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

Bakker, C.R. den

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Chapter 3

The role of mandatory research projects in medical students' research motivation

Charlotte R. den Bakker
Belinda W.C. Ommering
Arnout Jan de Beaufort
Friedo W. Dekker

Submitted

Abstract

Introduction Research experiences within medical school are mainly offered as elective or extracurricular initiative. Consequently, some students become doctors without hands-on research experience while every clinician is expected to be a scholar able to both use and contribute to research. Additionally, research experiences are needed to cultivate the next generation clinician-scientists as medicine is facing a clinician-scientist shortage. Research motivation is believed to play an important role in both using and actually participating in research as clinician(-scientist). However, development of motivation during a mandatory research project has not been investigated yet. Therefore, this study, investigates the role of mandatory research in medical students' research motivation and ambition. Using Theory of Planned Behaviour and Self-Determination Theory, we included motivational determinants to further unravel motivational development, also in students that would not have participated in research if not mandatory.

Methods 304 medical students (response rate 94.4%) completed a questionnaire prior to, during, and after their mandatory research about research motivation, motivational determinants and research ambitions. Regression analyses were used to explore development of motivation, its determinants and research ambition during mandatory research.

Results Research perceptions, self-efficacy, autonomy, and relatedness increased in most students and strengthened intrinsic motivation (adjusted β=.38, .31, .15, .14, respectively). Both perceptions and self-efficacy strengthened extrinsic motivation (adjusted β=.37, .15, respectively). Intrinsic and extrinsic motivation fostered research ambitions (adjusted β=.82, .16, respectively). One out of four students stated that they would not participate if it had not been mandatory. Most of this subgroup increased in research motivation and ambitions, but did not reach levels equal to peers.

Conclusions Mandatory research projects foster both intrinsic and extrinsic research motivation in most students and, in turn, foster research career ambitions. The beneficial effects of mandatory research experiences were more pronounced in students who initially were not intending to participate in research. Furthermore, this study established the applicability of Theory of Planned Behaviour and Self-Determination Theory within a mandatory context. Our results suggests that substantial educational investments in and allocation of resources for mandatory research projects could be regarded as a meaningful step toward providing all future doctors with hands-on research experience. This experiences enables them to use and conduct research, thereby cultivating the next generation of clinician-scientists.

Introduction

'The conscientious, explicit and judicious use of the best evidence in making decisions about the care of patients' is at heart of *evidence-based medicine* (EBM).[1] This requires curious and capable doctors able to use, critically appraise, and appropriately apply the best available scientific evidence to individual clinical patient care. Furthermore, the development of EBM highly depends on doctors (i.e. clinician-scientists) actively engaged in research as they bring two worlds (i.e. clinical care and research) together. In line with this, a common belief is that every clinician should be a scholar able to both use and contribute to research and is incorporated in widely used frameworks like CanMEDS.[2]

Hands-on research projects are suitable opportunities for future doctors to serve these scholarly aims. During research participation, medical students are challenged to be curious and critically appraise and value research, relevant when using research in future clinical care. Furthermore, research participation during medical school is an important determinant in future research participation, e.g. choosing to pursue a research career,[3-6] and thereby, additionally, may help to counteract the concerning decline and shortage in clinician-scientists.[7,8] These projects can contribute to fostering and identifying research talent, useful in cultivating the next generation of clinician-scientists. However, research projects are time-consuming and require a lot of educational resources (e.g. supervision) as they are on individual or small group level. Consequently, they are mainly offered as elective or extracurricular initiative for students looking for extra challenges or those highly motivated for research. As a result of predominantly voluntary research opportunities, a significant number of students around the world graduates without any hands-on research experience.[4] Some initially lack research interest or have time pressure, while most did not participate in research due to a lack of opportunities.[9]

Motivation is an important factor for research engagement. Previous studies showed that research motivation strengthens research participation during and after medical school.[4,6,10] Therefore research motivation is believed to play an important role in using and actually participating in research as clinician(-scientist). As it is challenging to incorporate mandatory research projects in the curriculum, critically evaluating the role of mandatory research in motivation for research is important. Previous studies on mandatory research experiences have focused on perceived learning outcomes, research attitudes and publication rates.[4,9,11] However, no studies so far have focused on motivation of students doing mandatory research projects.

Two well-established theoretical frameworks to comprehend motivational dynamics are the Theory of Planned Behaviour (TPB) and the Self-Determination Theory (SDT).[12,13]

In the context of our study, these two theoretical constructs intersect, culminating in a comprehensive understanding of the determinants of motivation. According to TPB, attitudes serves as a prerequisite to motivation, which, in turn, correlates with specific behaviours. Attitudes reflect individual's perceptions of a certain behaviour including the evaluation of the behaviour. Subjective norms, encompassing societal influences and expectations, along with perceived behavioural control, somewhat similar to SDT's need for competence representing an individual's self-assessment of their capability to perform a behaviour, further contributes to shaping these intentions. Moreover, SDT advances a nuanced perspective on motivation, categorizing it into various forms. Of particular relevance to our study are *intrinsic motivation* (IM), characterized by an inherent interest in an activity (e.g. doing research out of interest), and *extrinsic motivation* (EM), propelled by external rewards or avoidance of penalties (e.g. doing research for a grade or to increase the chance of getting into a specific residency position). IM is believed to be of better quality as it promotes deep learning, academic achievement and feelings of well-being.[14-16] Furthermore, IM results in actual research participation later on.[4,6,10] According to SDT, feelings of autonomy (i.e. the need to feel ownership of one's behaviour), competence (i.e. the need to produce desired outcomes and to experience mastery, also referred to as self-efficacy) and relatedness (i.e. the need to feel connected to others) must be satisfied to be intrinsically motivated.

In sum, in our study, we integrated research perceptions, feelings of autonomy, research self-efficacy and relatedness as determinants of motivation in alignment with the theoretical frameworks. As these motivation determinants involve dynamic processes and can develop over time, we assume that students' type (i.e. IM and EM) and quantity of motivation develops as well. This study investigates the development of motivation, its determinants, as well as research career intentions during mandatory research (*Figure 1*), also in students who stated that they would not have participated in research if it had not been mandatory. It was hypothesized that, although research takes place in a mandatory setting, research perceptions, self-efficacy, autonomy and relatedness strengthen intrinsic motivation, also in students who initially did not intend to participate in research. Furthermore, we hypothesized that intrinsic motivation, in turn, fosters research ambitions. Insights in the effect of mandatory research on research motivation can contribute to the discussion if and how research should be integrated into medical curricula to further improve mandatory research experiences and enhance research motivation.

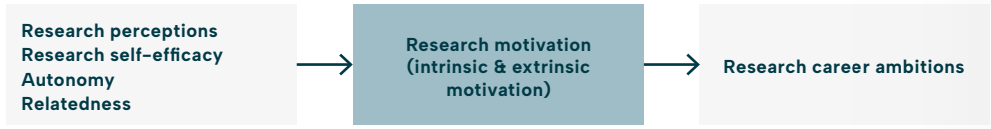

Figure 1. *Overview of tested study constructs according to the theoretical framework*

Methods

Setting

Leiden University Medical Center (LUMC) is one of eight Dutch medical schools which all use the same blueprint for learning outcomes,[17] and have mandatory individual research projects for master students. First, students need to arrange their internship at a health institute and department of preference, and choose a research domain e.g. clinical research, laboratory research, or public health research. Students are free to choose the timing to conduct their research before or after clerkships. During the research project, students work full-time on their authentic, hands-on research for four to six months. While students fulfil the role of primary investigator, they are mentored by one or few research supervisors, mostly (clinician-)scientists or PhD candidates. Students conduct their own research and develop research skills, such as searching and critically appraising literature, designing research, and analysing and interpreting data. As final products, students write a research report and present their findings orally at the department. Assessment consists of two parts: the research product and students' learning process. More than one out of four students voluntarily invest extra time and publish their report as a scientific paper in a peer-reviewed journal.[11]

Materials and definitions

This prospective cohort study included all medical students at LUMC who started and completed their research project between October 2020 and August 2022 (partly during the COVID-19 pandemic). We used a 7-point Likert type questionnaire with five scales ranging from 1 to 7 with multiple data collection moments (*Figure 2 and Appendix B*). Scales on intrinsic and extrinsic motivation for research, research perceptions, and research self-efficacy were used in previous studies in first-year medical students at the LUMC.[18,19] These studies confirmed the internal consistency (Cronbach's alpha between .77-.88) and construct validity within the SDT context. Additionally, the autonomy scale of the validated Work-related Basic Need Satisfaction Scale (WBNS) was used.[20] The relatedness scale was based on the relatedness scale of the WBNS combined with the 'integration of the research community' scale of the Dutch Student Perception of Research Integration Questionnaire.[20,21] We translated items of the autonomy and relatedness scales to Dutch using forward-backward translation procedure. Slight adjustments were made in order to fit the context of medical master students (e.g. replaced 'job' for 'research internship'). Lastly, we added items to the questionnaire to measure students' current (i.e. if students would or would not have participated in research if it had not been mandatory) and further research career ambitions as publication, research involvement, research career ambitions. Finally, we tested the refined pilot questionnaire among medical master students using a think-aloud procedure to ensure items were clearly

formulated and understood correctly. Subsequently, the questionnaire was reviewed by experts in the field before being distributed.

Procedure

Students filled in a questionnaire prior to starting their project (T0), around four weeks (T1), and after finishing their research project (T2) (*Figure 2*). Beforehand, they received information about the study and informed consent was asked to also use their data for scientific purposes. The T0-survey served as baseline measurement for research motivation, self-efficacy and perceptions. As feelings of relatedness and autonomy were not measurable prior to the research project, these constructs were measured early in the research project (T1, after around 4 weeks). Finally, all constructs were measured after the research project when students uploaded their research report (T2). As COVID-19 not only impacted healthcare but medical education including research internships as well, we included to what extent students worked from home.

T0 (start of research project)	T1 (early-stage evaluation around 4 weeks)	T2 (submission of research report)
Demographics		Demographics
Motivation for research	Autonomy	Motivation for research
Research self-efficacy	Relatedness	Research self-efficacy
Research perceptions		Research perceptions
Research career ambitions		Autonomy
		Relatedness
		Research career ambitions

Figure 2. *Overview of data points*

Analysis

Cronbach's alpha was checked for all scales. Development of motivation and its determinants was measured by means at T2, adjusted for baseline or early stage measurement at T0 or T1. We used linear regression analyses, both crude and adjusted for possible confounders, to study the relation between development of motivational determinants and actual motivational development, as well as between motivation and research career ambitions. A 95% confidence interval (CI) was used to determine statistical significance.

Ethical approval

Ethical approval was obtained from the Institutional Review Boards of Leiden University Medical Center (OEC/ERRB/20200414/1).

Results

In total, 304 out of 322 medical students (94%) consented to participate and completed questionnaires at T0, T1 and T2. Two thirds of the respondents were female, reflecting the male/female ratio in medical schools in The Netherlands. The mean age was 23.7 years (SD 2.07, 19-31 years). Most students conducted clinical research (74%, n=224) and chose a formal research period of 18 weeks (82%, n=250). *Table 1* shows the demographics of the participants. Approximately 35% of all students worked more than 80% at home during their research project. Cronbach's alpha of all constructs were between .74-.89. See *Table 2*.

Table 1. *Demographics of medical students*

Demographic variable	Categories	N	%
Sex	Female	209	68.7
	Male	95	31.3
Formal duration research project	18 weeks	250	82.2
	23 weeks	37	12.2
	28 weeks	17	4.6
Curricular timing	Before clerkships	174	57.2
	After clerkships	130	42.8
Type of research	Clinical research	224	73.7
	Public and primary healthcare	39	12.8
	Laboratory research	7	2.3
	Other	34	11.2
Extra-curricular research experience	Yes	84	27.6
	No	220	72.4
Worked at home due to COVID-19	0% of the research project	9	3.0
	10-40% of the research project	66	21.7
	50-80 % of the research project	116	38.1
	90% of the research project	61	20.1
	100% of the research project	52	17.1

Table 2. *Scales with corresponding Cronbach's alpha*

Construct	Cronbach's alpha[a]	Items (n)	Item example
IM T0	.86	5	*I enjoy doing research.*
EM T0	.86	4	*I believe that doing research benefits my CV.*
Research perceptions T0	.86	5	*Each clinician should be able to independently conduct research.*
Research self-efficacy T0	.89	6	*I believe that I am good in doing research.*
Relatedness T1	.89	3	*During my internship, I felt part of a group.*
Autonomy T1	.74	8	*I feel free to do my internship the way I think it could best be done.*
Research career ambitions T0	.87	2	*I would like to conduct research as part of my work once I am a medical doctor.*

[a] *Cronbach's alpha was not materially different at T1 and/or T2*

Development of motivation, its determinants and research career ambitions

Mean IM at baseline (T0) was 5.31 (SD .86) and 5.58 (SD .94) after the research project (T2). IM increased in almost three out of four students with a mean increase of .66 on a 7-point Likert scale. About a quarter of all students decreased in IM with a mean of .67. Mean EM at baseline (T0) was 5.26 (SD 1.03) and 5.32 (SD 1.11) after the research project (T2). EM increased in 60% of all students with a mean increase of .69 on a 7-point Likert scale, in other students EM decreases on average .88. Mean IM and EM at baseline (T0) were significantly lower (mean difference .24, $p<0.001$ and mean difference .52, $p<0.001$) in students who increased in IM or EM during their research project.

The majority of the students (68%, n=207) increased in positive research perceptions during the research project, with a mean of .63 point. One out of three students' research perceptions decreased with a mean of .80 point. Regarding research self-efficacy, approximately one out of four students had lower research self-efficacy scores after the research project. Within the group with growth of research self-efficacy during the research project, the mean increase was .90 point. Both relatedness and autonomy declined in almost half of students with on average .67 point. Students that increased in relatedness and autonomy increased with on average .63 and .44 point, respectively. Lastly, research career intentions increased in more than two out of three students with on average .78 point. Baseline scores of motivation, its determinants and research career ambitions were significantly lower in those who experienced an increase in these

constructs during the research project (all p-values<0.001). An overview of mean scores and development of the constructs is shown in *Table 3*.

Table 3. *Development of motivation, its determinants and research career ambitions based on a 7-point Likert scale*

Construct	All students who conducted and completed their research project	Students whose construct score increased during the research project (T0/T1-T2)	Students whose construct score decreased during the research project (T0/T1-T2)
IM			
N (%)	304 (100%)	216 (71.1%)	88 (28.9%)
Mean score T0 (SD; min-max)	5.31 (.86; 2.60-7.00)	5.24 (.85; 2.60-7.00)	5.48 (.88; 3.00-7.00)
Mean score T2 (SD; min-max)	5.58 (.94; 2.40-7.00)	5.90 (.73; 3.40-7.00)	4.81 (.96; 2.40-6.40)
Mean development[a] (SD; min-max)	+ .27 (.83; -2.20-3.00)	+ .66 (.62; .00-3.00)	- .67 (.39; -2.20– - .20)
EM			
N (%)	304 (100%)	183 (60.2%)	121 (39.8%)
Mean score T0 (SD; min-max)	5.26 (1.03; 2.00-7.00)	5.05 (1.07; 2.00-7.00)	5.57 (.89; 2.00-7.00)
Mean score T2 (SD; min-max)	5.32 (1.11; 1.50-7.00)	5.74 (.89; 3.25-7.00)	4.69 (1.10; 1.50-6.50)
Mean development[a] (SD; min-max)	+ .06 (1.01; -3.25-3.00)	+ .69 (.66; .00-3.00)	- .88 (.64; -3.25– - .25)
Perceptions			
N (%)	304 (100%)	207 (68.1%)	97 (31.9%)
Mean score T0 (SD; min-max)	5.12 (.97; 2.00-7.00)	5.02 (.97; 2.00-7.00)	5.34 (.94; 2.20-7.00)
Mean score T2 (SD; min-max)	5.29 (1.05; 2.00-7.00)	5.65 (.86; 2.20-7.00)	4.54 (1.03; 2.00-6.60)
Mean development[a] (SD; min-max)	+ .17 (.87; -2.40-3.80)	+ .63 (.59; .00-3.80)	- .79 (.53; -2.40– - .20)

Research self-efficacy			
N (%)	304 (100%)	234 (77.0%)	70 (23.0%)
Mean score T0 (SD; min-max)	4.66 (1.00; 1.00-7.00)	4.59 (1.04; 1.00-7.00)	4.91 (.82; 2.67-7.00)
Mean score T2 (SD; min-max)	5.16 (.95; 1.33-7.00)	5.44 (.75; 3.33-7.00)	4.21 (.95; 1.33-6.00)
Mean development[a] (SD; min-max)	+ .50 (1.00; -2.67-4.33)	+ .85 (.82; .00-4.33)	- .70 (.44; -2.67– - .33)
Relatedness			
N (%)	304 (100%)	166 (54.6%)	138 (45.4%)
Mean score T1 (SD; min-max)	4.18 (1.22; 1.00-7.00)	4.05 (1.24; 1.00-6.88)	4.34 (1.18; 1.13-7.00)
Mean score T2 (SD; min-max)	4.22 (1.27; 1.00-7.00)	4.68 (1.19; 1.19;1.50-7.00)	3.67 (1.16; 1.00-6.75)
Mean development[a] (SD; min-max)	+ .04 (.85; -2.63-3.00)	+ .63 (.59; .00-3.00)	- .67 (.52; -2.63– - .13)
Autonomy			
N (%)	304 (100%)	169 (55.6%)	135 (44.4%)
Mean score T1 (SD; min-max)	5.20 (.86; 2.80-7.00)	5.02 (.81; 2.80-7.00)	5.43 (.87; 3.20-7.00)
Mean score T2 (SD; min-max)	5.15 (.91; 1.80-7.00)	5.46 (.75; 3.40-7.00)	4.76 (.95; 1.80-6.60)
Mean development[a] (SD; min-max)	- .05 (.73; -2.40-2.80)	+ .44 (.47; .00-2.80)	- .67 (.49; -2.40– - .20)
Research career ambitions			
N (%)	304 (100%)	210 (69.1%)	94 (30.9%)
Mean score T0 (SD; min-max)	4.26 (1.54; 1.00-7.00)	4.10 (1.59; 1.00-7.00)	4.62 (1.36; 2.00-7.00)
Mean score T2 (SD; min-max)	4.46 (1.64; 1.00-7.00)	4.88 (1.55; 1.00-7.00)	3.53 (1.45; 1.00-6.50)
Mean development[a] (SD; min-max)	+ .20 (1.17; -4.00-4.00)	+ .78 (.47; .00-2.80)	- .50 (.69; -4.00– - .50)

[a] *Mean development (T0 to T2 or T1 to T2) reflect the development of the construct during the research project*

Development of determinants of motivation in relation to development of motivation

Development of students' research perceptions and self-efficacy were significantly positively related to development of both IM (adjusted β=.38; .31, respectively) and EM (adjusted β=.37; .15, respectively). Furthermore, development of both relatedness and autonomy were significantly positively related to development of IM after adjustment for other variables (adjusted β=.15; .14, respectively), but no significant association with development of students' EM was found (adjusted β=.06; .06, respectively). An overview of the development of motivation and its determinant and possible confounders adjusted for is depicted in *Table 4*.

Table 4. *Development of different types of motivation (i.e. IM and EM) in relation to development of determinants of motivation (N=304)*

Theoretical determinant of motivation	Outcome	β (95% CI)	Adjusted R^2	Possible confounders adjusted for†
Development of perceptions (T0-T2)	Development of IM (T0-T2)	.39 (.30-.48)* .42 (.33-.51)* .38 (.30-.47)*	.10 .50 .55	Age, sex, before/after clerkship, previous research experience, duration, working from home due to covid, EM T0, research self-efficacy T0 + Autonomy T1, relatedness T1
Development of perceptions (T0-T2)	Development of EM (T0-T2)	.35 (.24-.47)* .38 (.27-.50)* .37 (.26-.49)*	.04 .43 .43	Age, sex, before/after clerkship, previous research experience, duration, working from home due to covid, EM T0, research self-efficacy T0 + Autonomy T1, relatedness T1
Development of research self-efficacy (T0-T2)	Development of IM (T0-T2)	.30 (.22-.39)* .31 (.23-.39)* .31 (.23-.39)*	.03 .49 .54	Age, sex, before/after clerkship, previous research experience, duration, working from due to covid, EM T0, research perceptions T0 + Autonomy T1, relatedness T1
Development of research self-efficacy (T0-T2)	Development of EM (T0-T2)	.10 (-.01-.20) .16 (.05-.27)* .15 (.04-.25)*	.00 .35 .36	Age, sex, before/after clerkship, previous research experience, duration, working from due to covid, IM T0, research perceptions T0 + Autonomy T1, relatedness T1

Theoretical determinant of motivation	Outcome	β (95% CI)	Adjusted R^2	Possible confounders adjusted for†
Development of relatedness (T1-T2)	Development of IM (T0-T2)	.12 (.02-.22)* .11 (.01-.21)* .15 (.05-.24)*	.01 .38 .45	Age, sex, before/after clerkship, previous research experience, duration, working from due to covid, EM T0, research perceptions T0, research self-efficacy T0 + Autonomy T1
Development of relatedness (T1-T2)	Development of EM (T0-T2)	.06 (-.07-.18) .04 (-.08-.16) .06 (-.06-.18)	.00 .34 .35	Age, sex, before/after clerkship, previous research experience, duration, working from due to covid, IM T0, research perceptions T0, research self-efficacy T0 + Autonomy T1
Development of autonomy (T1-T2)	Development of IM (T0-T2)	.11 (-.01-.23) .12 (-.00-.24) .14 (.02-.26)*	.02 .38 .40	Age, sex, before/after Alerkship, previous research experience, duration, working from due to covid, EM T0, research perceptions T0, research self-efficacy T0 + Relatedness T1
Development of autonomy (T1-T2)	Development of EM (T0-T2)	.07 (-.07-.21) .05 (-.09-.19) .06 (-.08-.21)	.00 .34 .35	Age, sex, before/after clerkship, previous research experience, duration, working from due to covid, IM T0, research perceptions T0, research self-efficacy T0 + Relatedness T1

† Motivational development was approached as motivation T2 scores adjusted for T0 scores as first step. Hereafter, we adjusted for possible confounders at T0. As relatedness and autonomy were not measurable at T0 (prior to the research project) and measured at T1 (early stage of research) we separately adjusted for these constructs in a final step.
** Indicating statistical significance $p < 0.05$*

Working from home (measured on 0-100 scale as percentage) due to COVID-19 significantly reduced intrinsic and extrinsic motivation after the research project (crude β=-.005; -.005, respectively). Furthermore, working from home significantly and negatively impacted development in relatedness (crude β=-.004), as well as both relatedness and positive research perceptions after the research project (crude β=-.021; -.005, respectively). Other relations between working from home and motivational determinants were not significant. An overview of the association between motivational determinants including working from home and the development of motivation is depicted in *Table 5*.

Table 5. *Overview of the impact of working from home due to COVID-19 on motivation and its determinants using regression analyses*

Determinant	Outcome	β (95% CI)
Working from home due to COVID-19	Intrinsic motivation T2*	-.005 (-.009 – -.001)
Working from home due to COVID-19	Development of IM (T0-T2)	-.003 (-.006 – .001)
Working from home due to COVID-19	Extrinsic motivation T2*	-.005 (-.009 – -.001)
Working from home due to COVID-19	Development of EM (T0-T2)	-.002 (-.005 – .002)
Working from home due to COVID-19	Research perceptions T2	-.005 (-.009 – -.001)
Working from home due to COVID-19	Development of research perceptions (T0-T2)	-.003 (-.007 – .000)
Working from home due to COVID-19	Autonomy T2	-.002 (-.005 – .001)
Working from home due to COVID-19	Development of autonomy (T0-T2)	-.003 (-.007 – .000)
Working from home due to COVID-19	Relatedness T2*	-.021 (-.026 – -.017)
Working from home due to COVID-19	Development of relatedness (T0-T2)*	-.004 (-.007 – -.001)
Working from home due to COVID-19	Research self-efficacy T2	-.004 (-.007 – .000)
Working from home due to COVID-19	Development of research self-efficacy (T0-T2)	-.001 (-.005 – .003)

** Indicating statistical significance $p < 0.05$*

Motivation and scientific outcomes

Students with higher IM and to a lesser extent EM after their research project had significantly more research career ambitions (adjusted β=.82, β .16, respectively). In addition, development of IM and to a lesser extent EM were significantly positively correlated with development of research career ambitions (adjusted β=-.74; .30, respectively). Almost 40% of all students reported that they will publish an article as a result of their research project, and 20% reported a probably publication. Approximately

40% did not intend to publish. In addition, one out of three students reported that they were planning on further participation in research at the department where they conducted their research internship. The association between motivation and research career ambitions is depicted in *Table 6*.

Table 6. *Motivation and research career ambitions*

Determinant	Outcome	Adjusted β (95% CI)	Adjusted R^2	Possible confounders adjusted for[a]
IM after research project (T2)	Research career ambitions after the research project (T2)	1.35 (1.23–1.48)* .82 (.63–1.02)*	.60 .66	Age, sex, before/after clerkship, previous research experience, duration, working from home due to covid, EM T2, perceptions T2, research self-efficacy T2, relatedness T2, autonomy T2
EM after research project (T2)	Research career ambitions after the research project (T2)	.78 (.63–.92)* .16 (.05–.28)*	.27 .66	Age, sex, before/after clerkship, previous research experience, duration, working from home due to covid, IM T2, perceptions T2, research self-efficacy T2, relatedness T2, autonomy T2,
Development IM (T0–T2)	Development in research career ambitions (T0–T2)	.75 (.62–.88)* .77 (.64–.90)* .74 (.61–.88)*	.67 .68 .68	Age, sex, before/after clerkship, previous research experience, duration, working from home due to covid, EM T0, perceptions T0, research self-efficacy T0 + Relatedness T1, autonomy T1
Development EM (T0–T2)	Development in research career ambitions (T0–T2)	.31 (.19–.43)* .33 (.21–.45)* .30 (.17–.42)*	.57 .57 .58	Age, sex, before/after clerkship, previous research experience, duration, working from home due to covid, IM T0, perceptions T0, research self-efficacy T0 + Relatedness T1, autonomy T1

[a] *Motivational development and development of research career ambitions were approached as T2 scores adjusted for T0 scores as first step. Hereafter, we adjusted for possible confounders at T0. As relatedness and autonomy were not measurable at T0 (prior to the research project) and measured at T1 (early stage of research) we separately adjusted for these constructs in a final step.*

* *Indicating statistical significance $p < 0.05$*

Outcomes if research would not have been mandatory

Approximately one out of four students (n=87, 29%) stated beforehand that they would not have participated in research if it had not been mandatory. This group (*group 2*) had significantly lower mean IM and EM prior to their research project (mean difference IM 1.07; mean difference EM .88), as well as less research career ambitions (mean difference 2.10) compared to students who wanted to participate in research without it being imposed on them or were neutral (*group 1)* (*Table 7*). Throughout the research experience, mean IM increased .47 and mean EM .08 point in group 2. Furthermore, their research career ambitions increased with on average .38 point. Mean IM, EM, and ambitions within group 1 increased as well throughout the research internship, but to a lesser extent. The majority in group 2 increased in IM (74%, n=64), EM (60%, n=52), research perceptions (67%, n=58), self-efficacy (74%, n=64), and research career ambitions (72%, n=63). Half of this group increased in relatedness (51%, n=44) and autonomy (52%, n=45), which is almost equal to group 1 and comparable to the average of all students. Of group 2, 35 students (40%) stated after the research project that they would participate in research if it had not been mandatory. Within group 1, 23 students (11%) changed their mind and stated after their research project that they would not have participated in research if it had not been mandatory. Of all students, after the research, 25% (n=75) stated that they would not have participated in research not mandatory, whereof 69% (n=52) stated the same prior to their research.

Table 7. *Group differences between students that prior to their research project stated that they would have (group 1) or have not (group 2) participated in research if research would not have been mandatory*

Mean construct	Group 1† (N=217)	Group 2†† (N=87)	Mean difference	95% CI
IM baseline	5.61	4.54	1.07*	.90 – 1.26
IM after research project	5.81	5.01	.80*	.56 – 1.05
IM development	.20	.47	.27*	-.50 – -.05
EM baseline	5.51	4.63	.88*	.64 – 1.12
EM after research project	5.57	4.70	.87*	.57 – 1.15
EM development	.06	.08	.02	-.31 – .27
Research perceptions baseline	5.41	4.39	1.02*	-1.23 – -.80
Research perceptions after research project	5.55	4.64	.91*	-1.18 – -.64
Research perceptions development	.15	.25	.10	-.14 – .35
Research self-efficacy baseline	4.93	4.00	.93*	-1.16 – -.70
Research self-efficacy after research project	5.33	4.74	.59*	-.84 – -.33
Research self-efficacy development	.40	.75	.35*	.05 – .64
Research relatedness baseline	4.35	3.75	.60*	-.90 – -.31
Research relatedness after research project	4.39	4.24	.59*	-.90 – -28
Research relatedness development	.04	.05	.01	-.20 – .23
Research autonomy baseline	5.27	5.02	.26*	-.47 – -.05
Research autonomy after research project	5.25	4.89	.36*	-.59 – -.14
Research autonomy development	-.02	-.13	.10	-.29 – .08
Research career ambitions baseline	4.86	2.76	2.10*	1.80 – 2.40
Research career ambitions after research project	4.99	3.14	1.85*	1.50 – 2.21
Research career ambitions development	.13	.38	.25	-.54 – .04

† *Students who initially wanted to participate in research if research would not have been mandatory in the curriculum or students who were neutral (T0)*
†† *Students who initially not wanted to participate in research if research would not have been mandatory in the curriculum (T0)*
* *Indicating statistical significance $p < 0.05$*

Discussion

This is the first longitudinal, theory based study on medical students' motivation for research students in a mandatory setting. Our study shows that mandatory research not only offers every future doctor a hands-on research experience, but also fosters both intrinsic and extrinsic research motivation, secondary to improvement of its determinants, first and foremost research perceptions and self-efficacy, in a majority of students. The development in both type and quantity of research motivation matters, as both students' intrinsic motivation and to a lesser extent extrinsic motivation after the research experience strengthen research career ambitions. Previous studies showed theory based determinants tested in our study contributed to motivation and that medical students are more likely to pursue research careers in students that voluntarily participated in research.[3-6,22] Our study adds that this is also true in a mandatory setting, when those who would otherwise become doctors without any hands-on research experience are included as well. Consequently, this also provides evidence for the idea that if these motivational determinants are fostered in a mandatory setting, motivation can be influenced as well. In turn, this offers opportunities to develop (mandatory) interventions and implement evidence-based strategies aiming to target students' motivation for research in early stages of medical school.

Although most students benefit from a mandatory research experience, a minority declines in research motivation (IM 29%, EM 40%), perceptions (32%), self-efficacy (23%), relatedness (45%), autonomy (44%), and/or research career ambitions (31%). Baseline scores of these constructs are lower in students who increase in these constructs compared to students who decrease during the research experience. The decrease in motivation, its determinants and research career ambitions might (partially) be due to regression to the mean, a principle that, over repeated sampling periods, random outliers tend to revert to the mean.[23] Explanations for a motivational decline may be the impact of COVID-19 (e.g. poor homeworking conditions) or supervision insufficiently tailored to students' needs and expectations. Another explanation could be that students beforehand overvalue research and along the way get a more realistic perspective of research e.g. due to the practical side of research not meeting their expectations. In this way, a hands-on research experience provides students an authentic opportunity to find out if research is their path forward. Next to research career orientation, mandatory research experiences could conceivably also give substance to other benefits, as it could provide better insight and relevant contacts in a desired specialty, (future) job opportunities and/or chances of publication within the desired specialty.[11,22] Thus, although a decrease in motivation and research career ambitions may be unfortunate, by doing so, a mandatory research experience may still be valuable for medical students' future careers.

In line with SDT, our study shows that an increase in intrinsic motivation is related to fulfilling the three basic psychological needs: research self-efficacy, autonomy and relatedness. While demonstrating statistical significance, the observed increase in both relatedness

and autonomy yields only marginal advancements in intrinsic motivation. Plausibly, the attenuated correlation between autonomy and relatedness with intrinsic motivation might be ascribed to their assessment taking place at a subsequent time point (T1), distinct from that of the other constructs (T0). Additionally, it is conceivable that the need for autonomy is less prominent when students engage in research for the first time, a notion supported by precedent studies in alternative contexts.[24,25] Furthermore, the need for autonomy could have been influenced by the obligatory nature of the requirement. Although we adjusted the relation between determinants and motivation for working from home due to COVID-19, it remains plausible that the pandemic affected the sense of relatedness while working at the department e.g. due to workplace restrictions, and thus, potentially impeding the cultivation of motivation. This potentially resulted in an underestimation of the observed mean increase in motivation.

Research in a mandatory setting mostly affects students who do not have interest beforehand and therefore would not have (voluntarily) participated in research. Barriers to participate in research are a lack of interest, time, supervision, and opportunities.[9,26] Mandatory research projects require substantial educational investments and resources, but can overcome students' barriers to participate in research. Prior to the mandatory research project, more than one in four students (29%) stated that they would not participate in research if not mandatory. Yet, after the mandatory research experience, the majority of this group has on average increased in motivation (IM 74%, EM 60%) and research career ambitions (72%). Despite not reaching equal final levels of motivation and research career ambitions compared to students who wanted to participate in research otherwise, their intrinsic motivation increased substantially more.

Only one in ten students did not have research interest beforehand together with a decline in intrinsic research motivation during the research project. While future research is useful to provide further insight in the complex process of motivational decline during research and the actual impact on both the use of research and participation in research as clinician, it can be considered undesirable that some students would otherwise not have participated in research and even become less motivated for research during their mandatory research experience. On the other hand, this raises the question if it would be more harmful when they become doctors aiming to practice evidence-based medicine without any hands-on research experience. Hence, high educational investments in and allocation of resources for mandatory research projects can be considered as a valuable investment in developing scholarly doctors able to both apply and develop EBM in their clinical care.

Strengths, limitations and future research

Our study with a large sample size and high response rate prospectively measured theory

based constructs and thereby provides a first insight in the applicability of TPB and SDT in new and relevant context including a mandatory setting. This study was partly conducted in an exceptional and unanticipated setting due to the COVID-19 pandemic, potentially limiting its generalizability to workplace learning. Our data showed, indeed, a negative impact of COVID-19 on relatedness, perceptions, and in line with TPB and SDT, eventually, motivation. Besides adjusting for working from home due to COVID-19, the pandemic might still have impacted the research experience in other ways. When students were allowed to (partly) do their research at the hospital, the workplace setting might was subjected to restrictions, e.g. less availability of supervisors or peers. Consequently, as the research project is a workplace learning experience by design, the described average increase in motivation as well as its determinants (e.g. relatedness) and outcomes, could be an underestimation compared to a non-pandemic setting without in-hospital workplace restrictions.

For future research it would be interesting to qualitatively explore students' research experiences within a mandatory setting to study how these theory based constructs can be fostered to further strengthen motivation for research. In addition, mandatory research experiences can be implemented in multiple ways. As insight in mandatory research is still limited and our study only studied one educational design of undergraduate research experiences, more research on various designs with e.g. differences in durations and group sizes would benefit insight in motivational development and can optimize resource allocation.would benefit insight in motivational development and can optimize resource allocation.

Conclusion

This study shows that substantial educational investments in and allocation of resources for mandatory research projects can be considered as a valuable investment, especially in students who did not intent to voluntarily participate in research. Many medical schools offer hands-on research experiences to medical students, though in many different forms (e.g. voluntarily and mandatory). If the pre-eminent goal of undergraduate research is to deliver scholarly medical doctors able to practice, develop and contribute to evidence-based medicine, it seems valuable to implement mandatory research experiences. It provides all future doctors with a hands-on research experience and enables them to use and conduct research within clinical practice, as well as cultivates the next generation of clinician-scientists. Furthermore, this study established the applicability of Theory of Planned Behaviour and Self-Determination Theory within the context of mandatory research within the medical domain.

References

1. Sackett DL. Evidence-based medicine. Seminars in Perinatology. 1997/02/01/ 1997;21(1):3-5.
2. Frank JR SL, Sherbino J, editors. . CanMEDS 2015 Physician Competency Framework. Ottawa: Royal College of Physicians and Surgeons of Canada; 2015.
3. Greenberg RB, Ziegler CH, Borges NJ, Elam CL, Stratton TD, Woods S. Medical student interest in academic medical careers: a multi-institutional study. journal article. Perspectives on Medical Education. November 01 2013;2(5):298-316.
4. Amgad M, Man Kin Tsui M, Liptrott SJ, Shash E. Medical Student Research: An Integrated Mixed-Methods Systematic Review and Meta-Analysis. PLoS One. 2015;10(6):e0127470.
5. Lopes J, Ranieri V, Lambert T, et al. 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.
6. Ommering BW, van Blankenstein FM, Wijnen-Meijer M, van Diepen M, Dekker FW. Fostering the physician–scientist workforce: a prospective cohort study to investigate the effect of undergraduate medical students' motivation for research on actual research involvement. BMJ Open. 2019;9(7):e028034.
7. Milewicz DM, Lorenz RG, Dermody TS, Brass LF. Rescuing the physician-scientist workforce: the time for action is now. The Journal of Clinical Investigation. 10/01/ 2015;125(10):3742-3747.
8. Eshel N, Chivukula RR. Rethinking the Physician-Scientist Pathway. Academic Medicine. 2022:10.1097/ACM.0000000000004788.
9. Griffin MF, Hindocha S. Publication practices of medical students at British medical schools: experience, attitudes and barriers to publish. Med Teach. 2011;33(1):e1-8.
10. Ranieri V, Barratt H, Fulop N, Rees G. Factors that influence career progression among postdoctoral clinical academics: a scoping review of the literature. BMJ Open. 2016;6(10):e013523.
11. 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.
12. Ryan R, Deci E. Self-determination theory. Basic psychological needs in motivation, development and wellness. New York, NY : Guilford Press. 2017:231.
13. Bandura A. Self-efficacy: toward a unifying theory of behavioral change. Psychol Rev. Mar 1977;84(2):191-215.
14. Ryan R, Deci E. An overview of self-determination theory. In: Deci EL, Ryan RM, eds. Handbook of self-determination research. University of Rochester Press; 2002.
15. Ryan R, Deci E. Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. Am Psychol. 2000;55
16. Vallerand R. Deci and Ryan's self-determination theory: A view from the hierarchical model of intrinsic and extrinsic motivation. Psychological Inquiry 01/01 2000;11:312-318.
17. ten Cate O. Medical Education in the Netherlands. Medical teacher. 11/01 2007;29:752-7.
18. Ommering BWC, van Blankenstein FM, Waaijer CJF, Dekker FW. Future physician-scientists: could we catch them young? Factors influencing intrinsic and extrinsic motivation for research among first-year medical students. Perspectives on Medical Education. 2018/08/01 2018;7(4):248-255.
19. Ommering BWC, van Blankenstein FM, Dekker FW. First steps in the physician-scientist pipeline: a longitudinal study to examine the effects of an undergraduate extracurricular research programme. BMJ Open. Sep 13 2021;11(9):e048550.
20. Van den Broeck A, Vansteenkiste M, De Witte H, Soenens B, Lens W. Capturing autonomy, competence, and relatedness at work: Construction and initial validation of the Work-Related Basic Need Satisfaction Scale. Journal of Occupational and Organizational Psychology. 2010; 83(4), 981–1002.
21. Visser-Wijnveen GJ, van der Rijst RM, van Driel JH. A questionnaire to capture students' perceptions of research integration in their courses. Higher Education. 2016/04/01 2016;71(4):473-488.
22. Ommering BWC, Wijnen-Meijer M, Dolmans D, Dekker FW, van Blankenstein FM. Promoting positive perceptions of and motivation for research among undergraduate medical students to stimulate future research involvement: a grounded theory study. BMC Med Educ. Jun 26 2020;20(1):204.
23. Barnett AG, van der Pols JC, Dobson AJ. Regression to the mean: what it is and how to deal with it. Int J Epidemiol. Feb 2005;34(1):215-20.
24. Ryan R, Lynch M, Vansteenkiste M, Deci E. Motivation and autonomy in counseling, psychotherapy, and behavior change: A look at theory and practice. The Counseling Psychologist. 2011;39:193-260.
25. Deci E, Ryan R. The support of autonomy and the control of behavior. Journal of Personality and Social Psychology. 1987;53:1024-1037.
26. El Achi D, Al Hakim L, Makki M, et al. Perception, attitude, practice and barriers towards medical research among undergraduate students. BMC Medical Education. 2020/06/17 2020;20(1):195.