# Future physician-scientists: let's catch them young! unravelling the role of motivation for research

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## First steps in the physician-scientist pipeline: a longitudinal study to examine effects of an undergraduate extracurricular research programme

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*Submitted*

## Abstract

**Purpose:** Medicine is facing a physician-scientist shortage. By offering extracurricular research programmes (ERPs), the physician-scientist training pipeline could already start in undergraduate phases of medical training. However, previous studies into the effects of ERPs are mainly retrospective and lack baseline measurements and control groups. Therefore, the authors conducted a prospective cohort study with baseline measurement and comparable control group to examine the effects of an ERP on academic achievement and motivational factors.

**Method:** One cohort of 315 medical undergraduates was followed and surveyed yearly. To examine the effects of the ERP on academic achievement after two years (i.e. in-time bachelor completion, bachelor GPA) and motivational factors after 18 months (i.e. intrinsic motivation for research, research self-efficacy, perceptions of research, curiosity), the authors used regression analyses to compare ERP students (n=56) to students showing ERP-interest only (n=38), adjusted for relevant baseline scores.

**Results:** ERP participation is related to a higher odds of obtaining a bachelor degree in the appointed amount of time. Furthermore, starting the ERP resulted in higher levels of intrinsic motivation for research, also after adjusting for gender, age, first-year GPA, and motivational baseline scores. No effect was found on research self-efficacy beliefs, perceptions of research, and curiosity.

**Conclusions:** Previous research suggested that intrinsic motivation is related to short- and long-term research engagement. As our findings indicate that starting the ERP is related to increased levels of intrinsic motivation for research, ERPs for undergraduates could be seen as an important first step in the physician-scientist pipeline.

## Introduction

The field of medicine is dynamic with many remaining 'unknowns'. In order to unravel the unknown and make advancements within the medical domain, research is key. However, to actually benefit patient care, research should be connected to clinical practice. That is, relevant questions and problems originating from daily clinical practice should be identified and translated into research designs (i.e. connecting bedside to bench) and research outcomes should be translated into daily practice (i.e. connecting bench to bedside). Within this process of translational research, physician-scientists play a crucial role.[1-4] Physician-scientists are healthcare professionals investing a solid amount of their time in both research and clinical duties, and are therefore in the unique position to connect bedside to bench and vice versa.[4,5]

Unfortunately, many concerns have been raised regarding the future of the physician-scientist workforce. As a result of the rising age of the current workforce, attrition from the physician-scientist training pipeline, and a decreasing interest to even pursue this pipeline or a scientific career, medicine is currently facing a physician-scientist shortage.[6-9]

A possible solution to foster the physician-scientist workforce is to engage medical students in research in early phases of medical school. Research engagement of medical students is related to research involvement further in medical training and in future professional practice.[10,11]As a result of engaging in research during medical training, students become aware of and motivated for research, possibilities for a research career are identified, and research talent is recognized by medical professionals.[12] In this way, the physician-scientist training pipeline could already start in undergraduate and pre-clinical phases of medical training. To this end, many medical schools have created scholarly programmes, both intra- and extracurricular.[6,8,13] Although extracurricular research programmes occur under diverse names, e.g. scholarly concentration programmes, capstone programmes, summer schools, and Honours programmes, they do share the common goal to engage students in research and cultivate future physician-scientists.

Within the past decades, many research initiatives emerged aiming to map the effects of extracurricular research programmes. For instance, Wolfson et al. (2017) showed that both satisfaction within a scholarly concentration programme and publication in scientific journals as a result of programme participation were related to an enhanced career-long research interest.[6]

A retrospective study by Radville et al. (2019) suggested that graduates who participated in a scholarly concentration programme are more likely to stay scientifically active, as they published more after graduating and more frequently took on an academic health centre job.[14] A recent study by DiBiase et al. (2020) also showed that participation in a scholarly concentration programme is related to increased levels of research self-efficacy, which in turn is related to an enhanced intention to pursue scientific work.[15]

However, within a systematic review it was concluded that most studies into extracurricular research programmes have a retrospective design and evidence for the effect of such programmes resulting from rigorous study designs is lacking.[16] After using the Medical Education Research Study Quality Instrument, the authors concluded that the included studies scored low on study design and validity and called for studies with more rigorous study designs.[16] More specifically, very few studies have investigated the effects of extracurricular research programmes on both academic achievement and motivational factors using a longitudinal design.[17] As grades do not by definition reflect all valued skills of future physicians, it seems beneficial to focus on more than just academic performance as an outcome measure. In addition, students choosing to participate in extracurricular research programmes are believed to differ from students not following this path. Therefore, a sound baseline measure is needed for which a prospective study seems to be a good approach. Lastly, a comparable control group of students who are not participating in the extracurricular research programme is absent in most studies as well. In these cases, the question arises if students would have developed in similar ways within the regular educational programme.[8,16,17]

The current study therefore combines a prospective, longitudinal study design with a sound baseline measure and comparable control group to answer the following research question: 'What is the effect of an extracurricular research programme on academic achievement, intrinsic motivation for research, research self-efficacy beliefs, perceptions of research, and curiosity'. Although with 18 months follow-up these are relatively short-term measures of research engagement, existing theories and previous studies indicate that these constructs are related to long-term research engagement and scholarly output.[10,11,18-21] Furthermore, keeping in mind that grades do not necessarily align with all valued skills as a future physician or physician-scientist, we specifically focused on more than just academic achievement. As the pre-eminent goal of extracurricular research programmes is to cultivate future physician-scientists, intrinsic motivation for research, research self-efficacy beliefs, perceptions of research, and curiosity may be seen as key outcome objectives, especially as they are related to future research involvement.[10,11,18-21]

## Methods

### Context

Leiden University Medical Center (LUMC) is one of eight universities within the Netherlands offering medical education, in line with the Dutch National Blueprint for Medical Education that is based on the CanMEDS.[22,23] Consequently, the structure of medical education is comparable in all universities with a six-year undergraduate educational programme. In addition to the core curriculum, LUMC implemented an extracurricular research programme (i.e. research-based Honours programme) aiming to foster research talent and cultivate future physician-scientists. The programme, starting in the second year of undergraduate medical education, provides students with opportunities to conduct research individually. Programme duration is two years and selection is mainly based on self-selection without very strict institutional criteria. Thus, every student can apply. As a result, approximately 50-60 motivated students start in the programme each year, representing 15-20% of the whole second year cohort of medical students. To get a certificate for this programme, students need to obtain 30 extra credits (ECTS, i.e. European Credit Transfer and Accumulation System, which means that students have to invest 30 x 28 hours of active study). At the same time, they have to obtain 180 regular ECTS for their three-year Bachelor programme with a grade point average (GPA) of at least 7 on a 10-point grading scale.[24]



### Design and participants

Within a longitudinal, prospective study design, one complete cohort of medical undergraduates was followed for three years. Every student starting medical school at the LUMC in 2016 was asked to participate and data was gathered longitudinally by surveying participants each year (i.e. November 2016, January 2018 and December 2018). Ideally, one would aspire a randomized controlled trial (RCT) in order to examine the effects of the extracurricular research programme, dividing students who expressed interest in the programme in a participating and a non-participating group at random. However, as randomization is not possible here, we tried to mimic an RCT by comparing students starting the extracurricular research programme to students that have showed interest in the extracurricular research programme, but eventually decided not to participate. Furthermore, we adjusted for potentially relevant baseline differences to make the groups as comparable as possible.

**Materials and definitions**

The effects of the extracurricular research programme were examined by comparing the two groups of students on academic achievement two years later and motivational factors 18 months later, while adjusting for relevant baseline scores. Motivational factors consisted of intrinsic motivation for research, research self-efficacy beliefs, perceptions of research, and curiosity.

*Academic achievement* was operationalized as students' in-time bachelor completion and bachelor GPA, which were both drawn from university files. For the motivational outcome measures, questionnaire data were used.[10] Existing and validated scales were used to compose the questionnaire, though adjusted to the medical education setting and focusing on conducting research (Appendix C). Students scored the items on a 7-point Likert scale ranging from 1 – 'totally disagree' to 7 – 'totally agree'. *Intrinsic motivation for research* was defined as motivation to conduct research out of pure enjoyment or interest. The scale consisted of five items (e.g. 'doing research is fun'), derived from the Interest/Enjoyment Scale of the Self-Determination Questionnaires.[25] *Research self-efficacy* was defined as students' beliefs about their own abilities to conduct research. This self-developed scale consisted of three items (e.g. 'I feel I am competent enough to do research') and was inspired by the Dutch General Self-Efficacy Scale and the Academic Efficacy Scale.[26,27] *Perceptions of research* was defined as students' beliefs about the value of research. The scale consisted of five items (e.g. 'It is important for medical professionals to have scientific skills'), derived from the Student Perception of Research Integration Questionnaire.[28] *Curiosity* was defined as students' desire for knowledge, promoting learning of new ideas and solving intellectual problems. The scale consisted of ten items (e.g. 'I enjoy investigating new ideas') of the Epistemic Curiosity Scale.[29]

## Procedure

The existing scales were adjusted to fit our setting, after which we used the forward and backward translation procedure to translate the questionnaire from English to Dutch. The questionnaire was pretested amongst ten medical students in their second year of undergraduate medical education, after which two minor adjustments were made to two items. For the actual longitudinal study, every student entering medical education in 2016 was approached by a member of the research team during a mandatory workgroup session in one of the first courses of the educational programme (baseline T1 – November 2016). These students were surveyed again in the first semester of their second (T2 – January 2018) and third year (T3 – December 2018) of undergraduate medical education. An overview of the timeline is illustrated in Figure 1. The goals and voluntary nature of participation in this study were communicated to students and it was explained that all data would be processed anonymously and used for research purposes only. Students filled in an informed consent form, approving to connect data of the questionnaires (T1, T2, T3) and the academic achievement components. The study was approved by the ethical review board of the Netherlands Association of Medical Education: reference number 952.

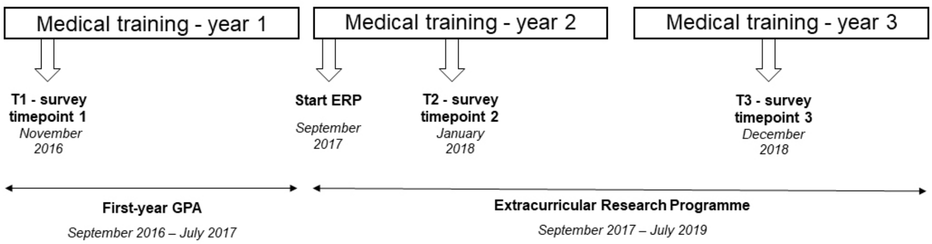


**Figure 1.** Timeline illustrating ERP start, ERP duration, and survey measurements



## Analyses

Descriptive statistics were used to report participants' demographics and Cronbach's alpha was calculated to estimate the reliability of the questionnaire scales. Mean scores were calculated for the motivational factors. Missing data was handled by using multiple imputation.[30] Univariate and multivariate logistic and linear regressions were used to compare students within the programme to the control group outside of the programme on academic achievement, intrinsic motivation for research, research self-efficacy beliefs, perceptions of research, and curiosity. Within the multivariate regressions we adjusted for potential confounding factors: gender, age, T1 baseline scores of all motivational outcome measures, and first-year GPA (i.e. covering the period before starting the extracurricular research programme). Results are presented with 95% confidence intervals. We analysed all data using IBM SPSS Statistics version 23.

## Results

Out of in total 315 medical students, 94 students were included within the current study, of whom 56 started in the extracurricular research programme (59.6%). The remaining 38 students (40.4%) showed interest in the extracurricular research programme without self-selecting themselves and actually participating, thus serving as the comparable control group within our study. Of the 56 students starting the programme, 43 students were female (76.8%) and 13 students were male (23.2%) with a mean age of 18.5 (SD = .91) years. The control group comprised of 30 female (78.9%) and 8 male students (21.1%) with a mean age of 18.6 (SD = 1.28) years. Baseline scores of both groups on first-year GPA and the motivational factors can be found in Table 1. Cronbach's alpha of the scales ranged from .78 to .86 at T1 baseline (first year of medical training – November 2016), .79 to .86 at T2 (second year of medical training – January 2018), and .82 to .89 at T3 (third year of medical training – December 2018). In-time bachelor completion, third-year GPA, and T3 scores on intrinsic motivation for research, research self-efficacy beliefs, perceptions of research, and curiosity are reported in Table 2.

### Academic achievement

A crude effect of starting the extracurricular research programme on in-time bachelor completion was found, showing that students starting the programme had higher odds of obtaining their bachelor degree in time (OR = 3.64, 95% CI = 1.29 – 10.27), also after adjusting for gender, age, first-year GPA, and all T1 baseline scores (OR = 2.95, 95% CI = .826 – 10.52). Participating in the extracurricular research programme, on its own, had an effect on students' bachelor GPA (β = .299, 95% CI = .097 – .500). After adjusting for gender, age, first-year GPA, and all T1 baseline scores the effect disappeared (β = -.026, 95% CI = -.160 - .108).

**Table 1.** Baseline characteristics divided by students entering the extracurricular research programme (ERP) and students showing interest without entering the ERP (n = 94)

| | *Non ERP*<br>*n = 38* | *ERP*<br>*n = 56* |
|---|---|---|
| Gender | | |
| Male | 8 (21.1%) | 13 (23.2%) |
| Female | 30 (78.9%) | 43 (76.8%) |
| Age | | |
| M (SD) | 18.63 (1.28) | 18.45 (.91) |
| Min-Max | 16-23 | 17-21 |
| First-year GPA | | |
| n | 38 | 56 |
| M (SD) | 6.76 (.45) | 7.18 (.55) |
| Min-Max | 6.0-8.1 | 6.4-8.9 |
| Intrinsic motivation T1 | | |
| n | 38 | 56 |
| M (SD) | 5.67 (.56) | 5.84 (.69) |
| Min-Max | 4.8-7.0 | 4.2-7.0 |
| Research self-efficacy T1 | | |
| n | 37 | 56 |
| M (SD) | 5.05 (.96) | 5.13 (.97) |
| Min-Max | 3.0-6.7 | 3.0-7.0 |
| Perceptions of research T1 | | |
| n | 38 | 56 |
| M (SD) | 5.68 (.67) | 5.87 (.79) |
| Min-Max | 4.4-7.0 | 2.8-7.0 |
| Curiosity T1 | | |
| n | 38 | 56 |
| M (SD) | 5.37 (.66) | 5.46 (.69) |
| Min-Max | 4.3-6.8 | 4.1-6.9 |

**Table 2.** Descriptives of outcome measures divided by non-ERP students and ERP students (n = 94 for academic measures and n = 82 for motivational measures)

| | *Non ERP* | *ERP* |
|---|---|---|
| In-time bachelor completion | | |
| in time | 25 (65.8%) | 49 (87.5%) |
| delay | 13 (34.2%) | 7 (12.5%) |
| Bachelor GPA | | |
| n | 38 | 56 |
| M (SD) | 6.93 (.47) | 7.23 (.50) |
| Min-Max | 6.0 – 8.1 | 6.3 – 8.9 |
| Intrinsic motivation T3 | | |
| n | 30 | 52 |
| M (SD) | 5.36 (.78) | 5.85 (.62) |
| Min-Max | 2.8 – 6.4 | 4.0 – 7.0 |
| Research self-efficacy T3 | | |
| n | 30 | 52 |
| M (SD) | 4.81 (1.16) | 4.85 (.90) |
| Min-Max | 1.7 – 7.0 | 2.0 – 7.0 |
| Perceptions of research T3 | | |
| n | 30 | 52 |
| M (SD) | 5.41 (.76) | 5.58 (.84) |
| Min-Max | 4.0 – 7.0 | 3.8 – 7.0 |
| Curiosity T3 | | |
| n | 30 | 52 |
| M (SD) | 5.22 (.71) | 5.37 (.66) |
| Min-Max | 4.0 – 6.7 | 3.8 – 6.9 |

### Motivational factors

There was a positive effect of starting the extracurricular research programme on intrinsic motivation for research in the third year of medical training ($\beta = .462$, 95% CI = .113 - .811), also after adjusting for gender, age, all T1 baseline scores, and first-year GPA ($\beta = .334$, 95%CI = .042 - .627). Students starting the programme report higher levels of intrinsic motivation for research in their third year of medical training. Starting in an extracurricular research programme did not, however, have an effect on research self-efficacy beliefs, perceptions of research, and curiosity. An overview of these findings can be found in Table 3.

**Table 3.** Regression model of the effect of starting the extracurricular research programme on the motivational factors in the third year of medical education (T3)

| | Crude<br>β (95%CI), p | Adjusted [a]<br>β (95%CI), p |
|---|---|---|
| Intrinsic motivation | .462 ( .113 - .811), .010 | .334 ( .042 - .627), .025 |
| Research self-efficacy | .108 (-.417 - .634), .684 | .015 (-.439 - .469), .949 |
| Perceptions of research | .208 (-.203 - .619), .320 | .080 (-.109 - .269), .673 |
| Curiosity | .136 (-.163 - .436), .372 | .113 (-.173 - .400), .449 |

[a] Adjusted for age, gender, motivational baseline scores (i.e. intrinsic motivation for research, research self-efficacy beliefs, perceptions of research, curiosity), and first-year GPA

## Discussion

Within this study, we compared students starting an extracurricular research programme with students that have showed interest in the same extracurricular research programme, but eventually decided not to participate. By using a longitudinal study design with a sound baseline measure and a comparable control group, we aimed to map the effects of an extracurricular research programme. With regard to academic achievement, our findings suggest that starting the extracurricular research programme leads to higher odds of obtaining a bachelor degree in the appointed amount of time. When it comes to the motivational factors included in our study, our findings showed that starting the extracurricular research programme only affected levels of intrinsic motivation for research significantly, as students starting the programme reported higher levels of intrinsic motivation for research in the third year of medical training. No effect was found on research self-efficacy beliefs, perceptions of research, and curiosity.



With regard to academic achievement, our findings suggest that starting an extracurricular research programme increases the odds of obtaining a bachelor degree in time. From a statistical perspective, this effect is borderline non-significant. There is a broad confidence interval, resulting in some uncertainty regarding the exact size of the effect. However, the best estimate is a strong and relevant effect, as the odds ratio of 2.95 suggests that the odds of success (i.e. in-time bachelor completion) is almost three times as high when students start the extracurricular research programme. Starting the programme did not, however, have a beneficial effect on bachelor GPA. As the crude effect on bachelor GPA disappears after adjusting for first-year GPA, it can be assumed that students' first-year GPA is a confounder related to their choice to participate within an extracurricular research programme as well as related to their subsequent bachelor GPA.

More importantly when focusing on the aim of extracurricular research programmes, our findings suggest there was an effect of the extracurricular research programme on levels of intrinsic motivation for research in the third-year of medical training. According to the Self-Determination Theory, intrinsic motivation (i.e. doing an activity out of pure interest or enjoyment) is related to better academic performances and general wellbeing. Furthermore, we already know that intrinsic motivation for research is related to actual involvement in research during medical training[10], which in turn is related to research involvement in future professional practice.[11,31] Moreover, results of a scoping review reveal that it is especially intrinsic motivation among professionals that influences scientific career progression.[32] These theoretical and scientific notions contribute to the perspective that intrinsic motivation for research is a key component in order to foster future physician-scientists.

Interestingly, however, the extracurricular research programme had no effect on the other motivational factors that we measured. Our results suggest that starting the programme does not significantly increase levels of research self-efficacy among students. This contradicts findings from a recent study, showing that participation in a scholarly concentration programme was related to higher levels of research self-efficacy.[15] However, as the scholarly concentration programme in that study was a mandatory part of medical training, a control group consisting of students not following the programme was absent, making it more difficult to attribute the higher levels of self-efficacy to participating in that specific programme. A possible explanation could be that participating students, while receiving in-depth research experiences, become aware that the process of conducting research could be time-consuming and hard, as is also acknowledged by our students already in their first-year of medical training.[18] In turn, this could diminish feelings of success, which according to the Social Cognitive Theory is related to levels of self-efficacy.[20]

Our findings also suggest that there is no effect of the extracurricular research programme on perceptions of research. Perceptions of research are believed to be related to an apparent connection of research to practice,[18] it could be that this connection to clinical practice is lacking for these young students while submerging in the world of research. It could also be that a course in the first-year of medical training in which students actively conduct research individually, as is implemented by Leiden University Medical Center, contributed to a broad perspective on research and already very positive perceptions of research before starting the extracurricular research programme in the second year of medical training.[18]

Our findings are partly in line with a previous study of Kool and colleagues, in which no effect of participation within an extracurricular programme was found on ability, creativity, and motivation. The reason mentioned for the absence of these effects was that their post-measure was six months after starting the extracurricular programme, which might have been too soon to note changes in ability, creativity, and motivation.[17] Our outcome measures were examined 18 months after starting the extracurricular research programme. Although this might have been too short-term to identify increasing levels of research self-efficacy, perceptions of research, and curiosity, we did find a positive effect on intrinsic motivation for research. The extracurricular research programme can thus be viewed as a way to enhance intrinsic motivation for research and subsequently a first step in the physician-scientist pipeline.

**Limitations, strengths and future research**

This was a single-institute study which might impact generalizability to other contexts. However, as 1) our educational programme is based on the Dutch National Blueprint for Medical Education, which is an adaptation from the CanMEDS and 2) many medical schools offer extracurricular research programmes to undergraduate medical students, we believe our findings might be translated to other educational contexts as well. Our study is one of the first to use a longitudinal, prospective study design with a sound baseline measure and comparable control group to examine both academic and motivational effects as a result of starting an extracurricular research programme. Future research could focus on identifying how levels of research self-efficacy, perceptions, and curiosity could be increased within the programme, using quantitative and qualitative methods to, for instance, uncover the effect of mentorship and success experiences on the abovementioned motivational factors. Furthermore, we established an effect on intrinsic motivation for research 18 months after starting the extracurricular research programme. Although theoretical and scientific notions corroborate the assumption that this will be related to research engagement even further in the physician-scientist pipeline, a relevant future research avenue could be to investigate if the effect persists. Subsequently, evidence-based strategies could then be implemented to enlarge the short- and long-term effects of extracurricular research programme participation aiming to foster future physician-scientists.

**Conclusion**

Previous research suggested that intrinsic motivation for research is an important incentive for research engagement during medical training and future professional practice. As we have shown now that starting in an extracurricular research programme is related to increased levels of intrinsic motivation for research, such programmes for undergraduates could be seen as a valuable first step in the physician-scientist pipeline.

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