.2)		6 (3.2)
If there is a well-structured MD-PhD program, would you encourage incoming students to apply to it?	134 (70.5)		50 (26.3)		6 (3.2)

Table 4. Do you encourage establishing such a program in the Kingdom? n (%)

		Yes	No/unsure	p-value
		n = 157	n = 33	
Sex	Female	50 (73.5)	18 (26.5)	0.013
	Male	107 (87.7)	15 (12.3)	
Educational level	5th year	93 (77.5)	27 (22.5)	0.014
	6th year	64 (91.4)	6 (8.6)	
Prior bachelor's degree	Yes	14 (87.5)	2 (12.5)	0.74
	No	143 (82.2)	31 (17.8)	
GPA	≤4.5	41 (82)	9 (18)	0.89
	>4.5	116 (82.9)	24 (17.1)	
First-in-family to attend medical school	Yes	69 (72.6)	26 (27.4)	<0.001
	No	88 (92.6)	7 (7.4)	

Abbreviation: GPA, Grade Point Average.

Table 5. If there is a well-structured MD-PhD program, would you encourage incoming students to apply to it? n (%)

		Yes	No/unsure	p-value
		n = 134	n = 56	
Sex	Female	46 (67.6)	22 (32.4)	0.52
	Male	88 (72.1)	34 (27.9)	
Educational level	5th year	75 (62.5)	45 (37.5)	<0.001
	6th year	59 (84.3)	11 (15.7)	
Prior bachelor's degree	Yes	12 (75)	4 (25)	0.78
	No	122 (70.1)	52 (29.9)	
GPA	>4.5	90 (64.3)	50 (35.7)	0.002
	≤4.5	44 (88)	6 (12)	
First-in-family to attend medical school	Yes	61 (64.2)	34 (35.8)	0.056
	No	73 (76.8)	22 (23.2)	

Abbreviation: GPA, Grade Point Average.

In Saudi Arabia, enrolment in medical school is directly after high school. This means that students in Saudi, generally, have not acquired pre-medical bachelor's degree upon their enrollment. Thus, all interviewees who answered this question disagreed or were concerned about incorporating a PhD during the undergraduate period. Instead, they recommend doing it later after having a bachelor's degree or designing a new curriculum to overcome this concern. This could be deduced from the following statements:

> "How can I modify my curriculum so I can have them graduate with medicine and science? Also, you have to know that there are a lot of logistic demands to approve a program . I'm not trying to be pessimistic, but I want to be realistic because combining the two together is not easy. Maybe it works in North America because they don't go to medicine directly from high school. They go through a pre-medical bachelor's degree first. Then they can do a science degree before they apply to medicine, so they have at least a bachelor's in biomedical science. That's why it's doable." [DE].

> " In Saudi, such programs should not enroll students directly from high school but rather after a bachelor's/ graduate degree like in the U.S. so that students are more sure and aware of their interest." [RE].

> " Why you do not move this PhD to the residency program instead of being in the college, which makes it more logical that after one finishes medical school and chooses the specialty, they can get more scientific background and basic science in the wanted specialty. It makes it more sensible. What is the aim of incorporating it during the MBBS program rather than the residency program here in the Kingdom!" [COM].

Hence, it expresses that doing this program during the postgraduate is more applicable due to the current situation.

Another dimension in this regard raised by our guests is the characteristics of those candidates:

> "In these programs, you want only the most competitive applicants. The individual should be motivated not only by someone covering their tuition fees but also by genuine desires in basic science research and clinical research." [RE].

> "Some specialties do not require you to study the science behind them. However, in hematology, genetics, inherited disease, and infectious diseases, these specialties doing a PhD may have a significant benefit where they need to have some solid information about the scientific background." [COM].

Question 2: *Interest and Impact*

> "Graduates tend to be comparable in both fields [scientific and medical]. MD colleagues tend to envy them due to their unique perspectives on things. They look at patients from a scholarly length in comparison to MDs. MDs can achieve a similar role, but this tends to depend on the individual compared to MD-PhD graduates." [RE].

> "In the MD-PhD program, besides being a proficient physician, you will also be a proficient research scientist. This allows them to enhance and further develop their own specialty. Research becomes an integral part of their identity rather than a complementary aspect. So, these scientist physicians will have an influence long term in science, in research, and in healthcare industry development." [DE].

> "How could the priority setting be a human-centric approach? How do you start this from society itself? For example, when I can produce a PhD researcher working as an advocate for a healthy community to take care of themselves from a genetic intervention that prevents them from getting hypertension and diabetes, you orient these people's science to the right society. Thus, they can care about themselves, preventing them from getting sick or having the disease in the long term. I am just giving you a very extreme kind of information." [COM].

Question 3: *Resources Needed*

The most crucial resource that is indispensable, and its absence makes the implantation of this program more harmful, is the clarity of the graduates' future careers. Not having an MD-PhD is missing a national opportunity towards scientific advancement but implementing an MD-PhD program without utilizing its graduates' capabilities is only a further restriction of their potential.

> As [COM] said, " … you have to ensure that the market is prepared", and [RE] also mentioned that one of the resources is to " … Clear a path following graduation: ensuring the establishment of truly academic centers that accommodate MD-PhD programs."

Thus, before implementing such a program, the current local status should be reassessed to demonstrate how these graduates will later be incorporated into the workforce. Along with the educational part of this project, a national, government-based strategy with collaboration from different sectors, including the private industries, should be instituted to ensure the success of this promising project.

Question 4: *Career Pathways*

> "There has recently been a positive trend where people do see the value [of such programs]. MD-PhD graduates now contribute to the transformation of medicine by envisioning it as a data-driven entity rather than one based on the experience of someone. There has been a tremendous impact on biotech industries in discovery and innovation [relative to graduates of these programs]." [RE].

[DE] and [COM] shared the same idea about this question. They view them in 1) academia, 2) pharmaceutical industries, 3) research facilities and labs, 4) running research centers, or 5) working on the Saudi FDA, CDC, or NIH.

Question 5: *Challenges*

The first step in implementing this program is the most considerable challenge because it includes convincing the decision-makers, which means a business case should be developed and presented. After this research, making this point is the principal responsibility to have this program in the kingdom soon.

> Following the initial step: " … you need a lot of curricular design to combine an MD with a PhD and specify the study duration. Moreover, make sure this new degree is accredited by higher management, namely university bodies, the Ministry of Education, and civil services. And the Saudi commission has to be on board as well." [DE].

Question 6: *Support for implementation*

All the previous interviewees' ideas shared the same concept until this question where the physician-scientist powerfully supported the implementation of an MD-PhD program track, whereas the decision-makers had some reservations. Their concerns can be communicated through the following quotes:

> "In short, yes, but it needs extensive introspective studying. You know what they say; if you fail to plan, you plan to fail." [DE].

> "Until now, I cannot see -it could be a shortage from me- where you are going to add value to this. So, if you linked these values to this question to me, I would definitely support it." [COM].

4.5. Alternate routes

Considering the major limitations this study presents to the establishment and recruitment of individuals into an MD-PhD program, the authors of this study emphasize the establishment of an MD program that incorporates a science diploma or a masters' degree first, which would allow policymakers to gauge recruitment, readiness, and appropriateness for the establishment of an MD-PhD program. In addition, research fellowships remain an integral component of the foundation of translational research in the country. Thus, we recommend the establishment of such a program with the goal of long-term effectiveness and impact assessment.

5. Limitations

This study, despite the information it provides, comes short because of multiple limitations, including that all the participants hailed from a single medical college. In addition, we suspect that selection bias was also a major limitation of this study as students volunteered to answer the survey (Althubaiti, 2016). Inferential analysis must be interpreted with caution as non-probability sampling approach is used; hence results cannot be generalized to the entire population. The lack of an existing MD-PhD program in the country, upon its data we could rely, also presented a major hurdle of the interpretation of this study's results. This study had only included interviews based on three selected interviewees. Thus, we suggest cautious interpretation of the provided responses. We hope that all these concerns be mitigated should this study be replicated elsewhere.

6. Conclusion

This study had reported multiple significant barriers to pursuing an MD-PhD study track among the medical students. These barriers had included barriers to research funding, substandard research facilities, and work-life balance, among others. Our participants reported an adequate level of perceived importance for the implementation of such a program track in the county. Thus, we urge government bodies to seriously consider the establishment of an MD-PhD program track, considering the reported perceived barriers in our study.

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IO: Conceptualization, investigation, methodology, validation, manuscript writing; NA: investigation, methodology, manuscript writing; GK: investigation, methodology, manuscript writing; AB: investigation, methodology, manuscript writing; AA: Conceptualization, formal analysis, methodology, project administration, software, validation, supervision.

Disclosure statement
No potential conflict of interest was reported by the author(s).

Data availability statement
The datasets used and/or analyzed during the current study are available from the corresponding author upon request.

Ethics approval and consent to participate
Informed consent was obtained from all participants and participation was voluntary. The approval for this study was provided by the Institutional Review Board at King Abdullah International Medical Research Center before the start of the data collection (JED-21-427,780-131,100). The authors confirm that all methods were carried out in accordance with relevant guidelines and regulations.

Correction
This article has been corrected with minor changes. These changes do not impact the academic content of the article.

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Appendix

Result and discussion of the qualitative part:

Three interviews have been conducted in this research. Variation of background from different sectors and authorities has been considered. The three interviewees were 1) the dean of one of the top 3 colleges of medicine in Saudi Arabia, 2) the Chief Executive Officer of a commission responsible for all regulatory rules concerning medical colleges and healthcare dynamics in Saudi Arabia, and 3) a physician-scientist at a leading research hospital in Saudi Arabia. Because of our interviewee confidentiality, their names were replaced by an abbreviation that indicated their position. The **DE**an, CEO in the **COM**mission, and **RE**searcher are shown later on respectively as **DE, COM**, and **RE**. Additional responses from them—not included in the text—will be illustrated in appendix 1.

Q1. What should be the entry requirements for an MD-PhD (i.e., previous qualification)?

In Saudi Arabia, enrolment in medical school is directly after high school. This means that students in Saudi, generally, do have not acquired pre-medical bachelor's degree upon their enrollment. Thus, all interviewees who answered this question disagreed or were concerned about incorporating a Ph.D. during the undergraduate period. Instead, they recommend doing it later after having a bachelor's degree or designing a new curriculum to overcome this concern. This could be deduced from the following statements:

"How can I modify my curriculum so I can have them graduate with medicine and science? Also, you have to know that there are a lot of logistic demands to approve a program [.] I'm not trying to be pessimistic, but I want to be realistic because combining the two together is not easy. Maybe it works in North America because they don't go to medicine directly from high school. They go through a pre-medical bachelor's degree first. Then they can do a science degree before they apply to medicine. So they have at least a bachelor's in biomedical science. That's why it's doable." ***[DE]***.

" In Saudi, such programs should not enroll students directly from high school but rather after a bachelor's/ graduate degree like in the U.S. so that students are more sure and aware of their interest." ***[RE].***

" Why you do not move this Ph.D. to the residency program instead of being in the college, which makes it more logical that after one finishes medical school and chooses the specialty, they can get more scientific background and basic science in the wanted specialty. It makes it more sensible. What is the aim of incorporating it during the MBBS program rather than the residency program here in the kingdom!" ***[COM].***

Hence, it expresses that doing this program during the postgraduate is more applicable due to the current situation.

Another dimension in this regard raised by our guests is the characteristics of those candidates.

"In these programs, you want only the most competitive applicants. The individual should be motivated not only by someone covering their tuition fees but also by genuine desires in basic science research and clinical research." ***[RE].***

"Some specialties do not require you to study the science behind them. However, in hematology, genetics, inherited disease, and infectious diseases, these specialties doing a Ph.D. may have a significant benefit where they need to have some solid information about the scientific background." ***[COM].***

Q2. What aspects of an MD-PhD program will be interesting compared to the MD program, considering its impact on patients, educators, university, and competencies of graduates?

"Graduates tend to be comparable in both fields [scientific and medical]. MD colleagues tend to envy them due to their unique perspectives on things. They look at patients from a scholarly length in comparison to MDs. MDs can achieve a similar role, but this tends to depend on the individual compared to MD-PhD graduates." ***[RE].***

"In the MD-PhD program, besides being a proficient physician, you will also be a proficient research scientist. This allows them to enhance further and develop their own specialty. Research becomes an integral part of their identity rather than a complementary aspect. So these scientist physicians will have an influence long term in science, in research, and in healthcare industry development" ***[DE].***

"How could the priority setting be a human-centric approach? How do you start this from the society itself? For example, when I can produce a Ph.D. researcher working as an advocate for a healthy community to take care of themselves from a genetic intervention that prevents them from getting hypertension and diabetes, you orient these people's science to the right society. Thus, they can care about themselves, preventing them from getting sick or having the disease in the long term. I am just giving you a very extreme kind of information." ***[COM].***

Q3. Can you list the top 3 resources needed to implement an MD-PhD program?

The most crucial resource that is indispensable, and its absence makes the implantation of this program more harmful, is the clarity of the graduates' future careers. Not having an MD-PhD is missing a national opportunity towards scientific advancement but implementing an MD-PhD program without utilizing its graduates' capabilities is only a further restriction of their potential. As **[COM]** said, " *. . . you have to ensure that the market is prepared"*, and **[RE]** also mentioned that one of the resources is to " *. . . Clear a path following graduation: ensuring the establishment of truly academic centers that accommodate MD-PhD programs."*

So before implementing such a program, the current local status should be evaluated and reassessed to demonstrate how these graduates will be absorbed. Along with the educational part of this project, there should be a national governmental strategy with collaboration from different sectors, including the private industries, to ensure the success of this promising project.

Refer to Table-1 (C) for the complete answer to this question.

Q4. What are the current career pathways for MD-PhD graduates?

"There has recently been a positive trend where people do see the value [of such programs]. MD-PhD graduates now contribute to the transformation of medicine by envisioning it as a data-driven entity rather than one based on the experience of someone. There has been a tremendous impact on biotech industries in discovery and innovation [relative to graduates of these programs]." ***[RE].***

[DE] and **[COM]** shared the same idea about this question. They see them in: 1) Academia, 2) pharmaceutical industries, 3) the research facilities and laps in the kingdom, 4) running research centers, or 5) working on the Saudi FDA, CDC, or NIH.

"the available research facilities -which indeed are not so many- like KAUST, KAIMRC, and King Feisal Specialist Hospital." ***[COM].***

All the research organizations in the kingdom are governmental; therefore, few research institutes exist. The private sector is not encouraged to invest in this area, so the government handles it alone. Although the country has a unique example of a research environment like KAUST, there is

still a need to assure the private sector to invest in this field. The KAUST's Smart-Health Initiative (KAUST-SHI) outcomes may attract the non-governmental institutes to build some partnership that contributes to finding the successful career for MD-PhD graduates.

There are other opportunities in the graduates' future that [COM] presented:

" *I think this can be linked to vision 2030 and its need, and you reverse engineer back on the significance of having this MD-PhD program. Megaprojects like NEOM and AMAALA, these kinds of projects have a lot of innovation and thinking that probably address the future. It may require having those people, which indeed KAUST is bringing them up now*." **[COM].**

Q5. From your perspective, what are the challenges of implementing an MD-PhD nowadays?

The first step in implementing this program is the most considerable challenge because it includes convincing the decision-makers, which means a business case should be developed and presented. After this research, making this point is the principal responsibility to have this program in the kingdom soon.

Following the initial step: *" . . . you need a lot of curricular design to combine an MD with a Ph.D. and specify the study duration. Moreover, make sure this new degree is accredited by higher management, namely university bodies, the Ministry of Education, and civil services. And the Saudi commission has to be on board as well." **[DE].***

As the dean mentioned the need for the commission in the previous answer, it is essential to find their perspective from one of the SCFHS's CEOs, who revealed several challenging points from his workforce planning view:

(a) *How I will utilize these guys to have the best lean process for me in the ecosystem. I don't want to add more burden to the ecosystem so that the process will have a huge waste.*

(b) *How do you provide the best environment for these people to work in and produce the best outcome? If they graduate without having the ability to find a place or other people helping them do their research, this will be a sort of waste.*

(c) *The value should be to improve the benefit of care quality and reduce the long-term cost. How will you achieve this value?*

(d) *The benchmark study needs to develop a business case that convinces decision-makers and rationalizes what you are doing.*

(e) *How to establish the "why."*

(f) *Why do you need these people, and how are you goanna link them to the direction of the demand. Beneficiaries will determine your demand from society to decision-makers, institutes of education and training, providers of care, and the professions themselves. You have to know the demands of this Ph.D. program and how you make a business case.*

(g) *The other thing is how you will link this to the priority setting for the demand.*

Another challenge from the student's future concern has been shown from the best one understanding this issue [RE]: *"Regulatory oversight, improper environment, and improper guidance where medical students knock on doors [to seek advice] rather than have structured guidance available for them. Many medical students will find it [MD-PhD program track] attractive, but it has to be made very clear to them what will happen 10–15 years following their degree to avoid any lack of clarity."*

Q6. Overall, do you support the implementation of an MD-PhD program track?

All the previous interviewees' ideas shared the same concept until this question where the physician-scientist powerfully supported the implementation of an MD-PhD program track, whereas the decision-makers had some reservations. Their concerns can be communicated through the following quotes:

"In short, yes, but it needs extensive introspective studying. You know what they say, if you fail to plan, you plan to fail." ***[DE].***

"Until now, I cannot see -it could be a shortage from me- where you are going to add value to this. So, if you linked these values to this question to me, I would definitely support it." ***[COM].***

They explain later how to overcome their reservations and get full support from them:

"I support what will serve the nation from a vision 2030 perspective. After you have done all the analysis we mentioned, and you brought to me a good program that you think will add to the value-based health care in the kingdom, I will tell you I support you 100%." ***[COM].***

"Anything if it's internationally renowned, we support it. But we don't want to do something quick only to find that we did not materialize it in the way it should be. I believe such a program is very innovative and ambitious; however, to ensure that it is done in the best way, it has to have a good amount of time under study." ***[DE].***

Meanwhile, notwithstanding the doubts questioning the validity of such a program, the suffered population request immediate implementation of this program's products, which will resolve their needs. As the scientist called from his solid supporting answer:

"Absolutely. Students should not go through the challenges that I went through … It was late for me to do a Ph.D. following graduation from medical college. I would have joined MD-PhD following graduation. I want the opportunity to be available for the next generation in a future full of innovation and discovery, a promising future." ***[RE].***

Undoubtedly, if all medical research communities express their need similarly to [RE] tone, the decision-makers will feel the needs and be convinced.

Also, [COM] states regarding the linkage of our research to implement the MD-PhD program that:

" *I think it is very ambitious and attractive to me, but I need to have more sort of objectives materials presented to me. I think having this kind of research probably will enlighten* us." ***[COM].***

Q7. Do you have anything else to add?

"I hope that research not to be a white pepper only. How are we going to translate this into something that we can achieve?" ***[COM].***

"I hope you do not take this research just as a little exercise. I hope you take it to start a conversation. We now have a proliferation of medical students, and we need to have a collective conversation with students." ***[RE].***

"Since we are the only university in the country that has stream two, not only that but we also KAIMRC, National Guard hospital, and Princess Norah Oncology Center right on campus in addition to the connection to Riyadh and Dammam, all of this gives us a great advantage and a head start to spearhead such a program if it does get established." ***[DE].***

At this point, they all illustrate their readiness and enthusiasm to sponsor this project and recommend elevating it to a higher level.

[COM] concluded his talk by elaborating on how the graduates from this program can be linked to the Saudi national plan "Visions 2030". His elaboration exists in Table-1 (G).

Q#: question number, KAIMRC: King Abdullah International Medical Research Center, KAUST: King Abdullah University for Science and Technology.

Table A1. ~TC~

Table-1	**[COM]**	**[DE]**	**[RE]**
A: Q1	illustrated in-text	illustrated in-text	illustrated in-text
B: Q2	I think this can be linked to the direction of demand and the priority of the demand. If you can answer these points, you can answer the things you asked in the second question. [. . .] The idea that I want you to keep in mind is that if we have these guys in the society or the ecosystem, are they going to be able to help us in the theme of value-based health care or not. This is an important priority that we should consider.	By the terminology of this program, you think somebody will have proficiency in science and research in addition to being a physician. Because to be a scientist, proficiency in research is the attribute you should have. In our college of medicine, we have a research block, but it's not meant to make our students primary researchers.	illustrated in-text

(*Continued*)

Table-1	**[COM]**	**[DE]**	**[RE]**
C: Q3	This is a very important question. We are demand-oriented in our planning, as we said, so that means you have to look for the pipeline of these human resources from its beginning. Talking from high school, then universities, then the postgraduate areas, and then will speak about the market or the demand (where you are going to have these people working) "*each one of those will need some sort of* ***educational element***." The education element either to be faculty or some sort of innovative kind of educational material like the virtual reality, simulation lap, and research lap where these people have to learn in. After that, when you finish from ***1) the educational supply chain***, either undergraduate or postgraduate, ***2) you have to ensure that the market is prepared***, and this refers back to the current assessment of the internal environment that we have in the kingdom. What's the ultimate/ outcome of the training in this field? When you finish the Ph.D., there should be a ***3) lap that you can work in.***	Since science is research, it would make sense to have a research body, facility, or center within the college. Secondly, it's very important to have faculty who are very much scientists because if you have only physicians teaching the different symptoms … they don't necessarily have the ability or capacity to teach the science and research component of that degree. Because we are a health sciences university, we need a scientist in each specific domain like an infectious disease, public health, pharmaceutical development, etc. So I think having a center and a faculty dedicated to the individual scientist would be important. Third, this ties in with the first, we should have science labs equipped with all the tools to conduct research. Conversely, if you have a research center, it should come with a budget and funding. If not, you can request grants from other centers like King Abdulaziz Research Center in Riyadh or KAIMRC, or any other center.	(1) Regulatory: Alfaisal (private university) struggled to institute its first MD-PhD program with KAUST since they are a private university. (2) Inviting atmosphere: students must be driven to pursue a dream and not look at it as a waste of time. (3) Clear a path following graduation: ensuring the establishment of truly academic centers that accommodate MD-PhD programs.
D: Q4 E: Q5 F: Q6	illustrated in-text		

(*Continued*)

Table A1. (*Continued*)

Table-1	[COM]	[DE]	[RE]
G: Q7	There is a very important point: I may have a graduate from this program tomorrow and will be considered a national outcome qualified to work in any place in the world. This is also an added value to the kingdom and will be linked to vision 2030 somehow. My graduate not necessarily to be limited to the kingdom border. The graduate can transfer this Saudi pilot experiment on this topic to somewhere outside the kingdom and then come back to benefit the kingdom. There is a program called "Human Capability Development Program," one of the vision's programs aims to produce a globally comitative citizen who can work in any place, any research lap, anywhere interested in these outcomes. I think this can be linked to vision 2030.	illustrated in-text	

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