The Munich Research Competence Scale: Research competence among doctoral candidates and graduates in medicine. Results from the second wave of the Bavarian Graduate Study in Medicine

Nurith Epstein, Maike Reimer, Martin Gartmeier, Martin R. Fischer, Pascal O. Berberat, Johanna Huber

Research education in medicine has been under discussion for quite some time, both to assess the status quo and to inform efforts to improve it. A newly developed scale of self-assessed research competences, which builds on a concept of medical research competences and reflects core aspects of reform goals, was piloted in the Bavarian Medical Graduate Study (N = 570). Exploratory factor analysis indicates a unidimensional scale. Replications of results from previous studies support the scale's content validity: overall, the competence assessment is in the middle range, doctoral graduates rate themselves significantly better than graduates without doctoral degree ($p = 0.047$). Female medical graduates rate themselves worse than male medical graduates ($p = 0.000$). Furthermore, our results suggest that intrinsic motives to do a doctorate mediate the gender effect. According to our analyses, there is a need to progress the research competences of medical graduates as a whole.

1 Background and goal

The quality of research training in medical studies and in medical doctoral studies has been the subject of heated debate in the press and in professional circles for some time now, especially in medical education research (Beisiegel, 2009; Epstein et al., 2016; Horstkotte, 2013; "Ills of the System", 2015). Efforts to improve research training in all phases of medical education, including residency, also relate to the goal of increasing the amount of physician scientists (Epstein et al., 2016; Gerst & Hibbeler, 2012; Senatskommission für klinische Forschung, 2010). Yet, research competences are also important for physicians who primarily work in patient care as these competences enable physicians to practise evidence-based medicine. Whereas this discussion is happening worldwide, in Germany it centers on the unique "Dr. med.", which is usually obtained during medical studies in a shorter period than a Ph.D. Since the doctorate usually represents the only opportunity for an independent research project in medicine, doctoral studies are a central learning context to acquire research competences.

To date, however, few empirical studies exist that examine research competences of medical students and graduates, link it to learning opportunities in the doctoral or postdoctoral stage, or address research careers after graduation. A study by Briedis et al. (2014) shows that doctoral graduates in medicine are 43 percent less likely to remain in academic research in comparison to other STEM fields. Epstein and Fischer (2017) were able to show that doctoral graduates in medicine have lower research-related self-efficacy expectations in comparison to doctoral graduates in other life science disciplines. However, the scale used is not suitable for mapping specific research competences in a differentiated way. Rather, it captures the extent to which respondents are confident in mastering certain challenges of a research career (e.g., "gaining recognition in my scientific community"). The Bavarian Graduate Study in Medicine (MediBAS), class of 2016, used the Freiburg Competency Questionnaire (Giesler et al., 2011), which among other things also encompasses research competences. It shows that also physicians with a doctorate do not always trust themselves to conduct independent research (Epstein et al., 2018). However, some of the questionnaire's items cover rather general analytical skills, and some items encompass multiple competences at once. Thus, the authors conclude that in addition, a more differentiated scale of research competences is needed to assess specific features relevant to the current discussion. In this paper, we introduce the newly developed scale that addresses this need.

2 Methods

As in the cited studies, the newly developed scale measures the respondents' competence level via self-assessments. These have several advantages: they are easy to assess, are highly correlated with external validity criteria for competences and strongly related to behaviour (Braun & Mishra, 2016). We analyse its properties using exploratory factor analysis and multivariate regression analysis. The multivariate analyses serve in particular to test the scale's content validity. Here, gender differences have been shown repeatedly in the past with lower competence assessment by females (Bakken et al., 2003; Epstein & Fischer, 2017). Moreover, a completed doctorate as well as intrinsic motives to pursue the doctorate are associated to higher research competence in medicine (Epstein et al., 2016; 2018). This makes sense since conducting a doctorate leads to more research experience and those with intrinsic motives to pursue a doctorate are probably more devoted to their doctoral project.

2.1 Sample

The Munich Medical Research Competence Scale was piloted within the MediBAS survey, class of 2017. The MediBAS is conducted on a regular basis by the Bavarian State Institute for Higher Education Research and Planning, in cooperation with the "Competence Network Medical Education Bavaria [Kompetenznetz Medizinlehre Bayern]" and its Quality Management and Graduate Survey Working Group. The online survey was directed at all medical graduates from 2017/18 who graduated from the medical faculties of FAU Erlangen-Nuremberg, LMU Munich, TU Munich, University of Regensburg, and JMU Würzburg. The survey was conducted between October 2018 and January 2019 (Reimer et al., 2019). A total response rate of 38 percent (N = 613) was achieved (cf. ibid.). The responses from human medicine (N = 570) were selected for the present study, excluding dentistry and veterinary medicine.

The proportion of female graduates was 66 percent, which is comparable to the nationwide gender distribution in human medicine (approximately 60 percent female; Statistisches Bundesamt, 2019). The majority of graduates were still in the doctoral process at the time of the survey (69 percent, N = 394). 16 percent had already completed their doctorate and 15 percent had not (yet) started. These data are comparable to reported nationwide doctoral rates in medicine (Hachmeister, 2019; Putz, 2011).

2.2 Operationalisation

2.2.1 Development of the Research Competence Scale

We developed the scale of research competences on the basis of the National Competence-based Catalogue of Learning Goals [Nationaler Kompetenzbasierter Lernzielkatalogs, NKLM] (2015), which describes a core set of medical, scientific skills "*as learning goals in medical studies*" (subchapter 14.a, p. 140). When developing the scale's items, we selected competences that covered all phases of empirical research (from determining the state of research to conducting one's own research, items 1–7). Moreover, the items cover the epistemic activities in research, described by Fischer et al. (2014). Those entail basic scientific reasoning processes that are central across discipline, e.g. identifying a problem, generating hypotheses, generating evidence, etc. In addition, the scale encompasses competences of practising evidence-based medicine (EBM) (Items 8–10)). We did not include competences of the NKLM's

subchapter on scientific skills, which were rather related to communicating evidence to patients. While the scale's competences can be assigned to different stages of research, they are also closely linked to one another as well as build on each other. One can argue that these competences can only collectively depict "research competence". This is supported by the conducted analyses (cf. Results, Table 1).

2.2.2 Independent variables

Intrinsic and extrinsic motivation to pursue the doctorate: The motives for taking up a doctorate were measured by a scale developed within the "E-Prom study"[1], encompassing intrinsic motives (e.g., "I wanted to pursue a doctorate in order to conduct research during the doctorate") and extrinsic motives (e.g., "…in order to attain a higher income") (Fischer et al., 2017). The items were very well suited for a factor analysis according to the Kaiser-Meyer-Olkin criterion (kmo = 0.82; Kaiser, 1974) and were analysed by means of explorative factor analysis (principal axis analysis, unrotated, with eigenvalue criterion >1 (Kaiser rule)). As suspected, a two-dimensional structure of intrinsic and extrinsic motives was revealed and supported by a postestimation screeplot and the Minimum-Average-Partial Correlation test (MAP-test) (Velicer, 1976; Velicer et al., 2000; see Appendix, Table A2, Figures A1 and A2). The item relating to the motive of the "customariness" of the doctorate in medicine was excluded due to low factor loading (< 0.5). Presumably, this item represents a separate motive that cannot be strictly classified as extrinsic. While extrinsic motives, such as a higher income, are goal-oriented and involve a weighing of costs and benefits, the present item seems to represent more of an automated choice, a "going with the mainstream" (Kroneberg, 2005). The items of the two subscales were summarised into two separate additive indices ranging from 1 to 5.

Doctorate: For the doctoral status, a distinction was made between the categories 1) "not holding a doctorate" and 2) "holding a doctorate". Persons who were in the process of obtaining a doctorate or discontinued it were excluded, since it remains unclear how advanced these doctorates were. For analyses limited to the group of doctoral graduates, the doctoral grade was summarised into the categories 1) "summa cum laude" 2) "cum laude", 3) lower grades, and 4) no grade (still pending or no grading system).

Sociodemographic background: In addition, we statistically controlled for gender (male vs. female), migration background (yes vs. no), and age of respondents.

[1] The project „Einfluss der Promotionsphase auf die Karriereentwicklung von NachwuchswissenschaftlerInnen in der Medizin und den Lebenswissenschaften" investigated factors influencing postdoc careers in the life sciences.

3 Results

3.1 Factor analysis, Research Competence Scale

The Kaiser-Meyer-Olkin criterion indicated a very good suitability of the items for factor analysis (kmo = 0.93; Kaiser, 1976). The scale was tested by exploratory factor analysis (principal axis analysis, unrotated, with Kaiser rule). The results of the factor analysis (Table 1), a postestimation screeplot and Velicer's MAP-test supported a unidimensional structure (Appendix, Figures A3 and A4). All items achieve satisfactory factor loadings.

Table 1: Exploratory factor analysis: Munich Medical Research Competence Scale[2]

To what extent did you acquire the following knowledge, skills and abilities in your studies?	Factor1
	Factor Loadings
Item 1: Ability to determine the state of research on a research question	0.64
Item 2: Ability to present the knowledge gained through an empirical study	0.75
Item 3: Ability to critically discuss the validity of a scientific investigation with regard to methodological aspects	0.80
Item 4: Ability to interpret the result of a statistical hypothesis test	0.78
Item 5: Ability to derive testable hypotheses based on the research question	0.82
Item 6: Ability to name possible research methods (e.g. from basic medical research, clinical or epidemiological research) and to justify them	0.81
Item 7: Ability to implement research ideas methodically and technically correctly	0.78
Item 8: Ability to derive concrete actions or therapeutic options from empirical evidence	0.79
Item 9: Ability to evaluate study results in terms of applicability to a patient case	0.79
Item 10: Ability to classify studies into evidence classes	0.64

Legend: *N* = 570, Question: (Scale: 1 = not at all to 5 = to a very high degree).

3.2 Descriptive results

Table 2 shows the descriptive results, mean values with standard deviations, of the self-assessed research and EBM competences – overall, as well as differentiated by gender and completed doctoral degree.

[2]The English items were translated by the authors for this publication only. The original German items are in the Appendix (Table A1).

Table 2: Self-assessed research competences, Munich Medical Research Competence Scale

	Overall		Female		Male			Dr.med.		No Dr.med.		
	M	*SD*	*M*	*SD*	*M*	*SD*	*p*	*M*	*SD*	*M*	*SD*	*p*
Item 1: determine state of research	3.42	1.05	3.36	1.04	3.55	1.05	0.052	3.62	1.00	3.38	1.06	0.029
Item 2: present knowledge from empirical study	2.86	1.04	2.79	1.04	3.01	1.01	0.020	2.92	1.04	2.84	1.04	0.474
Item 3: critically discuss a study's methodology	2.79	1.00	2.67	0.97	3.04	1.03	0.001	2.95	0.98	2.76	1.01	0.069
Item 4: interpret statistical test results	2.68	0.99	2.59	0.92	2.88	1.07	0.001	2.87	0.94	2.65	0.99	0.044
Item 5: derive testable hypotheses	2.50	0.97	2.41	0.90	2.72	1.05	0.000	2.66	0.99	2.48	0.96	0.103
Item 6: name possible research methods	2.57	0.95	2.43	0.87	2.83	1.04	0.000	2.78	0.95	2.53	0.95	0.014
Item 7: implement research ideas correctly	2.25	1.03	2.09	0.96	2.53	1.12	0.000	2.55	1.08	2.19	1.02	0.001
Item 8: derive therapeutic options from evidence	2.74	1.04	2.62	1.01	2.97	1.07	0.000	2.88	1.04	2.71	1.04	0.122
Item 9: evaluate studies' applicability to cases	2.74	1.03	2.63	1.01	2.92	1.04	0.002	2.83	1.03	2.72	1.03	0.327
Item 10: sort studies in evidence classes	2.77	1.13	2.62	1.06	3.04	1.18	0.000	2.78	1.15	2.77	1.12	0.794
N	**570**		**362**		**190**			**92**		**478**		

Legend: Means *(M)* and standard deviations *(SD)* rounded to the second decimal place, p-values rounded to the third decimal place and determined using two-tailed t-tests.

In relation to the scale midpoint, the surveyed physicians rated themselves as rather average overall. The competence of determining the state of research to a research question received the highest rating. The competences of presenting the knowledge gained from a study and evaluating the significance of a scientific study were rated lower. Activities that are more specific and require more methodological/statistical knowledge, such as interpreting the results of a hypothesis test, deriving hypotheses and selecting a research method, were rated even lower. The competence of implementing a research idea in a methodologically and technically correct manner received the lowest ratings, with the mean value below the scale midpoint. Respondents' self-ratings regarding EBM (deriving therapy options, evaluating applicability to the patient, and sorting studies into evidence classes) were in the middle range, too.

In terms of gender, it is noticeable that female graduates rated themselves slightly lower than male graduates. The differences in mean scores are small but significant and are evident across almost all items, with the exception of determining the state of research to a specific research question. Furthermore, we analysed gender differences regarding intrinsic and extrinsic motives for taking up a doctorate by means of two-sided t-tests. We found small but significant gender differences here: Women agreed less with intrinsic (M = 2.82 (SD = 1.10) vs. M = 3.10 (SD = 1.15), p = 0.006) *as well as* extrinsic motives (M = 2.94 (SD = 0.99) vs. M = 3.21 (SD = 0.90), p = 0.002).

The comparison of graduates with and without doctoral degree shows that doctoral graduates only rate themselves significantly better with regard to the competences of determining the state of research, interpreting the result of a hypothesis test, selecting a research method, and implementing a research method in a technically and methodologically correct manner. The mean differences are small, so that the self-assessed competences of doctoral graduates as a whole remain in the middle range. With regard to the items relating to evidence-based medicine, doctoral and non-doctoral graduates rate their competences comparably.

3.3 Multivariate results

In the following, we present results of multivariate regression analyses. First, we analyse the association among gender, age, migration background, completed doctorate and self-assessed competence level. Second, we include the doctoral grade as well as the information on the motivation for taking up the doctorate for the subgroup of doctoral graduates.

3.3.1 All survey participants

When considering all survey participants (see Table 3), the gender variable shows the biggest effect size. On average, women rate themselves –0.3 points lower on the overall scale of research competences. In addition to gender, only doctoral status is significantly related to self-assessed competences: Doctoral graduates, on average, rate themselves 0.19 points better. Neither age nor migration background show significant effects on the assessment of research competences.

Table 3: Multivariate regression analysis, dependent variable: Munich Medical Research Competence Scale (All survey participants)

	β	*SD*	*p*
Completed doctorate *(Reference: no completed doctorate)*	0.19	0.10	0.047
Female *(Reference: Male)*	–0.30	0.07	0.000
Age	0.00	0.01	0.683
Migration background *(Reference: None)*	–0.10	0.09	0.254
Constant	2.96	0.35	0.000
N	512		
Adj. R^2	0.04		

Legend: Multivariate regression analysis with dependent variable scientific competences, ß-coefficients and standard deviations (*SD*) rounded to the second decimal place, p-values rounded to the third decimal place.

3.3.2 Doctoral graduates

Looking only at doctoral graduates in Table 4, females assess their competences lower than men (Model 1), even when controlling for dissertation grade. In Model 2, we introduce the variables intrinsic and extrinsic motives for the doctorate. Intrinsic motives are positively and significantly associated with self-assessed competences, whereas there is no association with extrinsic motives. Moreover, the gender effect is no longer significant after the introduction of motives: Apparently, male and female doctoral graduates with equally pronounced motives for starting the doctorate do not differ with respect to self-assessed research competences.

Table 4: Multivariate regression analysis, dependent variable: Munich Medical Research Competence Scale (Doctoral graduates)

	Model 1			Model 2		
	β	*SD*	*p*	*β*	*SD*	*p*
Grade: Summa/Magna cum *(Reference: lower grade)*	0.47	0.18	0.009	0.30	0.18	0.093
Female *(Reference: Male)*	–0.39	0.18	0.033	–0.29	0.18	0.108
Age	0.02	0.29	0.942	–0.02	0.04	0.638
Migration background *(Reference: None)*	–0.06	0.04	0.210	0.17	0.29	0.561
Intrinsic motives				0.26	0.08	0.001
Extrinsic motives				0.05	0.09	0.589
Constant	4.78	1.46	0.002	2.15	1.52	0.162
N	77			77		
Adj. R^2	0.11			0.20		

Legend: Multivariate regression analysis with dependent variable scientific competences, ß-coefficients and standard deviations (*SD*) rounded to the second decimal place, p-values rounded to the third decimal place.

4 Summary and discussion

The aim of the present article was the analysis of research competences among medical graduates with the newly developed Munich Medical Research Competences Scale that was piloted at the medical faculties in Bavaria. The results of the exploratory factor analysis with postestimation screeplot and MAP-test supported a unidimensional scale. The replication of previous research results supports the content validity of the scale but also allow a more differentiated look on specific competences among medical graduates with and without doctoral degree.

Our results illustrate that research competences in medical graduates are in need of development, especially in the areas of study design, implementation, and interpretation. These competences, such as critically interpreting study results considering all aspects of the study – design, implementation and statistical analyses – do not only build the basis to become an independent researcher, but are also crucial for practising evidence-based medicine.

Doctoral graduates and male physicians assess their competences only slightly higher in comparison to those without completed doctorates and females. The small difference between those with and without a doctorate, among other reasons, might result from the level of independence during the doctorate. Since the doctorate in medicine, other than in any other discipline, is usually mainly pursued during undergraduate studies, there is less prior experience (e.g., through bachelor's and master's theses) and a lower degree of independence is a plausible assumption. However, no (comparative) analyses are available in this regard. The role of independence of doctoral research should be analysed in the future, ideally by comparing multiple disciplines.

The scales' items addressing competences in the area of EBM also indicate room for development. However, the question arises as to how these competences develop in the context of further professional experience. Analyses referring to those with completed doctorate show that the lower competence assessment of female doctoral graduates persists even under statistical control of the doctoral grade. This result is consistent with previous findings showing that female medical doctoral graduates indicate significantly lower research self-efficacy beliefs, even when including more achievement parameters, such as doctoral grades and publications (Epstein & Fischer, 2017). However, in the present study – in contrast to the cited one – the gender effect on competence assessment is no longer significant when controlling for doctoral motives: Intrinsic motives, which are less pronounced among females and significantly related to research competences, entirely explain the gender effect here. This warrants the assumption that those who begin the doctorate in order to gain research experience and possibly to continue to research after graduation, are presumably more eager

to acquire competences during the doctoral phase and possibly go beyond the mere requirements of the doctorate. Intrinsically motivated individuals may also choose a more scientifically demanding and better supervised doctoral project from the outset. Thus, grades and publications may not be sufficient to capture acquired competences. This could be one reason why these "objective" indicators cannot explain the gender effect.

Our analyses are based on cross-sectional data. Using the scale at different points in time from the beginning to the end of the study programme could reveal in which phases competence acquisition takes place and in which phases it stagnates. On this basis, targeted adjustments could be made to the curriculum. With regard to the recurring findings on gender differences in medicine – considering research self-efficacy and competences (Bakken et al., 2003; Epstein & Fischer, 2017) but also publications output (Pfeiffer et al., 2016) – complementary qualitative studies could help to understand this phenomenon. Due to the method of self-assessment, actual competences may differ between males and females. Furthermore, our results refer to five faculties in Bavaria; despite the broad data basis, the results may be different depending on the context, for example if research skills are trained more effectively in reformed medical programmes.

Conflicts of interest

The authors report no conflicts of interest.

Acknowledgements

We would like to thank all partners of the MediBAS survey for their kind cooperation and provision of the data. In this context, we would also like to thank the participants of the study for their valuable time and contribution.

References

Bakken, L.L., Sheridan, J., & Carnes, M. (2003). Gender differences among physician–scientists in self-assessed abilities to perform clinical research. *Academic Medicine, 78*(12), 1281–1286.

Beisiegel, U. (2009). Motivation des Nachwuchses für die medizinische Forschung. *Bundesgesundheitsblatt-Gesundheitsforschung-Gesundheitsschutz, 52*(8), 850-855.

Braun, E., & Mishra, S. (2016). Methods for Assessing Competences in Higher Education: A Comparative Review. In J. Huisman & M. Tight (Eds.), *Theory and Method in Higher Education Research* (Vol. 2, pp. 47-68). Emerald Group Publishing Limited. https://doi.org/10.1108/S2056-375220160000002003

Briedis, K., Jaksztat, S., Preßler, N., Schürmann, R., & Schwarzer, A. (2014). *Berufswunsch Wissenschaft. Laufbahnentscheidungen für oder gegen eine wissenschaftliche Karriere* (Forum Hochschule 8/2014). DZHW.

Epstein, N., Huber, J., Gartmeier, M., Berberat, P.O., Reimer, M., & Fischer, M. R . (2018). Investigation on the acquisition of scientific competences during medical studies and the medical doctoral thesis. *GMS Journal for Medical Education, 35*(2), Doc20.

Epstein, N., & Fischer, M.R. (2017). Academic career intentions in the life sciences: Can research self-efficacy beliefs explain low numbers of aspiring physician and female scientists? *PloS one, 12*(9), e0184543.

Epstein, N., Pfeiffer, M., Eberle, J., von Kotzebue, L., Martius, T., Lachmann, D., … Fischer, M.R. (2016). Nachwuchsmangel in der medizinischen Forschung. Wie kann der ärztliche Forschernachwuchs besser gefördert werden? *Beiträge zur Hochschulforschung, 38*(1-2), 162–189.

Fischer, M.R., Herzig, S., Neuhaus, B.J., Prenzel, M., & Berberat, P.O. (2017). Einfluss der Promotionsphase auf die Karriereentwicklung von NachwuchswissenschaftlerInnen in der Medizin und den Lebenswissenschaften, Kohorte 1 (E-Prom). *GESIS Datenarchiv, Köln. ZA6762 Datenfile Version 1.0.0.* https://doi.org/10.4232/1.12713

Fischer, F., Kollar, I., Ufer, S., Sodian, B., Hussmann, H., Pekrun, R., ... Eberle, J. (2014). Scientific reasoning and argumentation: advancing an interdisciplinary research agenda in education. *Frontline Learning Research, 2*(3), 28-45.

Gerst, T., & Hibbeler, B. (2012). Klinische Forschung: Ärztemangel im Labor. *Deutsches Ärzteblatt, 109*(37), 1804.

Giesler, M., Boeker, M., Fabry, G., & Biller, S. (2016). Importance and benefits of the doctoral thesis for medical graduates. *GMS J Med Educ. 33*(1), Doc8.

Hachmeister, C.-D. (2019). Im Blickpunkt: Promotionen als Indikator für die Leistung von Hochschulen. Auswertung von Daten des Statistischen Bundesamtes und des CHE Rankings 2019/20. *CHE Working Paper.* Retrieved on 05.11.2020 from https://www.che.de/wpcontent/uploads/upload/Im_Blickpunkt_Promotionen_2019.pdf.

Horstkotte, H. (2013). Wie gut sind Mediziner-Promotionen? *Zeit Online.* Retrieved from: https://www.zeit.de/studium/hochschule/2013-10/doktorarbeiten-promotionen-wissenschaft-mediziner.

Ills of the System. Reform is long overdue for Germany's archaic medical-education system, which puts undue pressure on students and contaminates the scientific literature. (2015). *Nature*, *527*, 7. doi: 10.1038/527007a.

Kaiser, H.F. (1974). An index of factorial simplicity. *Psychometrika, 39*(1), 31-36.

Kroneberg, C. (2005). Die Definition der Situation und die variable Rationalität der Akteure/The Definition of the Situation and the Variable Rationality of Actors: Ein allgemeines Modell des Handelns/A General Model of Action. *Zeitschrift für Soziologie, 34*(5), 344-363.

Nationaler Kompetenzbasierter Lernzielkatalog (NKLM). (2015). *MFT Medizinischer Fakultätentag der Bundesrepublik Deutschland e. V.* Retrieved 02/2021 from http://www.nklm.de/kataloge/nklm/lernziel/uebersicht.

Pfeiffer, M., Fischer, M.R., & Bauer, D. (2016). Publication activities of German junior researchers in academic medicine: which factors impact impact factors? *BMC Medical Education, 16*(1), 190.

Putz, R.M. (2011). Medizinstudium. Promotion. Habilitation in Deutschland. In D. Bitter-Suermann (Ed.), *Wissenschaftliche Medizinerausbildung – 100 Jahre nach Flexner. Tagung des Medizinischen Fakultätentages und des Wissenschaftskollegs zu Berlin* (pp. 51-56). Berlin: Medizinischer Fakultätentag der Bundesrepublik Deutschland.

Reimer, M., Kopecny, S., & Pünder, T. (2019). *Bayerische Humanmediziner Jahrgang 2017: Rückblick aufs Studium, Weiterbildung und Berufsübergang. Ergebnisbericht der MediBAS in Bayern für die Humanmedizin*. Bayerisches Staatsinstitut für Hochschulforschung und Hochschulplanung.

Senatskommission für Klinische Forschung. (2010). *Empfehlungen der Senatskommission für Klinische Forschung. Strukturierung der wissenschaftlichen Ausbildung für Medizinerinnen und Mediziner*. Deutsche Forschungsgemeinschaft (DFG).

Statistisches Bundesamt. (2019). *Bildung und Kultur, Prüfungen an Hochschulen 2018*. (Fachserie 11, Reihe 4.2).

Velicer, W.F. (1976). Determining the number of components from the matrix of partial correlations. *Psychometrika, 41*(3), 321-327.

Velicer, W.F., Eaton, C.A., & Fava, J.L. (2000). Construct Explication through Factor or Component Analysis: A Review and Evaluation of Alternative Procedures for Determining the Number of Factors or Components. In R.D. Goffin & E. Helmes (Eds.), *Problems and Solutions in Human Assessment* (pp. 41-71): Springer. https://doi.org/10.1007/978-1-4615-4397-8_3

Manuscript received: 04.02.2021
Manuscript accepted: 26.07.2021

Appendix

Table A1: Münchner Skala zu Forschungskompetenzen in der Medizin

Frage: In welchem Maße haben Sie die folgenden Kenntnisse, Fähigkeiten und Fertigkeiten in Ihrem Studium erworben? (Skala: 1 = gar nicht bis 5 = in sehr hohem Maße)
Item 1: Fähigkeit, den bisherigen Kenntnisstand zu einer Fragestellung zu recherchieren
Item 2: Fähigkeit, den durch eine Untersuchung erreichten Erkenntnisgewinn darzustellen
Item 3: Fähigkeit, die Aussagekraft einer wissenschaftlichen Untersuchung hinsichtlich methodischer Gesichtspunkte kritisch zu diskutieren
Item 4: Fähigkeit, das Ergebnis einer statistischen Hypothesenprüfung zu interpretieren
Item 5: Fähigkeit, von der Forschungsfrage ausgehend, testbare Hypothesen herzuleiten
Item 6: Fähigkeit, mögliche Untersuchungsmethoden (z. B. aus der medizinischen Grundlagenforschung, der klinischen oder epidemiologischen Forschung) zu benennen und wissenschaftlich zu begründen
Item 7: Fähigkeit, Forschungsideen methodisch und technisch korrekt umzusetzen
Item 8: Fähigkeit, konkrete Handlungen bzw. Therapiemöglichkeiten aus der empirischen Evidenz abzuleiten
Item 9: Fähigkeit, Studienergebnisse in Bezug auf die Anwendbarkeit auf einen Patientenfall zu bewerten
Item 10: Fähigkeit, Studien in Evidenzklassen einzusortieren

Table A2: Scale of intrinsic and extrinsic motives, results of exploratory factor analysis

I wanted to do a doctorate ...	**Factor 1**	**Factor 2**
	intrinsic	**extrinsic**
(since the doctorate is largely common in my subject)	(–0.069)	(0.395)
since I feared disadvantages on the job market without a doctorate	0.137	0.555
to be able to work in research after the doctorate	0.794	0.009
to develop my professional competences	0.803	–0.086
to research during the doctorate	0.873	–0.098
to be able to work more intensively on the specific topic of my doctorate	0.732	–0.094
to keep the possibility of a research career open	0.733	0.100
to be better able to practise and understand EBM	0.610	–0.018
to earn a higher income than without a doctoral degree	0.167	0.503
for a higher societal reputation	0.002	0.744
to be perceived by patients as a competent physician	–0.092	0.746
to have a higher reputation among colleagues	0.119	0.744

Legend: N = 570. (scale: 1 = not at all true to 5 = completely true). Factor loadings rounded to the third decimal place.
Principal axis analysis, unrotated. Excluded item in parentheses.

Figure A1: Postestimation Screeplot, intrinsic and extrinsic motives

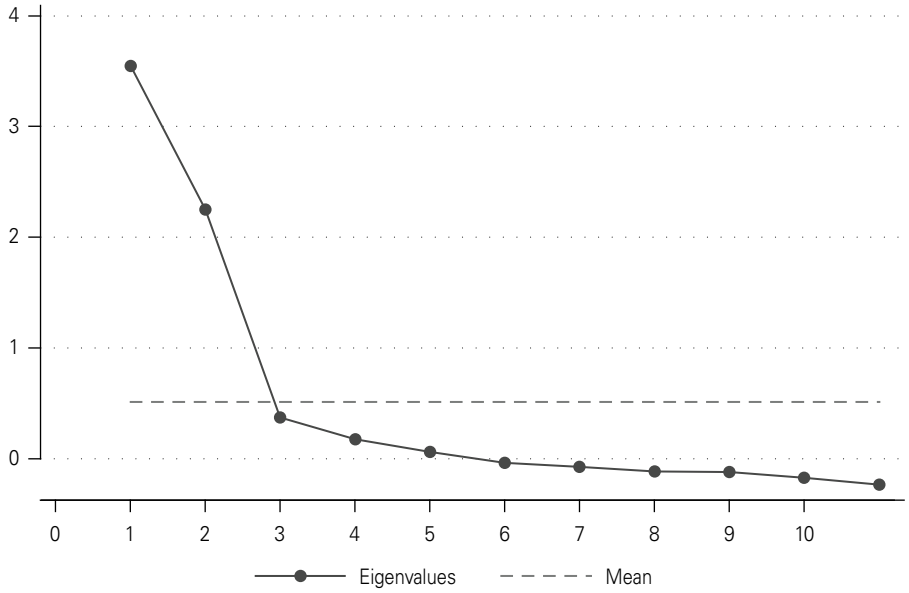

Figure A2: MAP-Test, intrinsic and extrinsic motives

Minimum Average Partial Correlation for Number of Principal Components

NOTE: Pick number of components (m) at which fm is minimum.
If f1 > f0 (average intervariable correlation)
then no components should be extracted.

m = 0 f 0 = .13469679

m = 1 f 1 = .06969177
m = 2 f 2 = .0406374
m = 3 f 3 = .05284884
m = 4 f 4 = .06925403
m = 5 f 5 = .10751293
m = 6 f 6 = .13994796
m = 7 f 7 = .20594091
m = 8 f 8 = .31526583
m = 9 f 9 = .56000138
m = 10 f10 = 1

minap procedure suggests that 2 principal components should be extracted.

For comparison, the Kaiser eigenvalue > 1 rule suggests extracting 2 principal components.

Figure A3: Postestimation Screeplot, Munich Medical Research Competences Scale

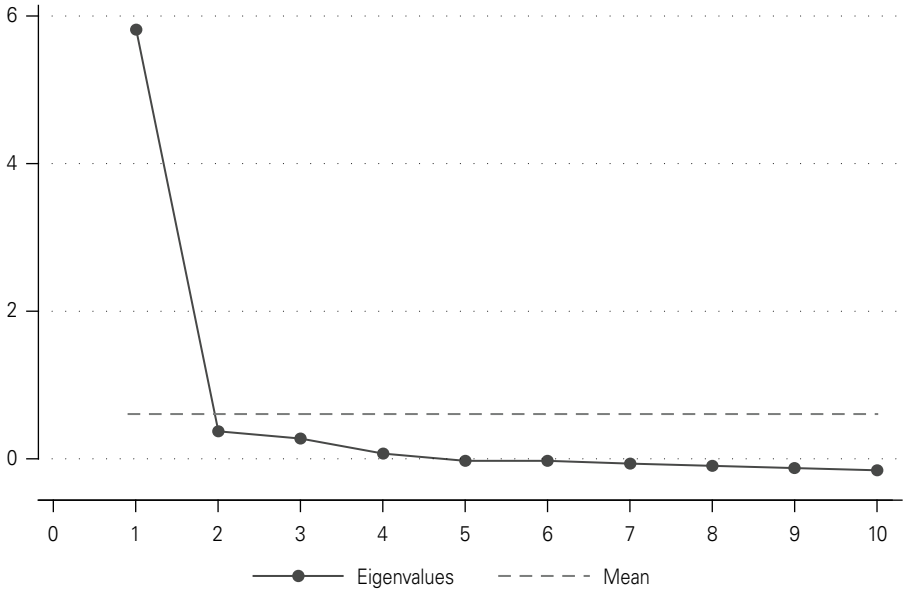

Figure A4: MAP-Test, Munich Medical Research Competences Scale

Minimum Average Partial Correlation for Number of Principal Components

NOTE: Pick number of components (m) at which fm is minimum.
If f1 > f0 (average intervariable correlation)
then no components should be extracted.

m = 0 f0 = .33736399

m = 1 f1 = .03093972
m = 2 f2 = .04512596
m = 3 f3 = .06018905
m = 4 f4 = .09967063
m = 5 f5 = .13665191
m = 6 f6 = .19713592
m = 7 f7 = .27515224
m = 8 f8 = .44932073
m = 9 f9 = 1

minap procedure suggests that 1 principal component should be extracted.

For comparison, the Kaiser eigenvalue > 1 rule suggests extracting 1 principal =component.

Information about the authors:

Dr. Nurith Epstein, M.A.
Dr. Johanna Huber, MPH
Prof. Dr. Martin R. Fischer, MD, MME (Bern)
Institut für Didaktik und Ausbildungsforschung in der Medizin
LMU Klinikum, LMU München
Pettenkoferstr. 8a
80336 München

Dr. Maike Reimer
Bayerisches Staatsinstitut für Hochschulforschung und Hochschulplanung
Lazarettstraße 67
80636 München

PD Dr. Martin Gartmeier
Prof. Dr. Pascal O. Berberat, MD, MME (Heidelberg)
TUM Medical Education Center
Lehrstuhl für Medizindidaktik, medizinische Lehrentwicklung
und Bildungsforschung
TUM School of Medicine, Technische Universität München
Nigerstraße 3
81675 München

Nurith Epstein is a research associate at the Institute of Medical Education at the University Hospital of LMU Munich. Her research interests include career paths of doctoral graduates, research careers and the acquisition of research competences in undergraduate and doctoral studies.

Johanna Huber is a research associate at the Institute of Medical Education at the University Hospital of LMU Munich. Her research interests include evaluation both in medical education and in the area of health research capacity building.

Martin R. Fischer is an internist, endocrinologist and medical educator. He is the director of the Institute of Medical Education at the University Hospital of LMU Munich. His research focuses on diagnostic competences, clinical reasoning, and technology-enhanced learning in medicine.

Maike Reimer is a research associate at the Bavarian State Institute for Higher Education Research and Planning (IHF). Her research interests include educational trajectories, transitions after higher education, research careers and disciplinary differences.

Pascal O. Berberat is a surgeon and the director of the TUM Medical Education Center. He is engaged in the development of evidence-based didactic measures through a better understanding of teaching/learning processes. He further investigates attitudes, motivations and behaviours of physicians as university lecturers.

Martin Gartmeier is research coordinator at the TUM Medical Education Center. His research interests include, among others, fostering professional communication competence in the domains of medicine and teaching and learning from errors in professional contexts.