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The clinician-scientist pipeline: undergraduate and postgraduate supply, leaks and perspectives

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Chapter 7

Inspecting the leaky clinician-scientist pipeline: a national study on medical PhD candidates' motivations in the Netherlands

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Abstract

Introduction The number of medical doctors embarking on a PhD trajectory, considered to be the most common educational track for clinician-scientists training, has tremendously increased. Meanwhile, the clinician-scientist pathway is often referred to as 'the leaky pipeline' as a subset drops out during a PhD or becomes scientifically inactive soon after obtaining a PhD, contributing to the clinician-scientist shortage. This study investigates PhD candidates' quantity and type of motivation and the relation to its determinants and perceived doctoral outcomes, aiming to gain better insight in the leaky clinician-scientist pipeline.

Methods In total, 1509 medical PhD candidates participated in this nationwide cross-sectional questionnaire study based on well-established motivational theories. They were questioned about their motivations for a PhD, expectancies of success, values, work engagement, (expected) delay, drop-out intentions, and clinician-scientist career ambitions.

Results One out of seven (14%) PhD candidates has very low to low autonomous motivation for a PhD and of all PhD candidates with high to very high autonomous motivation almost a quarter had high to very high controlled motivation for a PhD as well. Autonomous motivation was related to higher work engagement, lower drop-out intentions, and more clinician-scientist career ambitions, while controlled motivation was inversely related to these perceived doctoral outcomes.

Conclusions Both quantity and type of motivation are relevant factors in the leaky clinician-scientist pipeline. To train and retain clinician-scientists it is crucial to focus on fostering autonomous motivation and mitigating controlled motivation in (potential future) PhD candidates. This could be achieved by (1) (potential future) PhD candidates carefully reflecting on their expectancies, values, motivational profile and corresponding perceived doctoral outcomes, (2) PhD candidates and their supervisors investing in well-known drivers for autonomous motivation during the PhD programme, such as research self-efficacy, autonomy and relatedness, (3) challenging programme directors on their perceived value according to (potential future) PhD candidates, more specifically inviting programme directors to explicitly and critically appraise the value of a doctoral profile within their specialty, and (4) flexibility in research career pathways including entering a PhD later on during a clinical career or engagement in research on other levels than a full PhD.

Introduction

Clinician-scientists play a vital role in advancing healthcare. They are key in bringing research from bedside to bench and vice versa. A continuous inflow of newly educated clinician-scientists is essential to ensure scientific developments. However, a decline in clinician-scientists is of growing global concern. This decline is often referred to as the result of 'the leaky pipeline' in the pathway of becoming a clinician-scientist.[1-3]

Development of potential clinician-scientists is a continuum that starts early: in medical curricula, students are introduced in academic and scientific training often right from the beginning of their study. In the following years, students and graduated junior doctors dive in the medical domain and start developing their professional identity, including perceptions on whether doing research fits their talents and ambitions and the value of research within the field and community they aspire to become part of.

Previous studies have focused on the early stage of this continuing pathway by looking at interventions to foster research interest in initial phases of medical training, aiming to inspire medical students for a clinician-scientist career.[4-6] This approach may be deemed successful, as the number of graduates entering a medical PhD programme, which is considered a common pathway in training clinician-scientists, has increased worldwide. For example, in the Netherlands, the number of medical dissertations has increased by 263% over the past 20 years.[7] Danish universities enrol approximately 60% more MD-PhD students compared to 2006,[8,9] and similar trends in doctoral admissions are also seen outside the European Union e.g. in Australia, Canada and the USA.[10-14] However, despite this tremendous increase in graduates entering the clinician-scientist pipeline, the number of MD-PhDs actually working as clinician-scientists has declined in the past few decades.[1-3]

A PhD can be a long, bumpy, and challenging journey.[15-17] Some candidates drop out during this journey,[13,18] for example due to lack of time, support, and supervision, questionable research practice, and poor well-being.[16,19,20] The average completion rate of Dutch PhDs in healthcare is around 75%,[21] which is relatively high compared to PhD completion rates in other countries.[13-15,22] Furthermore, many of those completing their PhD do not aspire academic positions and become scientifically inactive shortly after obtaining a PhD.[11,23-28] Perhaps, motivations for a PhD may not match the actual experience or intended outcomes and, hence, contribute to the leaky pipeline. Moreover, medical doctors with a PhD degree possibly are at an advantage in future career steps, as programme directors frequently use a PhD degree in the selection for postgraduate training programmes[29-31] or subspecialty and consultant positions.[26] Some studies state that a PhD degree is nowadays simply an instrument to get into (sub)specialty training and that doctors, especially in highly competitive specialties[27,32,33]

enter a PhD programme to 'tick the box', without really having the ambition for a clinician-scientist career. At the same time, one may argue that a PhD can still be considered valuable for clinicians even if they are not active as clinician-scientists. However, a systematic review by Zuckerman described that previous research experience or output predicts future research performance, but does not predict other areas of residency success.[34]

To date, little is known what motivates the growing group of junior doctors that pursue a PhD degree. Motivation is defined as the process whereby activities are *initiated* and *sustained*.[35] Within (doctoral) education, motivation has been proposed as a determinant of degree completion and (further) academic performance.[13,36,37] Some studies have qualitatively investigated motivation of PhD candidates focussing on exploring motivations for obtaining a PhD.[38-43] However, in line with the qualitative approach, these studies did not provide insights into the extent to which these motivations exist on a larger scale. Few quantitative studies on PhD candidates' motivation exist. Most of these studies are conducted over 15 years ago, in non-medical settings, or conceptualized motivation as a single dimension lacking a valid theoretical framework and, consequently, are barely transferable to current medical PhD candidates.[27,44-49] Therefore, our study aims to contribute to the dialogue on the leaky clinician-scientist pipeline by inspecting both the quantity and type of motivation, how motivation is formed and what outcomes are related to motivation among those who are currently in the PhD pipeline.

We use Self-Determination Theory (SDT) and Expectancy-Value Theory (EVT) as theoretical lenses.[35,50,51,52] SDT and EVT are well-established theories of motivation and can be complementary.[53,54] Combining both theories can unravel different qualities of motivations of those who actually started and currently are in the PhD pipeline (using SDT), whereas EVT supports additional exploration of what expectations and values 'came and counted' *before* these participants actually entered the PhD pipeline and how these theoretical determinants might relate to different qualities and quantities of motivation.

The SDT is commonly used as framework to investigate the complex nature of motivation.[48,50] According to this theory, motivation is a multidimensional concept which consists of various qualities that regulate behaviour and can coexist within an individual. Moreover, SDT distinguishes two broader categories: (1) *autonomous motivation* (AM) consisting of intrinsic, integrated and identified regulation, and (2) *controlled motivation* (CM) consisting of introjected and external regulation. Intrinsic regulation is the most autonomous type of motivation and is an incentive to engage in a PhD that derives from pleasure and genuine interest in the research itself. In contrast, external regulation is the most controlled type of motivation and refers to engaging in a PhD as a means to an end that is separate from the activity itself, for example to obtain a reward (e.g. a desired job position). AM has been

reported to be associated with positive outcomes in education, such as intention to persist and subjective well-being, whereas CM is associated with negative outcomes, such as anxiety and lower positive affect.[55-57]

To gain insight into the process before embarking on a PhD, we applied EVT, which offers a framework for better understanding the motivation behind *initiating* a specific task. In our study, we focused on the motivation to initiate a PhD trajectory.[35,51,52] According to this theory, motivation to initiate and sustain in activities is a sequel of expectancies of success and perceived task values. Expectancy of success is the degree to which individuals believe they will be successful if they try, also referred to as self-efficacy.[58] Perceived task values include intrinsic value (i.e. enjoyment gained from doing the task itself) and utility value (i.e. perceived usefulness of the task for realizing one's long-term goals), attainment value (i.e. personal importance of doing well on the task), and costs (i.e. competition with other goals). In some versions of EVT, costs are considered as separate components rather than sub-components, or are not considered at all.[59] If both – expectancies and values – are lined up well, it is expected that a person initiates the task.

It is important to understand both how and to what extent PhD candidates are motivated (from the perspective of SDT), as well as how motivational types (i.e. AM and CM) and quantity relate to its determinants (based on EVT) and factors potentially influencing staying or leaving the clinician-scientist pipeline (i.e. doctoral outcomes) (*Figure 1*). Doctoral outcomes include *(expected) delay, work engagement, drop-out intentions,* and *clinician-scientist career ambitions*. Work engagement and burn-out have typically been found to be negatively related to each other.[60,61] This means that PhD candidates experiencing high levels of work engagement are likely to experience low levels of burn-out and vice versa. In addition, burn-out during doctoral studies is related to doctoral study delay and drop-out intentions[15,62], while engagement in doctoral studies has been shown to be positively related to study progress and negatively related to drop-out intentions.[12]

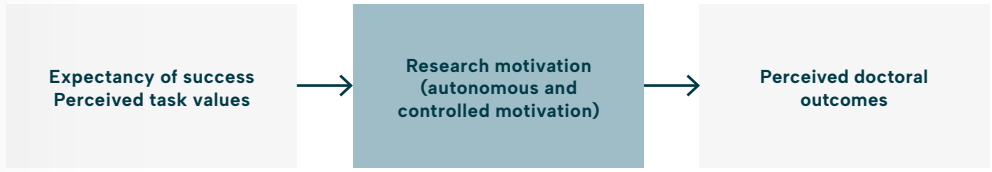

Figure 1. *Overview of tested study constructs according to the theoretical framework*

In this study, we aim to answer the following research questions:
1. Do expectancy of success and values affect types and quantities of motivation of medical PhD candidates?
2. What is the effect of types and quantities of motivation on perceived doctoral outcomes?
3. What are the differences in types and quantities of motivation of PhD candidates in different positions in their careers (e.g. doctors not in training and medical specialists), in different doctoral phases, and in less competitive versus highly competitive specialties?
4. What motivational profiles can be identified and quantified among medical PhD candidates, and how do they relate to determinants of motivation and perceived doctoral outcomes?

Inspecting the leaky pipeline with a focus on types and quantities of PhD candidates' motivation could optimize attracting academically aspired candidates to enter and stay in the clinician-scientist pipeline. In addition, graduate schools and PhD supervisors can benefit from a better understanding of why the pathways of PhDs differ based on different motivations and how these motivations are related to pre-PhD expectancy of success and values, as well as perceived doctoral outcomes.

Methods

Design and setting

We performed a cross-sectional nationwide questionnaire study among Dutch medical PhD candidates. Once the choice is made to pursue a PhD degree there are three main ways to get into a PhD programme: (1) most common in the Netherlands, and similar to for example Australia and the UK, is after graduation and before applying for a specialty training position. Most junior doctors start to gain work experience as a doctor not in training (DNIT) or apply for a position as PhD candidate before or after their clinical work experience; (2) a smaller part applies already as medical student to start a parallel MD-PhD track and graduate as MD and PhD; (3) residents already in training or medical specialists can participate in a PhD programme, but this includes a minority. Some doctors combine their clinical job as a DNIT, resident or medical specialist with obtaining a PhD degree in their spare time, while others take a break from their clinical job to obtain a PhD degree. Most PhD candidates are paid as regular employees, except those obtaining a PhD in their spare time next to a clinical job.

Recruitment and data collection

In the Netherlands, academic medical centres have Graduate Schools (n=8) that facilitate all medical PhD programmes. PhD candidates are admitted to a Graduate School until

completion of their dissertation. We obtained informed consent from all eight medical schools for contacting all medical PhD candidates. All eight Graduate Schools sent an online survey that included two reminders to their medical PhD candidates. To reach Dutch medical (future) doctors who are obtaining their PhD degree, Graduate Schools only invited medical PhD candidates with a Dutch nationality and a (future) medical degree. PhD candidates consented to participate by clicking on the link after reading study information. They were informed that their response data would not be linked to any other personal data. Participation was voluntary, anonymous, and without incentive. Data were collected from April 2021 to June 2021.

Development of questionnaire

The first part of the online questionnaire (*Appendix D*) consisted of demographics. This included age, gender, personal characteristics (e.g. position before starting a PhD, specialty (preference)), and doctoral characteristics (e.g. progression, (expected) delay). The second part consisted of the following constructs (1) determinants of motivation (i.e. expectancy of success and values), (2) motivation (i.e. autonomous and controlled motivation), (3) perceived doctoral outcomes (work engagement, (expected) delay, drop-out intention, clinician-scientist career ambition). We used a stepwise approach for survey scale design in medical educational research.[63] Scales were mostly based on existing validated scales with adjustments to fit the context of Dutch medical PhD candidates (e.g. replacing study or work for PhD).

Expectancy of success & perceived task value The expectancy of success scale consisted of three items about the belief in one's ability to successfully conduct research (perceptions of competence), previously validated and used in studies on medical students' motivation for research in the Netherlands, with a reported Cronbach's alpha of .86.[64] As a validated perceived task value scale is lacking in the current literature, this scale was self-constructed to identify how PhD candidates perceived the value of a PhD in the medical field. Bryan et al. qualitatively identified four domains of doctoral value: personal, social, skills, and career.[38] Career values were twofold, as they could relate to medical *or* research careers. Interviews with stakeholders revealed societal (i.e. doctoral studies benefit society) and external values (i.e. the perceived value of colleagues in the same specialty). We converted these perceived task values into items and validation resulted in three factors, labelled according to the EVT: (1) skills, personal, and societal value were labelled as *intrinsic and attainment value*, (2) clinical career values and external values were labelled as *medical utility value*, and (3) social and clinician-scientist career value were labelled as *research utility value*.

Motivation The Motivation for PhD Studies Scale (MPhD), developed and validated by Litalien et al., was used to measure motivation for a PhD, consisting of different qualities

of motivation according to SDT.[48] Adjustments and additions were made based on the suggestions of Litalien, literature, and interviews to fit the Dutch medical doctoral context. This scale included the following subscales: intrinsic motivation (five items), integrated regulation (four items), identified regulation (five items), introjected regulation (three items), and external regulation (10 items), which were further merged as autonomous and controlled motivation. Factor analysis did not materially differ between the MPhD scales and modified MPhD scales. To approach motivation as a multidimensional construct and explore the association between expectations, values, and perceived doctoral outcomes, we created motivational profiles. To the best of our knowledge, no previous studies have described MPhD cut-off values. Therefore, we arbitrarily classified very low to very high motivation based on a 7-point Likert scale.

Perceived doctoral outcomes It has been suggested that work engagement is indicative of an optimal PhD experience characterized by vigor, dedication, and absorption.[60,65] To measure work engagement, we included a short version (9 items) of one of the most internationally used instruments to assess work engagement: the Utrecht Work Engagement Scale (UWES-9).[66] Again, slight adjustments were made to fit the medical doctoral context (e.g. replace 'job' for 'PhD trajectory'). The drop-out intention scale consisted of four items inspired by the Turnover Intention Scale 6 (TIS-6) and interviews.[67] Delay and (further) expected delay were both measured as a single item. Lastly, the clinician-scientist career ambition scale was constructed based on the literature and interviews, as the literature lacks a validated scale. All items were translated into Dutch using a forward-backward procedure. PhD candidates had to indicate their answers on a 7-point scale (1=strongly disagree, 7=strongly agree). Exploratory factor analysis showed sufficient validation of these constructs.

Data analysis

All statistical analyses were performed using IBM SPSS Statistics 25. First, Cronbach's alpha and mean scores for every scale were calculated. Descriptive statistics were used for demographics. Hereafter, we performed linear regression analyses to investigate both crude and adjusted relations between motivation and its determinants and perceived doctoral outcomes (*RQ 1 and 2*). We performed complete case analysis and adjusted for potential common causes. Unpaired t-tests were used to explore motivational differences between PhD candidates in different positions (e.g. DNIT and medical specialist), in different doctoral phases, and in less competitive versus highly competitive specialties (*RQ 3*). To differentiate between less and highly competitive specialties a Dutch report 'De keuzemonitor Geneeskunde' was used, including specialty preferences of Dutch medical students during the year of graduation compared to the corresponding capacity of specialty training positions advised by the Advisory Committee on Medical Manpower Planning (ACMMP).[64,69] Finally, we quantified motivation as a multidimensional construct (AM combined with CM)

as it occurs in practice within medical PhD candidates and investigated how these profiles relate to both determinants and perceived doctoral outcomes (*RQ 4*).

Ethical Approval

The Educational Institutional Review Board of Leiden University Medical Center approved this study (reference number OEC/ERRB/20210112/1).

Results

Demographic results

In total, 1509 PhD candidates filled in our survey (response rate ≈ 42%), 1398 participants completed the survey. *Table 1* presents the demographics of the participants. Of all respondents, 70% were female and 29.7% were male, reflecting the female/male ratio of Dutch medical students. The average age was 29.8 years (SD 4.4, ranging from 22-64 years). More than 80% of the PhD candidates were MD-PhD student or DNIT with/without clinical experience (i.e. not resident or medical specialist yet) and at the time of questioning 76% of them had not obtained a specialty training position (yet). MD-PhD students and DNITs were mostly (84%) aspiring a highly competitive specialty prior to their PhD and 1 out of 5 (20%) had changed their specialty preference at the time of the survey. Most PhD candidates (84%) were employed as PhD candidate, with one out of ten candidates doing a PhD parallel to their clinical job. The formal length of their PhD programmes was on average 46 months (SD 19.9). Almost one out of five participants (18.6%) participated while their formal end date was passed without defending their thesis yet. Participants completed 33 months of their PhD trajectory (SD 24.6) and 2.2 articles (SD 2.4) were accepted.

Table 1. *Demographics of participating Dutch medical PhD candidates*

Demographic variable	Categories	N	%
Gender	Female	1061	70.3
	Male	448	29.7
Job position before PhD	Medical student	170	11.3
	Doctor not in training with clinical work experience	621	41.1
	Doctor not in training without clinical work experience	454	30.1
	Resident (hospital based specialty)	161	10.7
	Resident (non-hospital based specialty)	20	1.3
	Medical specialist	83	5.5
Employed (paid) or unemployed (unpaid) PhD trajectory	Employed as a PhD candidate as MD-PhD student / doctor (not) in training / medical specialist	1260	83.5
	Unemployed as a PhD candidate as doctor (not) in training / medical specialist	173	11.5
	Other	76	5.0
Specialty preference prior to PhD	Less competitive	136	11.2
	Highly competitive	1021	84.2
	Don't know yet	56	4.6
Changed specialty preference during PhD	Yes	910	75.0
	No	303	25.0
PhD progression related to formal end date	0-25%	269	17.8
	25-50%	285	18.9
	50-75%	263	17.4
	75-100%	323	21.4
	>100%	281	18.6
	No clear/fixed start and/or end date or missing	88	5.8
Accepted papers	0	471	32.4
	1	263	18.1
	2	206	14.2
	3	170	11.7
	4	111	7.6
	≥5	231	15.9
	Unknown	57	3.8

Motivations with related determinants and perceived doctoral outcomes

Table 2 shows the descriptive values of the variables including means and Cronbach's alpha ranging from .67 to .93. As expected, Cronbach's alpha of the Motivation for PhD Studies Scale increased when self-constructed items were added.

Table 2. *Variable descriptives based on a 7-point Likert scale*

Theoretical predictor or doctoral outcome	Cronbach's alpha	Items (n)	Mean score (SD)	Item example
Expectancy of success	.91	3	5.00 (0.97)	*I feel competent enough to do research as a PhD candidate.*
Research utility value	.67	4	5.63 (0.76)	*A PhD is an important step towards a career as clinician-scientist.*
Medical utility value	.75	5	5.16 (0.97)	*A PhD increases the chance of future jobs (e.g. residency position, fellowship, job as medical specialist).*
Intrinsic & attainment value	.80	7	5.45 (0.78)	*Obtaining a PhD makes you more resilient as a person.*
Autonomous motivation	.86	14	4.92 (0.85)	*I am doing a PhD for the satisfaction I feel when I surpass myself in my PhD activities.*
Controlled motivation	.84	15	3.34 (1.01)	*I am doing a PhD for the prestige associated with a PhD.*
Work engagement	.93	9	4.56 (1.15)	*I am proud of the activities I do in my PhD project.*
Delay	N/A	1	3.80 (1.74)	*So far, I am on schedule with my PhD trajectory (compared to the current official end date). [reflected item]*
Expected delay	N/A	1	3.84 (1.64)	*I expect that I will be (further) delayed during my PhD trajectory.*
Drop-out intention	.68	4	2.59 (1.00)	*I am considering to quit my PhD trajectory.*
Clinician-scientist career ambitions	.83	6	4.04 (1.16)	*As a doctor, I want to combine scientific research and clinical tasks after my PhD.*

Higher expectancy of success resulted in significantly more autonomous motivation and less controlled motivation (adjusted β=.15; adjusted β=-.23) (*Table 3*). Furthermore, PhD candidates with more research utility and intrinsic and attainment values were significantly more autonomously motivated (adjusted β=.28; adjusted β=.45). PhD candidates with higher medical utility values were significantly less autonomously motivated (adjusted β=-.07) and more controlled motivated (adjusted β=.33).

Table 3. *Effect of expectancies and values on motivation according to the Expectancy-Value Theory*

Determinant	Outcome	Crude β (95% CI)	Adjusted β (95% CI)[a]
Expectancy of success	AM	.269 (.230 – .307)*	.145 (.112 – .177)*
Medical utility value	AM	.031 (-.015 – .077)	-.065 (-.101 – -.029)*
Intrinsic & attainment value	AM	.626 (.579 – .672)*	.446 (.395 – .497)*
Research utility value	AM	.545 (.494 – .597)*	.278 (.224 – .331)*
Expectancy of success	CM	-.212 (-.259 – -.165)*	-.226 (-.272 – -.180)*
Medical utility value	CM	.300 (.249 – .352)*	.327 (.276 – .378)*
Intrinsic & attainment value	CM	.090 (-.157 – .023)*	-.045 (-.117 – .028)
Research utility value	CM	-.024 (-.093 – .045)	-.011(-.087 – .066)

[a] *Adjusted for the other determinants listed in this table. With additional adjustment for age and gender results were not materially different (results not shown).*
** Indicating statistical significance p < 0.005*

Table 4 shows that, when looking at motivation for a PhD and its perceived doctoral outcomes, PhD candidates with higher AM were significantly more engaged in their PhD (adjusted β=.42) and were more intending to pursue a clinician-scientist career after obtaining a PhD degree (adjusted β=.25). Both crude effects became stronger after adjusting for CM. In addition, they were more likely to expect (further) delay (adjusted β=.05) and had less drop-out intentions (adjusted β=-.04). In contrast, PhD candidates with higher CM were significantly less engaged in their PhD (adjusted β=-.22), were less delayed (adjusted β=-.04), had higher drop-out inentions (adjusted β=.36), and were less intending to pursue a clinician-scientist career (adjusted β=-.18). All crude effects besides (expected) delay became stronger after adjusting for AM.

Table 4. *Effect of motivation on perceived doctoral outcomes*

Type of motivation	Outcome	Crude and adjusted β (95% CI)	Adjusted for[a]
AM	Work engagement	.506 (.475 – .538)* .540 (.475 – .538)* .416 (.377 – .454)*	- CM + Delay, expected delay, drop-out intention, clinician-scientist career ambition
AM	Delay	-.140 (-.168 – -.112)* -.133 (-.162 – -.105)* -.016 (-.039 – .008)	- CM + Work engagement, expected delay, drop-out intention, clinician-scientist career ambition
AM	Expected delay	-.040 (-.071 – -.010)* -.030 (-.061 – .001) .048 (.025 – .071)*	- CM + Work engagement, delay, drop-out intention, clinician-scientist career ambition
AM	Drop-out intention	-.377 (.422 – -.331)* -.413 (-.464 – -.362)* -.038 (.085 – -.030)*	CM + Work engagement, delay, expected delay, clinician-scientist career ambition
AM	Clinician-scientist career ambition	.425 (.390 – .461)* .438 (.400 – .475)* .248 (.214 – .282)*	- CM + Work engagement, delay, expected delay, drop-out intention
CM	Work engagement	-.296 (-.343 – -.250)* -.421 (-.484 – -.357)* -.221 (-.288 – -.153)*	- AM + Delay, expected delay, drop-out intention, clinician-scientist career ambition
CM	Delay	.090 (.057 – .123)* .076 (.042 – .110)* -.040 (-.075 – -.005)*	- AM + Work engagement, expected delay, drop-out intention, clinician-scientist career ambition
CM	Expected delay	.102 (.067 – .137)* .097 (.062 – .131)* .011 (-.024 – .046)	- AM + Work engagement, delay, drop-out intention, clinician-scientist career ambition
CM	Drop-out intention	.449 (.397 – .500)* .488 (.431 – .545)* .358 (.291 – .425)*	- AM + Work engagement, delay, expected delay, clinician-scientist career ambition
CM	Clinician-scientist career ambition	-.258 (-.306 – -.211)* -.294 (-.352 – -.236)* -.177 (-.231 – -.122)*	- AM + Work engagement, delay, expected delay, drop-out intention

[a] *With additional adjustment for age and gender results were not materially different (results not shown).*
** Indicating statistical significance p < 0.005*

Motivation in different career positions, PhD phases and specialties

We found a significant difference in AM (mean difference = 0.17, 95% CI .06–.29) in (future) doctors without specialty training positions (MD-PhD students and DNITs) as compared to doctors with a specialty training position (residents) and/or medical specialists, with slightly higher AM in the first group. Also CM was significantly higher within the first group (mean difference = 0.47, 95% CI .35–.56). Furthermore, AM and to a lesser extent CM significantly decreased with more PhD progression in years (β=–.06, 95% CI –.09 – –.04; β=–.03, 95% CI –.06 – –.00, respectively) with a mean formal PhD duration of almost four years. PhD candidates with less competitive specialty preferences prior to the start of their PhD were slightly higher autonomously motivated (mean difference = .07, 95% CI –.10–.25) and slightly less controlled motivated (mean difference CM = –.18, 95% CI –.39–.02) compared to PhD candidates with preferences for a highly competitive specialty prior to their PhD. However, these differences were not statistically significant.

Motivation profiles

For further analysis PhD candidates were grouped based on their motivation on a two dimensional axis; AM and CM. Subgroups were divided based on quartiles on both axis with very high = 5.50–7.00, high = 4.00–5.50, low = 2.50–4.00, very low = 1.00–2.50 (*Figure 2*).

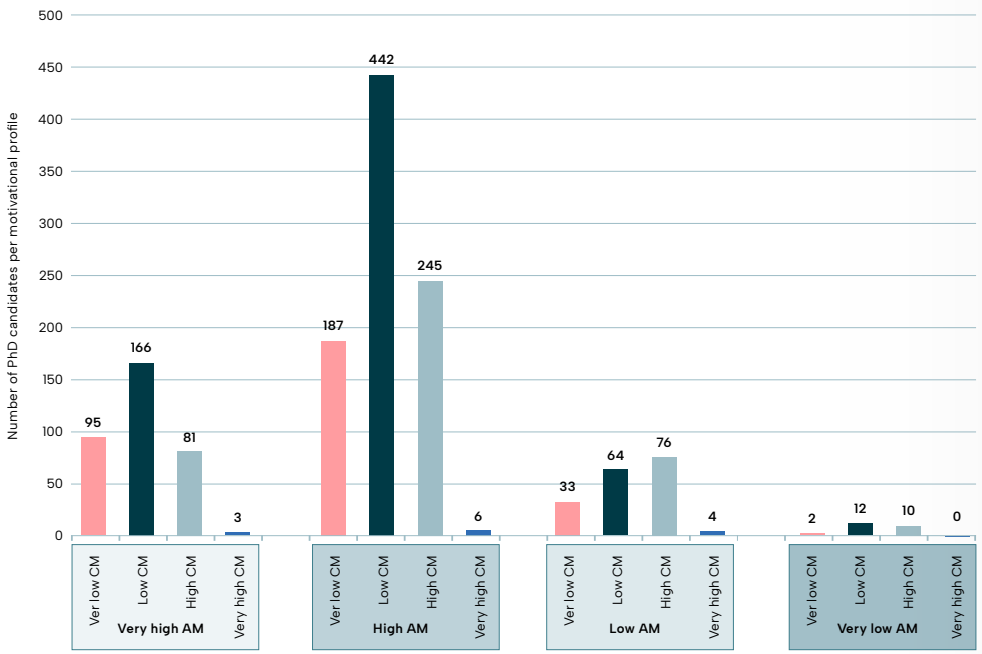

Figure 2. *Number of PhD candidates per motivation profile*

Figures 3–5 show two-dimensional motivation profiles with (1) expectancy of success and perceived task values scores, (2) unfavourable perceived doctoral outcomes (i.e. (expected) delay and drop-out intentions), and (3) favourable doctoral (potential) outcomes (i.e. work engagement and clinician-scientist career ambitions). Within AM profiles with the same classification (very high/high/low/very low), increasement in CM results in generally lower expectancy of success, research utility value, intrinsic and attainment value, work engagement, and clinician-scientist career ambition, as well as higher medical utility value, (further expected) delay, and drop-out inentions.

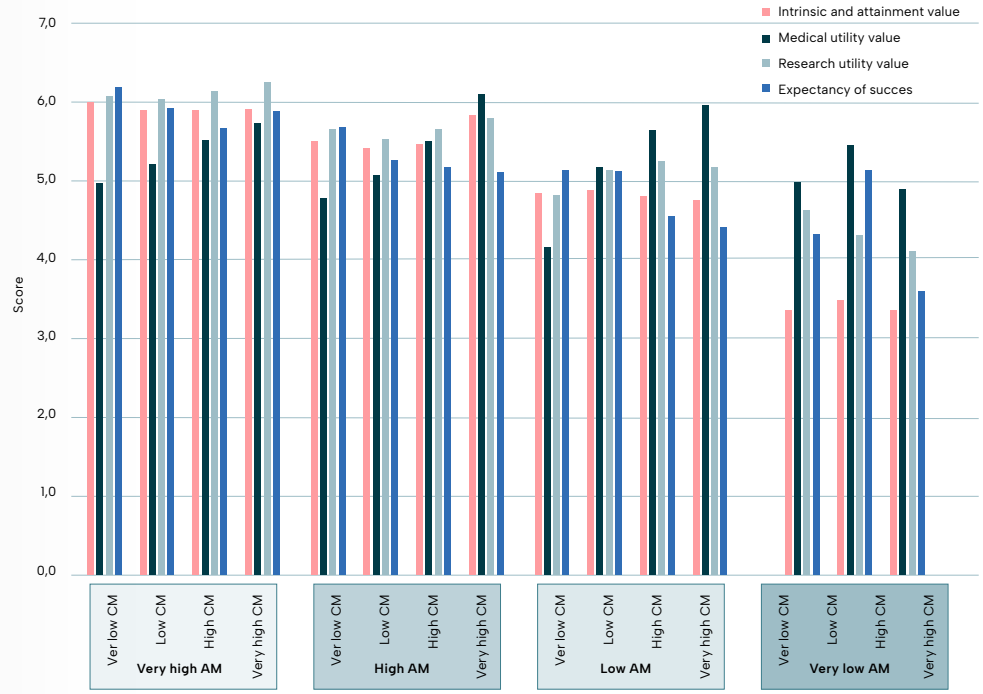

Figure 3. *Expectancy of success scores and values scores (Y-axis) per motivation profile (x-axis)*

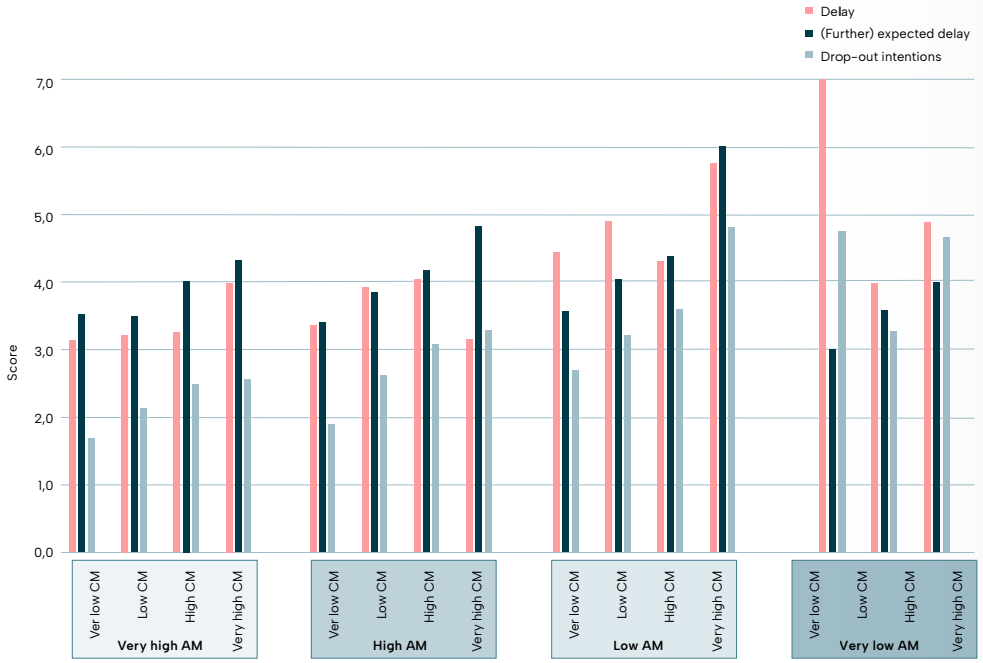

Figure 4. *Unfavourable perceived doctoral outcomes scores (Y-axis) per motivation profile (X-axis)*

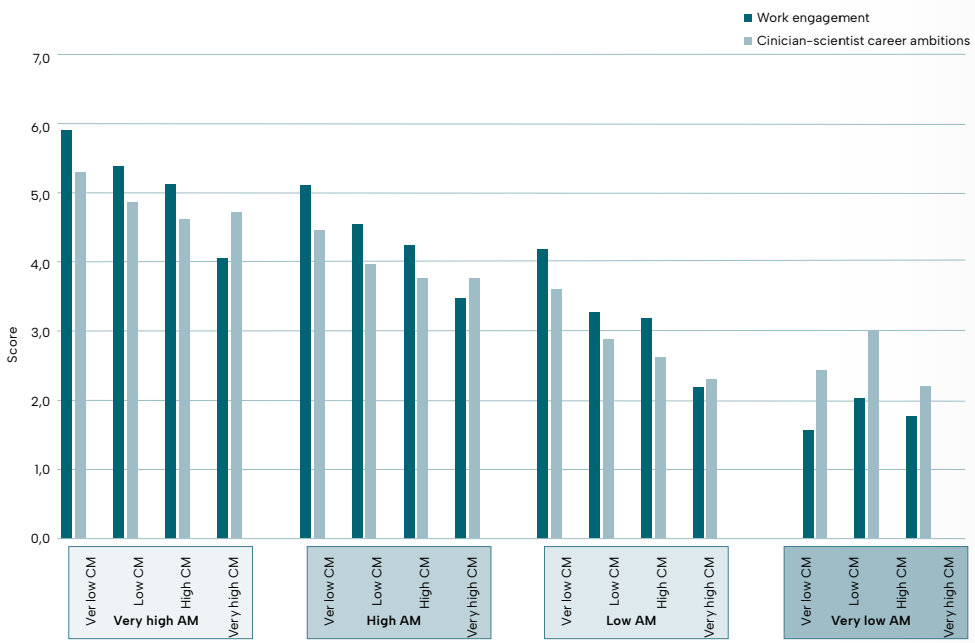

Figure 5. *Favourable perceived doctoral outcomes scores (Y-axis) per motivation profile (X-axis)*

Discussion

Our study showed that the majority of medical PhD candidates is highly autonomously motivated for their PhD. However, of those with (very) high autonomous motivation almost a quarter had (very) high controlled motivation for their PhD as well. Furthermore, one out of seven PhD candidates showed a poor motivation profile with (very) low autonomous motivation. In those with low autonomous motivation and/or high controlled motivation, we found higher expected delay and drop-out intention scores, while they are also less engaged in their work and have less ambitions for a clinician-scientist career. This suggests that type and quantity of motivation both contribute to the leaky pipeline of clinician-scientists.

This study has several strengths and limitations. It is a nationwide study including all Dutch University medical centres and based on well-established motivational theories with mostly validated scales. To our best knowledge, this is the first study that provides insight in the role of motivation of medical PhD candidates for getting into and staying in the clinician-scientist pipeline. Furthermore, this study approaches motivation as a multidimensional construct including determinants of motivation and perceived doctoral outcomes with relatively high response rate, resulting in a large sample size. However, due to the cross-sectional design and despite CM negatively affects drop-out intentions and clinician-scientist career ambitions, we have no follow-up on changes in motivation and on actual academic drop out during or after the PhD programme. Comprehensive research on doctoral attrition is challenging and one of the foremost reasons is that there is no proper registry of attrition in many countries, including the Netherlands.[70] Finally, there might be some circular or mutually influencing effects between different scores based on the questionnaire we used. However, the existing literature and motivational theories substantiate the directions of the effects tested in this study.

Our results are in line with Ghedri et al., who showed that almost 80% of the medical students valued a PhD as means to get into a highly competitive specialty training programme.[32] An equal number of these medical students was motivated to pursue a PhD, of whom almost 40% (out of 80%) indicated that they would not aspire to a PhD if it would not benefit the chance of obtaining a specialty training position, which can be labelled as CM. Apparently, motivation and perceptions of the value of pursuing a PhD degree have already settled before graduation. As no follow-up was performed by Ghedri et al., it is unknown to what extent these values acted upon after graduation.

In our study, 22% of the PhD candidates stated that they would not have participated in their PhD programme if it would not impact their chance of obtaining a future job position (e.g. specialty training position). In addition, our study included mostly postgraduate doctors who acted upon their expectancy of success and values, and showed that different values are related to AM and CM. More specifically, building on Ghedri et al., medical utility value (e.g. the value of a PhD for programme directors and future job positions) fosters CM for a PhD.

While values and corresponding qualities of motivation for obtaining a PhD degree are apparently already formed before entering a PhD programme, they are likely to further develop throughout the PhD journey. We found somewhat lower AM and CM in PhD candidates who were further along with their PhD programme. According to the SDT, AM can be strengthened by enhancing feelings of competence, relatedness and autonomy. We therefore deem it relevant to further investigate development of motivation during a PhD and to foster feelings of research competence, relatedness, and autonomy.

Almost all PhD candidates in our study were (future) doctors without specialty training (yet) (83%) aspiring a career in a highly competitive specialty (84%). A highly competitive setting can be a strong incentive for CV building, even more so when programme directors highly value a PhD degree as selection criterium,[29–31] which in the Netherlands is more common in hospital based specialties (mostly highly competitive) in comparison with non-hospital based specialties (mostly less competitive).[32] This is called credential inflation (i.e. increase in the education credentials required for a job) and can result in less career opportunities for MDs without a PhD degree and thereby possibly underappreciation of profiles other than research, as well as devaluation of PhD degrees. Surprisingly, we found no motivational differences between PhD candidates with less competitive specialty preferences compared to PhD candidates with highly competitive specialty preferences. Although PhD candidates with less or highly competitive specialty preferences have similar AM and CM, the abundance of PhD candidates and, consequently, clinicians with a PhD degree within highly competitive specialties compared to less competitive specialties, may fragment scientific development of the medical field.

When inspecting the leaky pipeline, it is a matter of concern that a subset of PhD candidates demonstrates lower autonomous drive and/or a high degree of controlled motivation. Additionally, it is noteworthy that some might not have participated in a PhD programme if it did not impact future job prospects. Our study revealed that this particular group was less engaged in their work, expressed stronger intentions to drop-out, and showed lesser ambition towards a clinician-scientist career. Encouragingly, PhD candidates

could be empowered to select paths in harmony with their inherent values and passions, rather than solely driven by external pressures such as competitive job positions. Those whose interests do not lie in research engagement or a clinician-scientist career might find greater fulfillment specializing in other profiles valuable to the medical workforce and society, rather than embarking on the time-intensive PhD trajectory. Beyond the investment of time already spent in the pipeline, the timing within the medical career to enter the clinician-scientist pipeline matters as well. Residents or medical specialists had approximately similar autonomous motivation but lower controlled motivation scores compared to doctors not in training and MD-PhD students. In line with this, Eshel and colleagues are making a plea for more flexible entry points into the clinician-scientist pipeline with protected time for research training and not necessarily as a full PhD, for example, during residency and fellowships.[71]

Although some PhD candidates may have compelling reasons to leave academia during or soon after their PhD, this 'leak' has impact on several levels. At the individual level, PhD candidates who drop out may have lower self-esteem and fewer employment opportunities.[13] When another road than a full PhD would be an option, a part of this group might be motivated to be involved in research to another extent (e.g. publish one or a few articles). Others might prefer developing themselves in other domains than research, such as medical education, leadership, management, or technology and innovation.[72–74] These are, next to research, crucial demands of future healthcare as well. At the academic institutional level, maintaining the current high-level PhD programmes for a growing number of PhD candidates requires substantial investments in time, education, supervision, support, and funding. A more targeted approach could optimize the return on investment by nourishing those who clearly aspire a strong research profile as part of their future career, while allowing others to choose differently. This also might benefit quality of doctoral supervision in practice, which is squeezed by increasing research supervision demands.[75] Last, at the societal level, society might profit from some clinicians entering medical practice years earlier as they do not feel obliged or have to include a PhD trajectory in their already yearlong training period.

We found that autonomous motivation positively relates to clinician-scientist career ambitions *after* a PhD, however, our data do not provide insight into actual academic involvement after a PhD. A recent study found that 10 years after obtaining a PhD degree, 43% of MD-PhDs had an academic oriented career.[23] Furthermore, a postdoctoral academic career was more likely in medical specialties (48%) compared to surgical related (33%) and non-hospital based specialties (23%), and men were twice as likely to publish compared to women in academic careers. Irrespective of motivation and corresponding (lack of) academic ambition resulting in potentially leaking out the pipeline after a PhD,

other well-known barriers to stay academically involved are rising clinical responsibilities in residency, work-life balance, lack of funding, and insufficient supervision.[76-78] On the other hand, if all MD-PhDs would have academic ambitions the demand will probably exceed the number of available academic positions in the medical field.

Even for those who are no longer academically involved after obtaining a PhD, their doctoral degree can still be considered valuable. MD-PhDs develop scientific and generic competences, thereby enhancing academic standards and the quality of healthcare in non-academic hospitals.[15] Moreover, large-scale PhD research significantly contributes to scientific advancement and consequently, enhances clinical care. Furthermore, a quarter of PhD candidates alter their specialty preferences during their doctoral studies, a factor that might have been underestimated due to the inclusion of candidates from all phases of the doctoral programme. This aspect underlines the potential of a PhD journey to facilitate career orientation, as candidates closely engage with a specialty for multiple years. Ultimately, this has the potential to mitigate attrition among medical trainees, which is a global concern.[79,80]

Conclusion

To train and retain aspired clinician-scientists it is crucial to focus on fostering autonomous motivation and mitigating controlled motivation prior to and during PhD programmes, as our findings implicate that both type and quantity of motivation contribute to the leaky pipeline of clinician-scientists. This could be achieved by (1) (potential future) PhD candidates carefully reflecting on their expectancies, values, motivational profile and corresponding perceived doctoral outcomes; (2) PhD candidates and their supervisors investing in well-known drivers for autonomous motivation during the PhD programme in line with SDT, such as research self-efficacy, autonomy, and relatedness; (3) challenging programme directors on their perceived value according to (potential future) PhD candidates, more specifically inviting programme directors to explicitly and critically appraise the value of a doctoral profile within their specialty; and (4) flexibility in research career pathways including entering a PhD later on during a clinical career or engagement in research on other levels than a full PhD.

References

1. Eley DS, Jensen C, Thomas R, Benham H: What will it take? Pathways, time and funding: Australian medical students' perspective on clinician–scientist training. BMC medical education 2017, 17(1):242–242.
2. Milewicz DM, Lorenz RG, Dermody TS, Brass LF: Rescuing the physician-scientist workforce: the time for action is now. The Journal of Clinical Investigation 2015, 125(10):3742–3747.
3. Ley TJ, Rosenberg LE: The physician-scientist career pipeline in 2005: build it, and they will come. JAMA 2005, 294.
4. den Bakker CR, Ommering BW, van Leeuwen TN, Dekker FW, De Beaufort AJ: Assessing publication rates from medical students' mandatory research projects in the Netherlands: a follow-up study of 10 cohorts of medical students. BMJ Open 2022, 12(4):e056053.
5. Möller R, Shoshan M: Medical students' research productivity and career preferences; a 2-year prospective follow-up study. BMC Medical Education 2017, 17(1):51.
6. Conroy MB, Shaffiey S, Jones S, Hackam DJ, Sowa G, Winger DG, Wang L, Boninger ML, Wagner AK, Levine AS: Scholarly Research Projects Benefit Medical Students' Research Productivity and Residency Choice: Outcomes From the University of Pittsburgh School of Medicine. Acad Med 2018, 93(11):1727–1731.
7. PhD Explosie. Retrieved August 28, 2022, from https://www.artsenauto.nl/phd-explosie/
8. Andreassen P, Christensen MK: Science in the clinic: a qualitative study of the positioning of MD-PhDs in the everyday clinical setting. BMC Med Educ 2018, 18(1):115.
9. Andreassen P, Wogensen L, Christensen MK: The employers' perspective on how PhD training affects physicians' performance in the clinic. Dan Med J 2017, 64(2).
10. Eley DS: The clinician-scientist track: an approach addressing Australia's need for a pathway to train its future clinical academic workforce. BMC medical education 2018, 18(1):227–227.
11. Traill CL, Januszewski AS, Larkins R, Keech AC, Jenkins AJ: Time to research Australian physician-researchers. Internal Medicine Journal 2016, 46(5):550–558.
12. Castelló M, Pardo M, Sala-Bubaré A, Suñe-Soler N: Why do students consider dropping out of doctoral degrees? Institutional and personal factors. Higher Education 2017, 74(6):1053–1068.
13. Litalien D, Guay F: Dropout intentions in PhD Studies : a comprehensive model based on interpersonal relationships and motivational resources. Contemporary Educational Psychology 2015, 41:218–231.
14. Shin M, Goodboy A, Bolkan S: Profiles of doctoral students' self-determination: susceptibilities to burnout and dissent. Communication Education 2021.
15. Anttila H, Lindblom-Ylänne S, Lonka K, Pyhältö K: The Added Value of a PhD in Medicine – PhD Students' Perceptions of Acquired Competences. The International Journal of Higher Education 2015, 4:172–180.
16. Woolston C: Graduate survey: A love–hurt relationship. Nature 2017, 550(7677):549–552.
17. Kusurkar R, van der Burgt S, Isik U, Mak-van der Vossen M, Wilschut J, Wouters A, Koster A: Burnout and engagement among PhD students in medicine: the BEeP study. Perspect Med Educ 2021, 10(2):110–117.
18. Wollast R, Boudrenghien G, Linden N, Galand B, Roland N, Devos C, Clercq M, Klein O, Azzi A, Frenay M: Who Are the Doctoral Students Who Drop Out? Factors Associated with the Rate of Doctoral Degree Completion in Universities. International Journal of Higher Education 2018, 7:143.
19. Kis A, Tur E, Lakens D, Vaesen K, Houkes W: Leaving academia: PhD attrition and unhealthy research environments. PloS one 2022, 17(10).
20. Nagy GA, Fang CM, Hish AJ, Kelly L, Nicchitta CV, Dzirasa K, Rosenthal MZ: Burnout and Mental Health Problems in Biomedical Doctoral Students. CBE Life Sci Educ 2019, 18(2):ar27.
21. VSNU Overzichten Promovendi 2018. Retrieved August 28, 2022 from: www.vsnu.nl/files/documenten/Feiten_en_Cijfers/Overzichten_Promovendi_2018.xlsx.
22. Jeffe DB, Andriole DA, Wathington HD, Tai RH: Educational Outcomes for Students Enrolled in MD–PhD Programs at Medical School Matriculation, 1995–2000: A National Cohort Study. Academic Medicine 2014, 89(1):84–93.
23. Wolters F: Academische carrièreperspectieven van gepromoveerde dokters: Een landelijk cohortonderzoek in de periode 1992-2018. Nederlands Tijdschrift voor Geneeskunde 2020, 164.

24. Kwan JM, Daye D, Schmidt ML, Conlon CM, Kim H, Gaonkar B, Payne AS, Riddle M, Madera S, Adami AJ et al: Exploring intentions of physician-scientist trainees: factors influencing MD and MD/PhD interest in research careers. BMC Med Educ 2017, 17(1):115.
25. Lopes J, Ranieri V, Lambert T, Pugh C, Barratt H, Fulop NJ, Rees G, Best D: The clinical academic workforce of the future: a cross-sectional study of factors influencing career decision-making among clinical PhD students at two research-intensive UK universities. BMJ Open 2017, 7(8):e016823.
26. Ranieri VF, Barratt H, Rees G, Fulop NJ: A Qualitative Study of the Influences on Clinical Academic Physicians' Postdoctoral Career Decision Making. Academic Medicine 2018, 93(11):1686–1693.
27. Giesler M, Boeker M, Fabry G, Biller S: Importance and benefits of the doctoral thesis for medical graduates. GMS J Med Educ 2016, 33(1):Doc8.
28. Wildgaard L, Wildgaard K: Continued publications by health science PhDs, 5 years post PhD-Defence. Research Evaluation 2018, 27(4):347–357.
29. ten Cate O: Medical Education in the Netherlands. Medical teacher 2007, 29:752–757.
30. Dijkhuizen K, Bustraan J, van den Bogaard MED, Velthuis SI, van Lith JMM, Driessen EW, de Beaufort AJ: Values and beliefs on trainee selection: What counts in the eye of the selector? A qualitative study exploring the program director's perspective. Med Teach 2020, 42(10):1179–1186.
31. Mattijsen JC, Ghedri, A., Reinhard, M.: Promoveren Opleiders. De Geneeskundestudent 2019.
32. Ghedri A, Bontje, W., Abdelmoumen, A. : Promoveren of profileren? . De Geneeskundestudent 2018.
33. Bisshop A: Een goede arts hoeft echt niet te promoveren. . Trouw 4:9 2019.
34. Zuckerman SL, Kelly PD, Dewan MC, Morone PJ, Yengo-Kahn AM, Magarik JA, Baticulon RE, Zusman EE, Solomon GS, Wellons JC, 3rd: Predicting Resident Performance from Preresidency Factors: A Systematic Review and Applicability to Neurosurgical Training. World Neurosurg 2018, 110:475–484.e410.
35. Cook DA, Artino Jr AR: Motivation to learn: an overview of contemporary theories. Medical Education 2016, 50(10):997–1014.
36. Determined to Succeed: Motivation Towards Doctoral Degree Completion. 2013.
37. Kusurkar R, ten Cate O, Vos C, Westers P, Croiset G: How motivation affects academic performance: A structural equation modelling analysis. Advances in health sciences education : theory and practice 2012, 18.
38. Bryan B, Guccione K: Was it worth it? A qualitative exploration into graduate perceptions of doctoral value. Higher Education Research & Development 2018, 37(6):1124–1140.
39. Brailsford I: Motives and Aspirations for Doctoral Study: Career, Personal, and Inter-personal Factors in the Decision to Embark on a History PhD. International Journal of Doctoral Studies 2010, 5.
40. Kemp MW, Molloy TJ, Pajic M, Chapman E: An analysis of reported motivational orientation in students undertaking doctoral studies in the biomedical sciences. BMC Med Educ 2014, 14:38.
41. Skakni I: Reasons, motives and motivations for completing a PhD: a typology of doctoral studies as a quest. 2018.
42. Terentev E, Rybakov N, Bednyi B: Why Embark on a PhD Today? A Typology of Motives for Doctoral Study in Russia. Voprosy obrazovaniya / Educational Studies Moscow 2020:40–69.
43. McCulloch A, Guerin C, Jayatilaka A, Calder P, Ranasinghe D: Choosing to study for a PhD: A framework for examining decisions to become a research student. Higher Education Review 2017, 49:85–106.
44. Clercq M, Frenay M, Azzi A, Klein O, Galand B: All You Need is Self-Determination: Investigation of PhD Students' Motivation Profiles and Their Impact on the Doctoral Completion Process. International Journal of Doctoral Studies 2021, 16:189–209.
45. Guerin C, Jayatilaka A, Ranasinghe D: Why start a higher degree by research? An exploratory factor analysis of motivations to undertake doctoral studies. Higher Education Research and Development 2015, 34.
46. Hands A: What's your type? An examination of first-year doctoral student motivation. Education for Information 2020, 36:371–387.
47. Lynch M, Salikhova N, Salikhova A: Internal Motivation among Doctoral Students: Contributions from the Student and from the Student's Environment. International Journal of Doctoral Studies 2018, 13:255–272.
48. Litalien D, Guay F, Morin AJS: Motivation for PhD studies: Scale development and validation. Learning and Individual Differences 2015, 41:1–13.

49. Anderson MS, Swazey JP: Reflections on the graduate student experience: An overview: An Exploration. In: 1998; 1998.
50. Ryan R, Deci E: Self-determination theory. Basic psychological needs in motivation, development and wellness. New York, NY : Guilford Press. 2017:231.
51. Wigfield A, Eccles JS: Expectancy-Value Theory of Achievement Motivation. Contemp Educ Psychol 2000, 25(1):68-81.
52. Eccles J, Dweck C: Handbook of competence and motivation. In.: New York, NY: Guidford Press; 2005.
53. Savolainen R: Self-determination and expectancy-value: Comparison of cognitive psychological approaches to motivators for information seeking about job opportunities. Aslib J Inf Manag 2018, 70:123-140.
54. Yue Y, Lu J: International Students' Motivation to Study Abroad: An Empirical Study Based on Expectancy-Value Theory and Self-Determination Theory. Front Psychol 2022, 13:841122.
55. Koestner R, Otis N, Powers TA, Pelletier L, Gagnon H: Autonomous Motivation, Controlled Motivation, and Goal Progress. Journal of Personality 2008, 76(5):1201-1230.
56. Deci E, Ryan R: The importance of autonomy for development and well-being. Self-Regulation and Autonomy: Social and Developmental Dimensions of Human Conduct 2005:19-46.
57. Wang CKJ, Liu WC, Kee YH, Chian LK: Competence, autonomy, and relatedness in the classroom: understanding students' motivational processes using the self-determination theory. Heliyon 2019, 5(7):e01983.
58. Bandura A: Self-efficacy: toward a unifying theory of behavioral change. Psychol Rev 1977, 84(2):191-215.
59. Barron K, Hulleman C: Expectancy-Value-Cost Model of Motivation. In., edn.; 2014: pp. 503-509 (Vol. 508).
60. Schaufeli WB, Salanova M, González-romá V, Bakker AB: The Measurement of Engagement and Burnout: A Two Sample Confirmatory Factor Analytic Approach. Journal of Happiness Studies 2002, 3(1):71-92.
61. Schaufeli W, Salanova M: (2006). Work engagement: An emerging psychological concept and its implications for organizations. DSSW Gilliland, Research in social issues in Management: Vol Managing social and ethical issues in organization Green, CT: InformationAgePublishers, 2007.
62. Pyhältö K, Toom A, Stubb J, Lonka K: Challenges of Becoming a Scholar: A Study of Doctoral Students' Problems and Well-Being. ISRN Education 2012, 2012:934941.
63. Artino AR, Jr., La Rochelle JS, Dezee KJ, Gehlbach H: Developing questionnaires for educational research: AMEE Guide No. 87. Med Teach 2014, 36(6):463-474.
64. Ommering BWC, van Blankenstein FM, van Diepen M, Dekker FW: Academic Success Experiences: Promoting Research Motivation andSelf-Efficacy Beliefs among Medical Students. Teach Learn Med 2021, 33(4):423-433.
65. Upadyaya K, Salmela-Aro K: Development of early vocational behavior: Parallel associations between career engagement and satisfaction. Journal of Vocational Behavior 2015, 90:66-74.
66. Balducci C, Fraccaroli F, Schaufeli WB: Psychometric Properties of the Italian Version of the Utrecht Work Engagement Scale (UWES-9) A Cross-Cultural Analysis. European Journal of Psychological Assessment 2010, 26:143-149.
67. Bothma CFC, Roodt G: The validation of the turnover intention scale. Sa Journal of Human Resource Management 2013, 11:1-12.
68. De Keuzemonitor Geneeskunde. Retrieved from https://www.nivel.nl/sites/default/files/bestanden/keuzemonitor_geneekunde_2015.pdf July, 2021.
69. Butterman O, Slenter V, Velden LVd, Batenburg R: Gender differences in attrition rates of hospital-based medical specialty programs: attributable to gender composition of the clinical specialty? In.: Research Square; 2020.
70. Bair CR, Haworth JG: Doctoral Student Attrition and Persistence: A Meta-Synthesis of Research. ASHE Annual Meeting Paper. In: 1999; 1999.
71. Eshel N, Chivukula RR: Rethinking the Physician-Scientist Pathway. Academic Medicine 2022:10.1097/ACM.0000000000004788.
72. Ireri SK, Walshe K, Benson L, Mwanthi MA: A qualitative and quantitative study of medical leadership and management: experiences, competencies, and development needs of doctor managers in the United Kingdom. Journal of Management & Marketing in Healthcare 2011, 4:16 – 29.

73. Sherbino J, Frank JR, Snell L: Defining the Key Roles and Competencies of the Clinician–Educator of the 21st Century: A National Mixed-Methods Study. Academic Medicine 2014, 89(5):783-789.
74. Vogel L: Doctors need retraining to keep up with technological change. CMAJ 2018, 190(30):E920.
75. Carter S, Kensington-Miller B, Courtney M: Doctoral Supervision Practice: What's the Problem and How Can We Help Academics? Journal of Perspectives in Applied Academic Practice 2016, 5.
76. Chakraverty D, Jeffe DB, Tai RH: Transition Experiences in MD–PhD Programs. CBE Life Sciences Education 2018, 17.
77. Mills JMZ, Januszewski AS, Robinson BG, Traill CL, Jenkins AJ, Keech AC: Attractions and barriers to Australian physician-researcher careers. Intern Med J 2019, 49(2):171-181.
78. Ortega G, Smith C, Pichardo MS, Ramirez A, Soto-Greene M, Sánchez JP: Preparing for an Academic Career: The Significance of Mentoring. In: MedEdPORTAL. vol. 14; 2018: 10690.
79. Bustraan J, Dijkhuizen K, Velthuis SI, van der Post RS, Driessen EW, van Lith JMM, De Beaufort AJ: Why do trainees leave hospital-based specialty training? A nationwide survey study investigating factors involved in attrition and subsequent career choices in the Netherlands. BMJ Open 2019, 9.
80. Bongiovanni T, Yeo H, Sosa JA, Yoo PS, Long T, Rosenthal M, Berg D, Curry L, Nunez-Smith M: Attrition from surgical residency training: perspectives from those who left. Am J Surg 2015, 210(4):648-654.