

Aus der
Medizinischen Universitätsklinik und Poliklinik Tübingen
Innere Medizin VI

**Professional and Academic Pre-Qualifications in
Medical Education: Associations with Academic
Success, Study Satisfaction, and Career Preferences**

**Inaugural-Dissertation
zur Erlangung des Doktorgrades
der Humanwissenschaften**

**der Medizinischen Fakultät
der Eberhard Karls Universität
zu Tübingen**

**vorgelegt von
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2026

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Tag der Disputation: 14.10.2026

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Ein herzliches Dankeschön!	148

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List of abbreviations

AdH	Auswahlverfahren der Hochschulen
CI	Confidence Interval
CFA	Confirmatory Factor Analysis
CoP	Community of Practice
EMMs	Estimated Marginal Means
FestBW	Fonds Erfolgreich Studieren in Baden-Württemberg
GPA	Grade Point Average
HAM-Nat	Hamburg Natural Science Test
M1	First state examination, “Physikum”
M2	Second state examination
MCAT	Medical College Admission Test
MMI	Multiple Mini-Interviews
MWK	Ministerium für Wissenschaft, Forschung und Kunst Baden-Württemberg
NC	Numerus Clausus
NKLM	Nationaler Lernzielkatalog Medizin
OR	Odds Ratio
OSCE	Objective Structured Clinical Examination
REML	Restricted Maximum Likelihood
RIASEC	Realistic, Investigative, Artistic, Social, Enterprising, and Conventional
MLR	Robust Maximum Likelihood Estimation
SamBaWü	Selektion und Auswahl im Medizinstudium Baden-Württemberg
SJT	Situational Judgment Tests
SRL	Self-regulated learning
SEM	Structural Equation Model
STEM	Science, Technology, Engineering and Mathematics
TMS	Test for Medical Studies
UKCAT	University Clinical Aptitude Test
VSM-BW	Verbund Studierendenauswahl Medizin in Baden-Württemberg
ZEQ	Zusätzliche Eignungsquote

„Das Menschenleben ist eine fortgehende Schule“

Gottfried Keller in seiner Gotthelf-Rezension zu Uli der Knecht - Uli der Pächter, Blätter für literarische Unterhaltung, Brockhaus, Nr. 302/05, Dezember 1849

1 Theoretical Background

The study of human medicine is highly popular among prospective students. Applicants are driven by a range of factors, including altruistic motives, interest in medicine as a scientific discipline, prestige, having a physician in the family, and personal experiences with illness (González-Amarante & Olivares-Olivares, 2021). However, motivations for pursuing a medical career may differ across countries with different income levels (Goel et al., 2018). The most recent publicly available figures for Germany indicate that in the summer semester of 2025, there were 6.9 applicants per first-year place, and 3.2 applicants per place in the winter semester of 2024/25 (Statistisches Bundesamt, 2025). This strong demand is not unique to Germany, as medical schools internationally, for example in the United States, also receive more applications than there are available study places (Strowd et al., 2019). In response to this high demand, medical schools seek to identify applicants who are best suited to the demands of medical training and the medical profession. Consequently, a wide range of selection methods is used worldwide (Patterson et al., 2016), with prior academic performance remaining a central criterion in many countries (Monroe et al., 2013; Patterson et al., 2016; Powis, 2015). The medical admissions process in Germany differs from international approaches, as it is based on a quota system that has undergone several revisions over the past decades (Erschens et al., 2021; Hampe et al., 2009; Schröpel et al., 2024). Recent changes aimed to enhance fairness in access to medical education, identify the most suitable candidates for the medical profession, and address societal needs, such as physician shortages in rural areas (Müller-Hilke et al., 2024). Although cognitive criteria continue to play a dominant role in medical school admissions in Germany, the quota-based admission system also provides alternative pathways for applicants with prior practical qualifications, particularly through the Additional Aptitude Quota (”Zusätzliche Eignungsquote“, ZEQ) and the University Selection Procedure (”Auswahlverfahren der Hochschulen“, AdH) (Stiftung für Hochschulzulassung, 2026).

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Within these pathways, *completed vocational training in a medical field* (e.g., paramedics, nurses, physiotherapists) is especially valued and may substantially improve admission chances. Several studies indicate that a considerable proportion of medical students in Germany have completed vocational training prior to entering medical school (Amelung et al., 2022; Erschens et al., 2021; Schröpel et al., 2024). Similarly, smaller-scale practical experiences, such as *voluntary service* of at least eleven months, may also enhance the likelihood of admission through ZEQ and AdH. However, they are typically weighted less strongly than completed vocational training in the medical field and subsequent professional experience. A prior *academic degree* completed before entering medical school represents another form of pre-qualification (second-degree applicants). Applicants with an academic degree are not considered directly within the ZEQ or AdH, but instead are allocated places through a preliminary quota alongside international applicants, hardship cases and candidates for the rural physician quota (Stiftung für Hochschulzulassung, 2026). These three “professional and academic pre-qualifications” (i.e. vocational training in the medical field, academic degree, voluntary service) constitute the core variables of this dissertation.

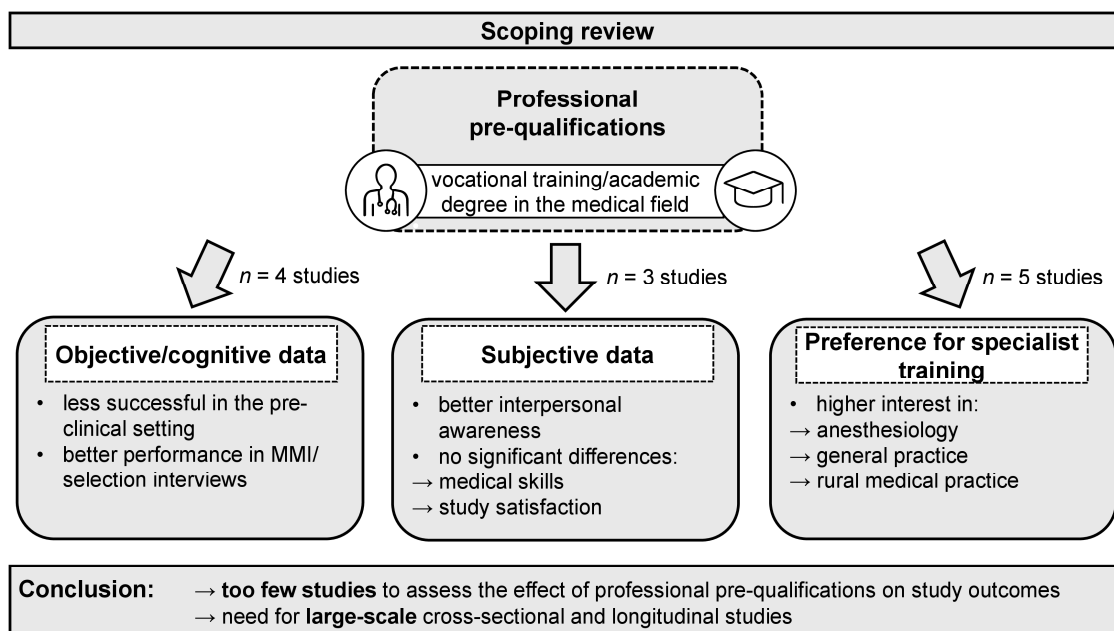
Although pre-qualifications play a decisive role in many medical school-specific selection procedures in Germany, their implications for academic performance, career preferences and relevant outcomes in medical education have so far received little empirical attention. This gap was highlighted in a scoping review by Erschens and colleagues (2021). The authors examined whether medical students with pre-qualifications differed from those without, regarding objective and cognitive indicators of study success, subjective outcomes, and preferences for subsequent specialist training. They defined “professional pre-qualifications” similarly to this dissertation as vocational training or studies in the medical field. Overall, medical students with professional pre-qualifications were found to perform slightly worse than those without, at least in the preclinical stage of their studies. Regarding subjective data, no differences in medical skills or study satisfaction were identified, but individuals with professional pre-qualifications demonstrated greater interpersonal awareness. Those with prior professional qualifications were more interested in anesthesia, general medicine and rural medical practice. However, Erschens and colleagues concluded that too few studies had been conducted to enable definitive statements to be made, and that large-

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scale cross-sectional or longitudinal studies on prior professional qualifications are required. See figure 1 for an overview on the results of the scoping review by Erschens et al. (2021). The results of this review provide an important basis for the present dissertation and will be integrated into and discussed throughout the thesis.

Building on this background, the aim of this dissertation is to provide a comprehensive examination of a cohort that has thus far received limited scholarly attention: medical students with professional and academic pre-qualifications (i.e. vocational training in the medical field, academic degree, voluntary service). The dissertation investigates the associations between these pre-qualifications and key outcomes in medical education, namely academic success, study satisfaction, and specialty preferences, with a particular focus on interest in rural medical practice. By distinguishing between different types of pre-qualifications and linking them to educational and career-related outcomes, this work contributes empirical evidence to medical admissions and education research.

Figure 1. Overview of the key findings of the review by Erschens et al. (2021) on the effect of professional pre-qualifications on objective study success and subjective variables, as well as on preference for subsequent medical specialty training.



Note. Overall, 11 studies were included in the scoping review, MMI = Multiple Mini-Interviews

1.1 Admission to medical school

Due to the international popularity of medical studies, the number of applicants exceeds the number of available study places. This requires medical schools to implement structured and evidence-based selection procedures to identify candidates best suited to the medical profession (Cleland et al., 2025; Soemantri et al., 2020; Strowd et al., 2019). In their systematic review, Patterson et al. (2016) identified eight different selection methods, namely aptitude tests, academic records, personal statements, reference letters, assessments of social skills (e.g. situational judgment tests, SJT), and tests to assess personality and emotional intelligence, traditional interviews/multiple mini-interviews (MMI), and selection centers.

Traditionally, selection procedures have focused strongly on cognitive criteria (e.g. school-leaving grades, undergraduate grade point average, GPA) as they are significant predictors of academic performance in medical school (Patterson et al., 2016; Powis et al., 2020; Schwibbe et al., 2018). Many systems complement school-leaving grades with aptitude tests, which assess cognitive abilities beyond school qualifications (Kadmon et al., 2012). Different tests are used internationally demonstrating varying levels of predictive validity, such as the UKCAT (University Clinical Aptitude Test) in the United Kingdom, Australia, and New Zealand (Bala et al., 2022; McManus et al., 2013), and the MCAT (Medical College Admission Test) in the United States and Canada (Donnon et al., 2007; Hanson et al., 2022; Roberts, 2020). The TMS (Test for Medical Studies) and HAM-Nat (Hamburg Natural Science Test) constitute the two official aptitude tests for medical studies in Germany showing substantial incremental validity over school-leaving grades (Hissbach et al., 2011; Jaehn et al., 2025; Kadmon et al., 2012). Recent analyses indicate that both assess similar cognitive abilities, although based on different theoretical frameworks (Levacher et al., 2023). Nevertheless, neither grades nor aptitude tests capture personal competencies relevant to medical training and profession, such as social skills, teamwork, and resilience (Koenig et al., 2013). For this reason, increasing attention has been paid to selection methods such as MMIs, which use standardized interview stations that can be adapted to institutional needs (Fleck et al., 2025; Pau et al., 2013). Recent evidence suggests that MMI-based procedures can reliably capture interactional competencies relevant to medical practice (Fleck et al.,

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2025; Lin et al., 2022). Additionally, literature shows that SJTs are cost-effective and valid selection methods in the assessment of personal characteristics (Knorr et al., 2024; Mielke et al., 2025; Patterson et al., 2016).

Germany's medical school admission system is characterized by a quota-based allocation mechanism that has been repeatedly reshaped by political decisions. The centralized allocation of medical school places was introduced in 1973 (Hampe et al., 2009; Kahmann, 2015) establishing secondary school performance (specifically undergraduate GPA, "Abitur") as a core selection criterion from the very beginning. Through the *Abitur grade quota* ("Abiturbestenquote"), applicants with the best school-leaving grades receive a study place. Alongside this pathway, a *waiting-time quota* was implemented, enabling applicants excluded from the Abitur grade quota to receive a study place following the accumulation of waiting semesters. Since 2005, medical faculties played a more active role in student selection through the *university selection procedure* (AdH). Within this framework, medical faculties can define their own priorities and weight criteria such as overall Abitur grades, subject-specific grades, aptitude tests, vocational training or professional experience, and selection interviews. Substantial changes to the admission system were discussed followed a ruling by the German Federal Constitutional Court in December 2017, which declared parts of the existing admission procedure unconstitutional (Bundesverfassungsgericht, 2017). As a result, a revised admission system came into force at the beginning of 2020. Under the revised system, 30% of medical school places are now allocated through the Abiturbestenquote, 60% via the AdH, and 10% via the *additional aptitude quota* (ZEQ). The waiting-time quota was abolished after a transition period that extended until 2022. Under the revised AdH, universities are now required to consider at least two grade-independent criteria, while the ZEQ is entirely independent of school grades. Such criteria may include results of subject-specific aptitude tests, performance in selection interviews, completed vocational training or professional experience in the medical field, honorary or volunteer activities, and awards in education-related competitions (Stiftung für Hochschulzulassung, 2026).

Table 1 summarizes the development of admission criteria in Germany since the introduction of a centralized allocation of medical school places. Overall, practical

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experience has consistently played a role in the German admission system, albeit with varying emphasis. This relevance has manifested either directly through explicit weighting within the AdH or ZEQ, or indirectly through the former waiting-time quota, which many applicants used to complete vocational training in a healthcare occupation during their waiting period (Herbst & Müller-Hilke, 2019).

Table 1. *Overview of the history of admission criteria for medical studies in Germany.*

Time Period	Description of changes
Since 1973	Centralized allocation of medical school places in Germany (Hampe et al., 2009; Kahmann, 2015) <ul style="list-style-type: none"> • 60% of places based on applicant qualifications (best undergraduate GPA = “Abitur” grade, bonus for completing vocational training) • 40% of places allocated via waiting-time quota (“Wartezeitquote”)
Since 1975	Introduction of additional criteria alongside “Abitur” grades (Hampe et al., 2009; Kahmann, 2015) <ul style="list-style-type: none"> • Weighted, subject-specific grades • Completed vocational training • Subject-specific aptitude test (TMS) • Selection interviews
2004	Recommendation by the German Council of Science and Humanities (“Wissenschaftsrat”) that universities should take a more active role in the selection process (Hampe et al., 2009; Kahmann, 2015)
Winter semester 2005/2006	New admission criteria (Hampe et al., 2009; Kahmann, 2015) <ul style="list-style-type: none"> • 60% of places based on university selection procedure (AdH) <ul style="list-style-type: none"> ◦ e.g. Abitur grades, individual subject grades, subject-specific aptitude tests, vocational training or professional experience, selection interviews • 20% waiting-time quota • 20% Abitur grade quota
March 2017	“Masterplan Medizinstudium 2020”, Update of the National Competence-Based Learning Objectives Catalogue for Medicine (NKLM) (Erschens et al., 2021; Wissing, 2018): <ul style="list-style-type: none"> • consideration of social and communication skills and professional experience in addition to the “Abitur” grade • Introduction of a rural doctor quota (“Landarztquote”)
December 2017	Federal Constitutional Court ruling: admission procedures partially unconstitutional (Bundesverfassungsgericht, 2017; Herbst & Müller-Hilke, 2019) <ul style="list-style-type: none"> • Numerus clausus (NC) permissible only to a limited extent • Waiting-time quota must be limited in duration, not mandatory • Location preferences and preferential treatment are not permissible
Since 2020	New criteria (Schröpel et al., 2024; Stiftung für Hochschulzulassung, 2026) <ul style="list-style-type: none"> • 60% university selection procedure (AdH) • 30% Abitur grade quota • 10% additional aptitude quota (ZEQ)

1.2 Academic success

Academic success is not uniformly defined in the literature. Instead, it has been operationalized in a variety of ways, such as examination grades, performance practical assessments, and the number of examinations passed (Amelung et al., 2022; Eva et al., 2009; Gröne et al., 2022; Hampe et al., 2008; Kadmon et al., 2014). This heterogeneity complicates comparisons across studies and limits the generalizability of findings.

As admissions procedures continue to focus mainly on cognitive performance, prior professional or academic qualifications may offer a way to identify applicants who have already developed relevant personal competencies through practical experience (Erschens et al., 2021; Schröpel et al., 2024). From a theoretical perspective, prior professional or academic qualifications should confer an advantage in terms of academic success. The Experiential Learning Theory, for instance, emphasizes the central role of immediate and concrete experiences in the learning process (Kolb, 2014). Accordingly, practical and life experiences are core components of learning (Kolb, 2014; McCarthy, 2016; Morris, 2020). According to Kolb's theory, learning is a cyclical process involving the following phases that a learner must go through: concrete experience, abstract conceptualization, reflective observation and active experimentation. Knowledge is formed by transforming experiences (Kolb, 2014; McCarthy, 2016; Morris, 2020). Medical students with prior practical experience in the medical field should therefore be particularly well positioned to integrate theoretical knowledge with practice, which could lead to improved academic performance.

This assumption is supported by a study conducted by Amelung et al. (2022), which found that students with completed vocational training in the medical field achieved better grades in the first two years of medical studies than peers without such training but with comparable school-leaving grades. The authors explained these effects by referring to competencies acquired during vocational training, such as stress resistance or practical medical knowledge. Similarly, Fleck et al. (2025) demonstrated that applicants with prior healthcare experience performed better in MMI-based assessments of interactional competencies.

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However, for students with these pre-qualifications, medical school often represents a second educational pathway. This group typically has a longer interval since high school graduation and different life circumstances (e.g. employment or family responsibilities), which may affect academic performance. In their scoping review, Erschens et al. (2021) found that students with professional pre-qualifications showed slightly poorer performance in the preclinical phase compared to students without such qualifications. However, students with prior healthcare experience tended to perform better in selection interviews and showed higher readiness for interprofessional learning. However, according to Erschens et al. (2021), conclusions should be drawn with caution due to the limited number of available studies.

Also, short-term experiences such as voluntary service may have a limited influence on academic outcomes. For example, Hampe et al. (2008) reported no observable performance advantage among medical students with prior voluntary service experience. In summary, while school-leaving grades remain the most robust predictor of academic success, the evidence regarding professional and academic pre-qualifications remains mixed and limited. In order to gain a deeper understanding of the role of these pre-qualifications in medical education, multicenter studies using broader definitions of academic success are required.

1.3 Study satisfaction

1.3.1 Conceptualization and empirical correlates

In addition to objective indicators of academic success, students' subjective evaluation of their studies is an important outcome. Study satisfaction is highly relevant for universities, which is reflected in the widespread use of course evaluations and graduate surveys (Eyal & Cohen, 2006; Jalili et al., 2008; Schiekirka & Raupach, 2015). Some studies also analyze study satisfaction as an additional criterion for assessing academic success (Brandstätter & Farthofer, 2003; Spörer & Brunstein, 2005). Study satisfaction is associated with individual, teaching-related, and institutional factors. Table 2 provides examples of these factors and illustrates their relationships with study satisfaction in different cohorts of students.

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Conceptually, study satisfaction is understood as a subjective measure for evaluating teaching and the study experience (Westermann et al., 1996). Internationally, student satisfaction is assessed using a variety of approaches, with new methods of measurement continually being developed (Huang et al., 2023; Rahmatpour et al., 2019; Zhuang et al., 2025). An established German-language instrument is the *Study Satisfaction Questionnaire* by Westermann et al. (1996). Its short version assesses satisfaction with (1) study contents, (2) study conditions, and (3) coping with the study load. Westermann and colleagues define study satisfaction in accordance with the concept of job satisfaction as students' attitudes toward their studies (Apenburg, 1980; Locke, 1976; Westermann et al., 2018). Using this three-dimensional framework, Schiefele and Jacob-Ebbinghaus (2006) analyzed motivational and teaching-related factors and demonstrated that satisfaction with study content was related to personal interest in the subject, perceived vocational relevance of teaching, and performance-related extrinsic learning motivation. Satisfaction with study conditions, on the other hand, was associated with lecturer engagement as well as vocational and performance-related extrinsic motivation. Finally, satisfaction regarding coping with study load was related to perceived teaching overload, personal interest in the subject, and individual characteristics such as stress tolerance and social competence (Schiefele & Jacob-Ebbinghaus, 2006). Overall, study satisfaction is a relevant variable in higher education. In this context, Westermann's (1996) study satisfaction dimensions offer a nuanced approach to assessing medical students' satisfaction with their studies.

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Table 2. *Overview of individual, curriculum- and teaching-related, and institutional factors associated with study satisfaction in different cohorts of students.*

Factor associated with study satisfaction	student group	Reference
Individual factors:		
(+) mental health	multiple disciplines	Lehnchen et al. (2025)
(+) self-efficacy, environmental support	medicine	An et al. (2023)
(+) personal interest in the subject	psychology	Schiefele and Jacob-Ebbinghaus (2006)
(+) intrinsic motivation, conscientiousness	education	Kuensting and Lipowsky (2011)
(-) extrinsic motivation, neuroticism	education	Kuensting and Lipowsky (2011)
Curriculum- and teaching-related factors:		
(+) feeling cared for, satisfaction with teaching and assessment	medicine	Huang et al. (2023)
(+) class size, course planning	medicine	Ziaee et al. (2004)
(+) Problem-based learning (PBL)	health science	Tadesse et al. (2022)
Institutional factors:		
(+) faculty quality, curriculum, learning environment, social interaction, and opportunities for professional development	nursing	Cant et al. (2023)
(-) dropout rates	multiple disciplines	Duque (2014)

Note. Positive (+) and negative (-) associations with study satisfaction

1.3.2 Associations with part-time employment

Overall, study satisfaction may be influenced by individual characteristics, including students' backgrounds, prior experiences, and expectations regarding their studies. With regard to professional or academic pre-qualifications in medical education, the review by Erschens et al. (2021) found no evidence of a direct association between pre-qualifications and study satisfaction; however, only two studies could be included.

Exploratory analyses by Schröpel et al. (2024) suggest that students with prior vocational training or a previous academic degree tend to be older and receive less financial support from their parents than students without such backgrounds. This may reflect the fact that, for these students, studying medicine represents an additional

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qualification rather than a first educational pathway. In Germany, parents are legally required to financially support their children during their first education, and they represent the primary source of student funding (Kroher et al., 2023). For students for whom medical studies constitute a second qualification, parental financial support may therefore be less common. Although higher education in Germany is largely tax-funded and does not involve general tuition fees (Zavlin et al., 2017), students must still cover their living expenses. Moreover, several federal states, including Baden-Württemberg, charge tuition fees for second-degree students (Ministerium für Wissenschaft, 2026). Consequently, students with prior vocational training or an academic degree may be more reliant on part-time employment to finance their studies.

From the perspective of Westermann's (1996) dimensions of study satisfaction, part-time employment may negatively affect study satisfaction, particularly *satisfaction with study conditions* and *satisfaction with coping of study loads*. Medical curricula are highly demanding and are primarily designed as full-time programs (Erschens et al., 2024; Haider et al., 2022), which may make it challenging to combine academic requirements with paid employment. The additional organizational and time-related burdens associated with employment may therefore contribute to lower levels of study satisfaction. In addition, studies show a negative association between part-time employment and study satisfaction as well as academic success (Brandstätter & Farthofer, 2003; Nidogon Višnjić et al., 2024). In this sense, pre-qualifications may not directly influence study satisfaction, but they may be associated with contextual factors, particularly financial constraints and employment, that are relevant to students' subjective evaluation of their studies. There is limited empirical evidence on these pathways, highlighting the need for further research that explicitly considers the interplay between pre-qualifications, funding structures, employment and satisfaction with medical studies.

1.3.3 Associations with deep-processing learning strategies

Not only financial factors may shape the relationship between pre-qualifications and study satisfaction. While satisfaction with study conditions and the coping of study

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loads may be lower among medical students with pre-qualifications, as outlined in the previous chapter, *satisfaction with study content*, another dimension of study satisfaction proposed by Westermann and colleagues (1996), may be comparatively higher in this group. Previous research indicates that vocationally oriented and content-related motives for choosing a field of study are associated with greater satisfaction with study content (Hiemisch et al., 2005). Similarly, satisfaction with study content has been shown to be related to personal interest in the subject and the perception of curricular relevance to future professional practice (Schiefele & Jacob-Ebbinghaus, 2006). Students with professional or academic pre-qualifications may therefore experience higher satisfaction with the content of medical studies. Their prior experiences may allow them to perceive the curriculum as more professionally meaningful and to link new learning material more effectively with existing knowledge. This may particularly be the case for longer prior qualifications, such as completing vocational training or undertaking a degree before entering medical studies.

Such deep-processing learning strategies include elaboration, which involves integrating new information with existing knowledge (Schiefele et al., 2003). They also include critical thinking, which refers to the systematic questioning, evaluation, and reflection of learning content to promote deeper understanding (Spörer & Brunstein, 2005; Wild, 2000). Overall, deep-learning strategies are considered more effective than surface-level approaches (Wild, 2000) and they constitute a subset of cognitive learning strategies that describe how learners process information in order to acquire store knowledge (Dresel et al., 2015; Pintrich et al., 1993; Wild, 2000). Besides cognitive strategies, other strategy types have been identified by Wild and colleagues (Wild, 2000, 2005; Wild & Schiefele, 1994). These include metacognitive strategies, which involve monitoring and regulating one's own learning processes, and strategies for managing internal and external resources, such as time management, motivation regulation, or seeking social support (Dresel et al., 2015; Pintrich et al., 1993; Wild, 2000). Learning strategies are conceptualized within the framework of self-regulated learning (SRL), a central construct in educational research (Klingsieck, 2019; Panadero, 2017; Pintrich et al., 1993). SRL refers to learners' active engagement in the learning process, including goal setting, planning, monitoring, and regulating learning activities (Panadero, 2017; Schiefele & Pekrun, 1996; Zimmerman, 2002).

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Medical students with prior qualifications are likely to possess a broader and more relevant knowledge base, either through practical experience in the medical field or through their familiarity with academic learning environments, as theories indicate that prior knowledge plays a crucial role in learning processes (Boekaerts, 1997).

Accordingly, more advanced learners may use self-regulated learning strategies more frequently (Boerner et al., 2005; Seeber et al., 2006). The use of SRL strategies has been linked to various beneficial outcomes, including higher perceived competence, academic achievement, positive achievement emotions, and soft skills (Feraco et al., 2023a; Feraco et al., 2023b; Nabizadeh et al., 2019; Zimmerman, 1990). Importantly, empirical evidence also suggests a positive association between the use of self-regulated learning strategies and study satisfaction (Li, 2019; Wang et al., 2013). Taken together, these findings suggest that pre-qualifications may shape how deep-processing strategies relate to satisfaction with the content of studies. Medical students with prior academic degree or vocational training in the medical field may be able to integrate, evaluate, and interpret new learning content more meaningfully due to their existing knowledge base.

1.4 Medical specialty choice

For medical students, choosing a medical specialty is a major decision in their career. A systematic review found that several curricular determinants may shape interest in a specialty: positive clinical experiences, student involvement in curricular planning and structuring, voluntary offerings, and integration in the clinical team tend to increase interest in a specialty, whereas poor teaching quality and experiences of discrimination can discourage students from pursuing certain specialties (Schoon & Kötter, 2024).

From a theoretical perspective, medical specialty choice is the result of complex interactions. Theories emphasize the importance of congruence between a student's individual needs and the perceived attributes of a specialty, with the student's background and prior experiences also playing an important role (Bland et al., 1995). Similarly, a model proposed by Mitchell (1975) demonstrated that prior experiences constitute an important component within the personal characteristics domain in the medical student career decision-making process. Against this background, medical students with prior academic or professional qualifications may differ systematically in

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their specialty choices compared to students without such experience. Career development theories further suggest that career decisions depend on vocational exploration, defined as the continuous evaluation of one's own interests and abilities in relation to available career options (Flum & Blustein, 2000). This process is closely linked to the formation of identity and continues throughout life (Erikson, 1968). Students entering medical school with previous practical or academic experience may be further ahead in developing their professional identity and exploring their career options, enabling them to develop more specific specialty preferences.

Empirical findings support the assumption that practical experiences before medical school are associated with distinct patterns of specialty interest. Studies indicate that individuals with completed vocational training in the medical field are more likely to express interest in general practice or anesthesiology (Leutritz et al., 2024; Selch et al., 2021). One possible explanation is that vocational training in the medical field, such as in paramedicine, involves substantial patient contact and frequent exposure to acute and emergency situations, which overlap with core aspects of anesthesiology and may contribute to increased interest in this field (Gräsner et al., 2013; Pajonk et al., 2011; Sorgatz et al., 2018). Nevertheless, the available evidence remains insufficient to establish a clear relationship between professional and academic pre-qualifications and specific medical specialty preferences, as also highlighted by the scoping review conducted by Erschens et al. (2021). Further research is therefore needed to better understand how pre-medical experiences shape medical students' specialty preferences.

1.4.1 Interest in rural practice

Beyond theoretical considerations of medical specialty choice, Germany has implemented policy-based approaches that aim to address the needs of the healthcare workforce through targeted applicant selection. One example of this is the *rural physician quota* ("Landarztquote"). To address the shortage of rural physicians (Kesternich et al., 2017; Winkelmann et al., 2020), the rural physician quota was introduced as part of the Masterplan Medizinstudium 2020 (Erschens et al., 2021; Kesternich et al., 2017). Since the winter semester of 2019/20, many federal states in

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Germany have implemented this quota, allocating a proportion of medical school places to applicants who commit to working in underserved rural areas after graduation (Geier et al., 2025; Stiftung für Hochschulzulassung, 2026). Failure to comply with this contractual obligation may result in substantial financial penalties and current studies are investigating the effects of the rural physician quota on medical education and workforce distribution (Geier et al., 2025).

Against this background, it is relevant to consider which factors previous research has identified as fostering interest in rural medical practice. Existing studies have highlighted several barriers that discourage medical students from rural practice, including geographic isolation and perceived risks to career development and further education (Roberts et al., 2012). To ensure adequate medical care in rural regions, it is therefore crucial to identify and promote factors that increase interest in working as a rural physician.

International studies suggest that work-related motivational factors, such as task variety and working conditions (Abbiati et al., 2020) are associated with intentions to practice in underserved areas. In addition, an interest in general medicine is consistently linked to a greater willingness to work in rural or small-town settings (Abbiati et al., 2020; Deutsch et al., 2014; Kawahito et al., 2023). Moreover, a substantial body of evidence shows that a rural background seems to be positively associated with interest in rural medical practice. Attending school in rural areas (Feldman et al., 2008; Mitra et al., 2018), having a rural origin (Assefa et al., 2017; Selch et al., 2021; Wendling et al., 2019), or completing more than half of residency training in rural areas (Russell et al., 2022) was associated with a higher likelihood of choosing rural practice. These findings suggest that exposure to rural living and working conditions can help to reduce negative preconceptions and encourage interest in pursuing a career in rural medicine. Practical experience during medical education or internships has been shown to increase interest in rural general practice or to reinforce pre-existing interest (Abid et al., 2020; Connell et al., 2022; Delport & Beckett, 2019; Jensen et al., 2017; Rhee et al., 2018). More comprehensive approaches include physician shortage area programs, implemented in countries such as the United States (Kost et al., 2014). These programs aim to encourage medical graduates to work in underserved rural areas and have proven to be

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effective in increasing interest in rural medical careers (Barthen et al., 2016; Johnson et al., 2018).

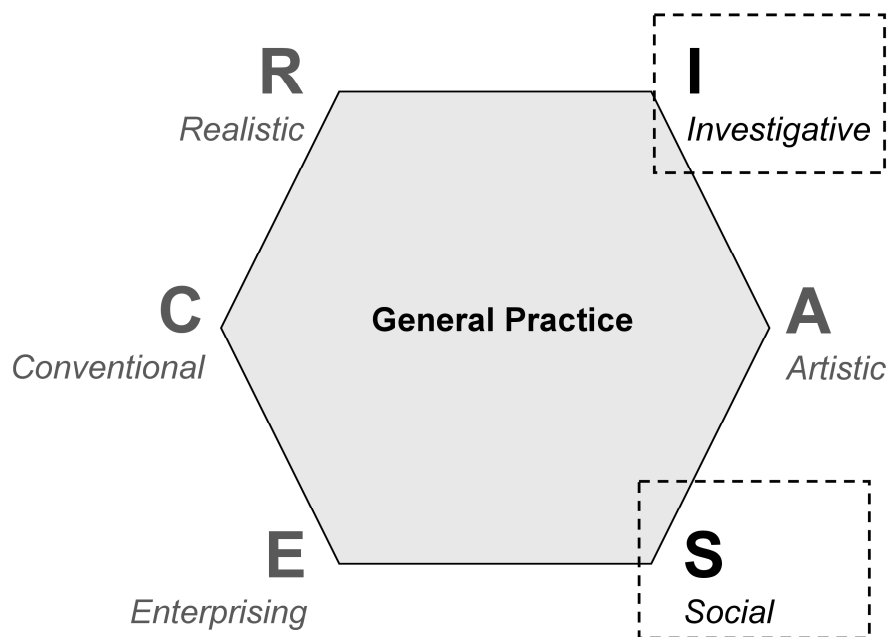
To better understand why some medical students are more inclined towards rural medical practice than others, it may be useful to consider individual vocational interest structures. According to Holland's RIASEC model, individuals are attracted to occupational settings that correspond to their interest orientations (Holland, 1997). Holland's theory (1997; 1969) distinguishes six broad interest types - Realistic, Investigative, Artistic, Social, Enterprising, and Conventional - arranged in a hexagonal structure (RIASEC). Beyond general career counseling (Morgan et al., 2019), the RIASEC model has also been applied to decisions within professions, including specialty choices in medical education. Evidence indicates that general practice and family medicine are commonly associated with social (S) interests, such as helping and teaching, and investigative (I) interests, including intellectual engagement and problem-solving (Borges et al., 2004; Gottfredson & Holland, 1996). Figure 2 illustrates the Holland hexagon, highlighting the dimensions of interest relevant to general practice. Given the overlap between general practice and rural medicine, it appears plausible that vocational interest patterns described by the RIASEC model may also be relevant for understanding interest in rural medical careers. However, research explicitly examining the relationship between RIASEC interest profiles and aspirations to work as a rural doctor remains scarce.

In addition to vocational interests, previous professional and academic experiences may further shape interest in rural practice. In particular, with regard to selection research, references to potential associations between prior experiences and specialist preferences could be relevant. Medical students who enter medical school with prior qualifications, such as practical experience in the medical sector or volunteer work, may show slightly greater interest in rural practice than students without such backgrounds (Erschens et al., 2021; Feldman et al., 2008). These experiences may foster familiarity with patient care and reinforce socially oriented motivations. Nevertheless, systematic research examining how professional and academic pre-qualifications relate to medical students' career aspirations remains limited, particularly with respect to rural practice (Erschens et al., 2021). Further studies are needed to examine the relationship between vocational

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interests and pre-qualifications, alongside established control variables such as rural origin and internships in rural areas, and interest in working as a rural physician.

Figure 2. Hexagonal representation of Holland's RIASEC model illustrating the six career types, with general practice shown as an example.



Note. The figure was cited from Schröpel et al. (2025b) and slightly adapted for this dissertation. Schröpel et al. (2025b) adapted the figure from the original model proposed by Holland et al. (1969)

1.5 The SamBaWü project as framework of this dissertation

The dissertation was conducted as part of the SamBaWü (“Selektion und Auswahl im Medizinstudium Baden-Württemberg”) research project. The SamBaWü project is a collaborative research initiative of the research network VSM-BW („Verbund Studierendenauswahl Medizin in Baden-Württemberg“, principle investigators: Prof. Dr. Stephan Zipfel, PD Dr. Rebecca Erschens). The study was conducted at all five medical faculties in Baden-Württemberg, namely Tübingen, Heidelberg, Mannheim, Freiburg, and Ulm. The project was funded by FestBW (“Fonds Erfolgreich Studieren in Baden-Württemberg”), a funding program of the Ministry of Science, Research and the Arts of Baden-Württemberg (MWK) to support higher educational institutions in the

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state of Baden-Württemberg. The project was funded under funding line 4 „Aptitude and Selection“. The overarching aim of SamBaWü was to investigate the potential influence of professional and academic pre-qualifications on academic success in medical studies as well as on subsequent medical specialization. The present dissertation addresses these main research questions and additionally examines the associations with study satisfaction. The project was approved by the Ethics Committees of the Faculty of Medicine at Tübingen University Hospital (No. 534/2019BO1).

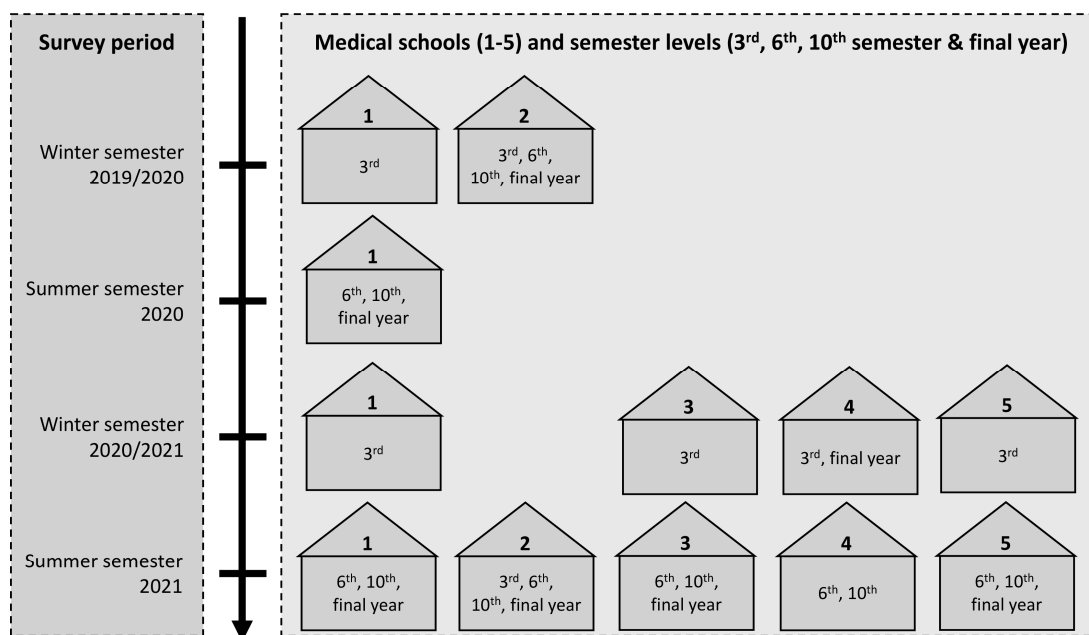
The study was a multicenter cross-sectional study conducted between the winter semester 2019/2020 and the summer semester 2021. At the five study sites, medical students from different stages of study (3rd, 6th, and 10th semesters, and final year) completed a questionnaire, either online via EvaSys or in paper-pencil format. Figure 3 illustrates the data collection process. Medical students received book vouchers as compensation for their participation. The overall questionnaire for the project included items addressing participants' socio-demographic background, study-related data, vocational interest orientations (Bergmann, 2003), preferences for specialist training, student burnout (Gumz et al., 2013), general self-efficacy (Schwarzer & Jerusalem, 1995), consciousness (Rammstedt et al., 2018), learning strategies (Klingsieck, 2019), and study satisfaction (Westermann et al., 1996).

One core component was a questionnaire developed by the project team to record professional and academic pre-qualifications. For each of the three pre-qualifications (i.e., vocational training, academic degree, voluntary service), questions were asked about the field in which the qualifying activity was acquired, whether the activity was completed, the final grade (if applicable), and - in the case of an academic degree or vocational training - whether the respondent subsequently worked in the field they had learned or studied, see Table 3 for the complete questionnaire. For the analyses, professional and academic pre-qualifications were operationalized as three dichotomous variables based on the questionnaire (see Schröpel et al., 2024). Based on the German admission criteria for medical studies (Stiftung für Hochschulzulassung, 2026), *vocational training* was defined as completed training in the medical field. The dichotomous variable (vocational training; yes vs. no) included only medical vocational

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trainings that were completed with a final grade. A *voluntary service* was also defined in accordance with the German admission criteria as a voluntary engagement with a minimum duration of 11 months (yes = completed voluntary service $\geq$ 11 months vs. no). Shorter services were not considered, as they are not taken into account in the admission process (Stiftung für Hochschulzulassung, 2026). An *academic degree* was defined as a completed degree program with a final grade (yes vs. no), without differentiating between bachelor's and master's degrees or between fields of study. This approach reflects the admission of second-degree students through the preliminary quota in Germany, which allows applicants to be considered irrespective of their previous field of study.

Figure 3. Structure of the data collection in the SamBaWü project across semesters, medical schools and survey periods.



Note. Figure was cited from Schröpel et al. (2025b), medical schools: 1= Heidelberg, 2= Tübingen, 3 = Freiburg, 4 = Mannheim, 5 = Ulm

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Table 3. *Questionnaire on professional and academic pre-qualifications.*

Vocational training	
Did you start or complete any vocational training before starting medical school?	Yes No
If yes, which type of training did you start or complete?	... in nursing ... in geriatric care ... in remedial care ... as a paramedic ... in another health profession/health sector (e.g. speech and language therapy, physiotherapy, medical assistant) ... in the pharmaceutical sector ... in a technical field (e.g. automotive engineering, electrical professions) ... in the field of creative work ... in the craft sector ... in another sector
The training was completed with the following overall grade:	[grade]
Did you start your training to increase the likelihood of being admitted to medical school?	Yes No
After you finished your vocational training, did you work in your trained profession? If yes, please indicate the duration (in years):	[years]
Academic degree	
Have you started or completed any other academic studies before medical school?	Yes No
If yes, which study programme did you start or complete?	... in the medical field (e.g. dentistry, molecular medicine human biology) ... in the field of nursing or health sciences ... in the field of pharmacy or pharmaceutical technology ... in STEM disciplines (e.g. mathematics, computing, biology, chemistry or physics) ... pedagogy and educational sciences ... in the field of psychology ... in the field of social work or social education ... in the field of home economics or nutritional sciences ... in another field
You have completed your studies with the following overall grade:	[grade]
After you finished your study programme, did you work in the field of your studies? If yes, please indicate the duration (in years):	[years]
Voluntary service	
Did you do any voluntary service before medical school?	Yes No

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If yes, in which area did you complete your voluntary service?	... health care ... care for the elderly ... care for the disabled ... child and youth welfare ... welfare ... in another field
The duration of the voluntary service (in months):	[months]
Did you do the voluntary service to increase the likelihood of being admitted to medical school?	Yes No

Note. Table was cited from Schröpel et al. (2024)

2 Aim of the present work

The overarching aim of this dissertation is to examine medical students with professional and academic pre-qualifications, a cohort that has received limited empirical investigation so far (Erschens et al., 2021). The review by Erschens and colleagues identified a research gap regarding objective performance indicators, subjective variables, and data specialty interests among medical students with prior qualifications. It also emphasized the need for large-scale studies that comprehensively examine this population. Building on the work of Erschens and colleagues, this dissertation aims to investigate the associations between different types of pre-qualifications and key outcomes in medical education, including academic performance, study satisfaction, and specialty preferences. The term “professional and academic pre-qualifications” refers, analogous to the German admission system, to completed vocational training in the medical field, at least eleven months of voluntary service (both of which can be taken into account via the AdH or the ZEQ), and previous studies regardless of the subject (second degree applicants). Since pre-qualifications are weighted in the German admission system, the question arises as to the extent to which they are associated with relevant training and career outcomes and the mechanisms through which these associations are mediated. To address these objectives, three studies were conducted, as illustrated in Figure 4.

Study 1 focuses on academic success, which is a criterion that carries substantial weight in selection and admissions research. The introduction revealed that academic success is not consistently defined in the literature and underscored the need for large multicenter studies to examine the associations between pre-qualifications and academic success using a more nuanced definition. To comprehensively operationalize academic success, the study examines multiple indicators, including grades obtained in the first (M1, “Physikum”) and second state examinations (M2), the number of repeated examinations, and adherence to the standard duration of study. The study investigates whether medical students with professional and academic pre-qualifications differ from those without such pre-qualifications in terms of academic success. As the first study, it

AIM OF THE PRESENT WORK

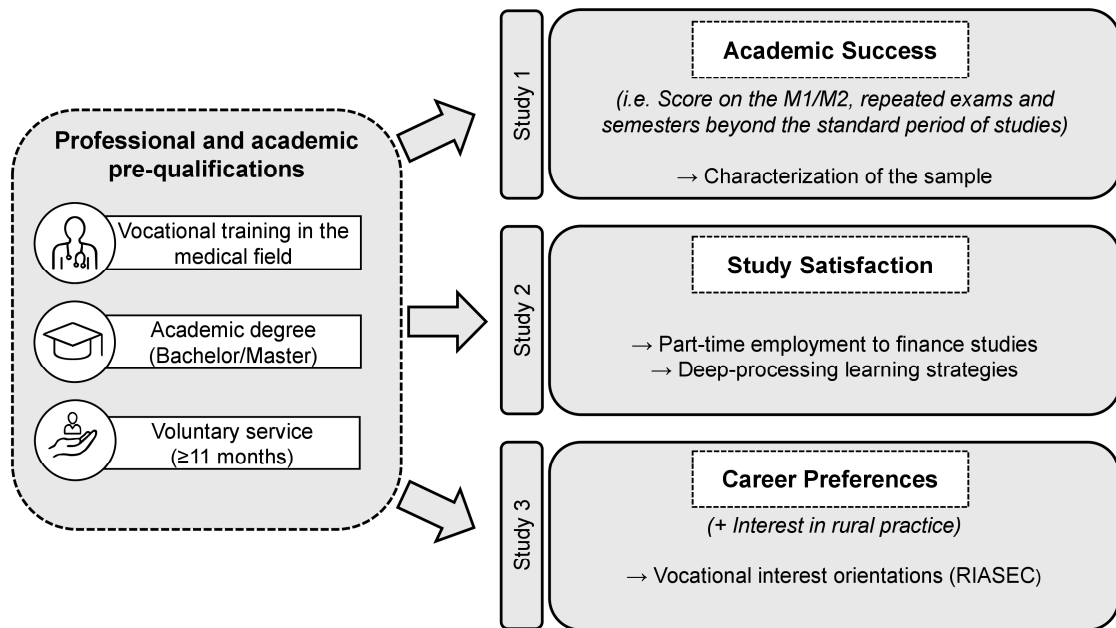
also provides a detailed characterization of the sample and a systematic description of the pre-qualifications.

Study 2 builds on the rather objective performance indicators examined in *Study 1* by analyzing medical students' levels of satisfaction as a subjective outcome. The introduction of this dissertation demonstrated that Westermann's (1996) three-dimensional model of study satisfaction, based on the concept of job satisfaction provides a differentiated framework for examining medical students' satisfaction with their studies. In the introduction it was also emphasized that prior experiences may foster the use of deep-processing learning strategies. Specifically, *Study 2* investigates whether professional or academic pre-qualifications are associated with satisfaction with the study contents, conditions and coping of study loads. Furthermore, the study examines whether these associations are explained by deep-processing learning strategies (i.e., elaboration and critical thinking) or by financing studies through part-time employment.

Study 3 examines differences in specialist preferences between medical students with and without the respective pre-qualifications. Particular emphasis is placed on interest in rural medical practice, as admissions policy in Germany is increasingly linked to healthcare and workforce goals, especially with regard to rural healthcare shortages. The study investigates how professional and academic pre-qualifications, as well as vocational interest orientations according to Holland's RIASEC model (Holland, 1997; Holland et al., 1969), which has so far found little application in specialist preferences, are associated with interest in practicing medicine in rural settings.

AIM OF THE PRESENT WORK

Figure 4. Overview of the three studies included in this dissertation.



Note. M1 = first state examination, “Physikum”; M2 = second state examination; RIASEC = Realistic, Investigative, Artistic, Social, Enterprising, Conventional

3 Results and Discussion

This dissertation comprises three studies, the results of which are reported below. This chapter reports the findings of each study separately, while a discussion of the overarching results is provided in Chapter 4. All three studies draw on the overarching study and dataset described in Chapter 1.5. *Study 1* examines the relationship between professional and academic pre-qualifications and academic success and provides a detailed description of the shared study sample across all three studies. *Study 2* examines the association between professional and academic pre-qualifications and study satisfaction, whereas *Study 3* examines the association with career preferences. The methodological approaches, key findings, research questions and hypotheses of the three studies are summarized in Table 4.

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Table 4. *Overview of the methodology and main findings of the studies included in this dissertation.*

	Study 1: Academic Success	Study 2: Study satisfaction	Study 3: Career Preferences
Research questions (RQ)/Hypotheses (H)	<u>RQ:</u> How are professional and academic pre-qualifications associated with academic success in medical school?	<u>Moderation:</u> The positive effect of elaboration and critical thinking on satisfaction with study contents is stronger within medical students with (H1a) completed vocational training in the medical field and (H1b) a prior academic degree than among students without these pre-qualifications. <u>Mediation:</u> vocational training (H2a)/academic degree (H2b) → financing studies more frequently through part-time employment → lower satisfaction with study conditions and coping of study loads. <u>Exploratory:</u> Does voluntary service affect study satisfaction?	<u>RQ1:</u> Do individuals with and without pre-qualifications differ in their preferences for specialty programs? <u>RQ1:</u> Do professional and academic pre-qualifications relate to interest in working as a rural doctor? <u>RQ1:</u> How do different vocational interests according to Holland's RIASEC model relate to interest in working as a rural doctor?
Dependent variables	<u>Academic success:</u> <ul style="list-style-type: none"> - Score on the M1 (very good, good, satisfactory, sufficient) - Score on the M2 (very good, good, satisfactory, sufficient) - Number of repeated exams (0, 1, 2, 3, ≥4) - Number of semesters beyond the standard period of studies (0, 1, 2, ≥3) 	<u>Study Satisfaction Questionnaire – Short Form FB-SZ-K; Westermann et al. (2018), subscales:</u> <ul style="list-style-type: none"> - Satisfaction with the study content (0-10) - Satisfaction with the study conditions (0-10) - Satisfaction with the coping of study loads (0-10) 	<u>RQ1:</u> Interest in 15 specialist programs (+ other), up to 3 preferences <u>RQ2+3:</u> Preference in working as a rural doctor (1-9)
Independent variables	<u>Professional and academic pre-qualifications:</u>	<u>Professional and academic pre-qualifications:</u>	<u>Professional and academic pre-qualifications:</u>

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	<ul style="list-style-type: none"> - Vocational training in the medical field (yes/no) - Academic degree (yes/no) - Voluntary service (yes/no) 	<ul style="list-style-type: none"> - Vocational training in the medical field (yes/no) - Academic degree (yes/no) - Voluntary service (yes/no) <p><u>Learning Strategies of University Students questionnaire - short version; LIST-K, Klingsieck (2019), deep-processing learning strategies</u></p> <ul style="list-style-type: none"> - Elaboration (1-5) - Critical thinking (1-5) <p><u>Interaction terms</u> (z-standardized): Vocational training*Elaboration Vocational training*Critical Thinking Academic degree*Elaboration Academic degree*Critical Thinking</p> <p><u>Mediator:</u> Financing studies through part-time employment (yes/no)</p>	<ul style="list-style-type: none"> - Vocational training in the medical field (yes/no) - Academic degree (yes/no) - Voluntary service (yes/no) <p><u>Vocational interests (Bergmann, 2003), Vocational interest in...</u> (grand-mean centered)</p> <ul style="list-style-type: none"> - social activities - intellectual-research activities - entrepreneurial activities - artistic-linguistic activities - practical-technical activities - orderly-administrative activities
Control variables	Gender, undergraduate GPA, level of experience, score on the M1	Gender (female, male), undergraduate GPA (mean-centered), age (mean-centered), medical school (A, B, C, D, ref: E), semester (3 rd , 6 th , 10 th , ref: final year)	Gender (female, male), age (mean-centered), semester level (3 rd , 6 th , 10 th , ref: final year), internship in general practice (planned, completed, ref: no), rural origin (yes/no), interest in general medicine (yes/no)
Analysis	<p><u>Ordinal logistic regression models</u> (distribution: multinomial, link: cumulative log odds)</p> <ul style="list-style-type: none"> - intercept-only model (between-school variance) <p><u>Post-hoc exploratory analysis:</u> <i>t</i>-tests and χ^2-tests</p>	<p><u>Confirmatory factor analysis (CFA)</u></p> <ul style="list-style-type: none"> - Robust maximum likelihood estimation (MLR) <p><u>Structural equation model (SEM)</u></p> <ul style="list-style-type: none"> - Maximum likelihood estimation (ML) - Bootstrapping (2000 samples) 	<p><u>RQ1:</u> Odds Ratio (OR), 95% confidence intervals (CI)</p> <p><u>RQ2 +3:</u> Linear mixed model with random intercept (restricted maximum likelihood estimation, REML)</p> <ul style="list-style-type: none"> - Level 2: survey period*medical school - Estimated marginal means (EMMs) to illustrate effects - Post-hoc sensitivity (G*Power)

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<p>Main findings</p>	<p>Vocational training → more repeated examinations (small effect) Academic degree → worse M2 scores (medium effect) Voluntary service → no significant relationship to academic success</p> <p><u>Exploratory analysis:</u> Especially for students with prior vocational training: associations with childcare responsibility and study financing type</p>	<p><u>Moderator Hypotheses:</u> not confirmed</p> <ul style="list-style-type: none"> - No moderating effects - Elaboration was positively and Critical Thinking associated with satisfaction with the study contents <p><u>Mediation hypotheses:</u> partly confirmed (small effects)</p> <ul style="list-style-type: none"> - Vocational training/academic degree → financing studies through part-time employment → lower satisfaction with the study conditions - Vocational training/academic degree → financing studies through part-time employment → higher satisfaction with the coping of study loads <p><u>Exploratory research question:</u></p> <ul style="list-style-type: none"> - Voluntary service → lower satisfaction with the coping of study loads 	<p><u>RQ1:</u> <u>Vocational training in the medical field</u></p> <ul style="list-style-type: none"> - Higher preference for Anesthesiology, General Medicine - Lower preference for Ophthalmology, Neurology, Otorhinolaryngology, Gynecology and Obstetrics, Psychiatry, Surgery, Radiology <p><u>Academic degree</u></p> <ul style="list-style-type: none"> - Higher preference for “Other” programs - Lower preference for Pediatrics <p><u>Voluntary service</u></p> <ul style="list-style-type: none"> - Higher preference for Anesthesiology, General Medicine, Radiology, Internal Medicine, Pediatrics - Lower preference for Ophthalmology, Otorhinolaryngology, Neurology, „other“, Surgery <p><u>RQ2+3:</u> pre-qualifications did not predict interest in rural practice</p> <ul style="list-style-type: none"> - Interest in practical-technical (realistic RIASEC type) and social activities (social RIASEC type) → more rural interest - Interest in intellectual-research activities (investigative RIASEC type) → less rural interest
<p>Other findings</p>	<p><u>Higher score on the M1:</u> higher undergraduate GPA, female students</p>	<p><u>Higher satisfaction with the study contents:</u> younger students, medical school (A,C,D>E)</p> <p><u>Higher satisfaction with the study conditions:</u> younger students, medical school (A,B,C,D>E)</p>	<p><u>Higher interest in working as a rural doctor:</u> older students, having planned or completed an internship in general practice, rural origin, interest in general medicine</p>

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	<p><u>Higher score on the M2:</u> higher (worse) undergraduate GPA, higher score on the M1</p> <p><u>Higher number of repeated exams:</u> higher undergraduate GPA, female gender, higher semester level</p> <p><u>Higher number of semesters beyond the standard period of studies:</u> female students, higher semester level</p>	<p><u>Higher satisfaction with the coping of study loads:</u> younger age, male gender, semester level (final year > 3rd, 6th)</p>	
Conclusion	<ul style="list-style-type: none"> - Professional and academic pre-qualifications pose no advantage to academic success - However, academic success was measured using mainly cognitive indicators and potential benefits may lie outside examination results 	<ul style="list-style-type: none"> - Encouraging elaboration (linking existing knowledge to new content) may enhance satisfaction regardless of pre-qualifications - Part-time work may conflict with the medical curriculum's structure but still help students to cope with academic challenges 	Professional identity shaped before medical school may influence specialty aspirations, but rural practice motivation depends more on underlying vocational orientations

3.1 Study 1: How professional and academic pre-qualifications relate to success in medical education

Schröpel, C., Festl-Wietek, T., Herrmann-Werner, A., Wittenberg, T., Schüttpelz-Brauns, K., Heinzmann, A., Keis, O., Listunova, L., Kunz, K., Böckers, T., Herpertz, S.C., Zipfel, S., & Erschens, R. (2024). How professional and academic pre-qualifications relate to success in medical education: results of a multicentre study in Germany. *PLoS One*, 19(3), e0296982. DOI: 10.1371/journal.pone.0296982

Every year, a large number of prospective students apply for a place at medical school (Bore et al., 2009). Medical schools therefore face the challenge of selecting candidates who can meet the demands of an intensive curriculum. However, admission research has largely focused on cognitive selection criteria, leaving the role of professional and academic pre-experience under-examined (Erschens et al., 2021). Moreover, academic success is often defined inconsistently across studies (Schröpel et al., 2024). To address this gap, this study examined how prior vocational training in the medical field, completion of a voluntary service, or possession of an academic degree are associated with academic success in medical school. Academic success was assessed using a broad set of performance variables, including scores on the first (M1, “Physikum”) and second state examinations (M2), the total number of repeated examinations and the number of semesters exceeding the standard period of study. Data were collected using a comprehensive questionnaire assessing medical students’ socio-demographic background, admission to medical school, study financing, other study-related aspects, and professional and academic pre-qualifications. For each outcome variable, ordinal logistic regression models were calculated (distribution: multinomial, link: cumulative log odds). Given the multi-level structure of the data, an intercept-only model was estimated to test for significant variations between-school variance across five participating medical schools. As no significant level-2 variance was found, subsequent analyses were conducted as single-level models. Gender, undergraduate GPA (“Abitur”), and experience level were added as control variables. In the model predicting M2 grades, performance on the M1 was additionally included as a predictor. The analyses showed that a total of 2,370 medical students participated in the study, the majority of whom were female (65%). Overall, 28% of all medical students reported

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having completed vocational training in the medical field prior to medical school, primarily as paramedics or nurses. A smaller proportion (6%) had completed an academic degree, primarily in STEM (Science, Technology, Engineering and Mathematics) or medical-related subjects. Additionally, 23% of all students reported a completed voluntary service, primarily in the health sector. The ordinal regression models revealed that professional and academic pre-qualifications did not significantly contribute to the models predicting M1 scores or the number of semesters beyond the standard period of study. However, having completed vocational training was associated with a slightly higher number of repeated examinations (small effect). In contrast, holding an academic degree was linked to poorer performance on the second state examination, with a medium effect size. No significant associations were found for voluntary service.

The findings suggest that professional and academic pre-qualifications do not confer an advantage in academic performance. In an exploratory analysis, associations between professional and academic pre-qualifications and selected sociodemographic characteristics were examined to provide potential explanations and a stronger basis for interpreting the results. This exploratory analysis suggests that medical students with prior vocational training may more frequently experience additional burdens, such as financing their studies through part-time employment, caring for children, or relying on savings, partners, or loans. These factors may limit the time available for studying and contribute to a higher number of repeated examinations. Students with vocational training were also less likely to report having parents with a tertiary degree and reported worse undergraduate GPAs (“Abiturnote”), which may reflect differences in educational opportunities associated with family educational background (Becker & Hecken, 2008). A prior academic degree was associated with poorer M2 performance, which may reflect longer educational pathways, differing life or financial circumstances (e.g. reduced financial support from parents or relatives as found in the exploratory analysis of *Study I*), as well as pre-existing academic differences, as indicated by worse undergraduate GPA in this group. Consistent with prior findings, no association were observed between pre-medical volunteering and academic success. This lack of association may reflect the typically limited duration of a voluntary service which may not be sufficient to measurably influence performance in medical school. The study

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makes an important contribution, as there is still limited research on the relationship between pre-qualifications and academic success (Erschens et al., 2021). To summarize, professional and academic pre-qualifications posed no advantage to academic success. However, this finding warrants cautious interpretation, as academic success was operationalized using objective and performance-related indicators; the benefits of prior experience may instead manifest through personal attributes not captured by examination outcomes.

RESEARCH ARTICLE

How professional and academic pre-qualifications relate to success in medical education: Results of a multicentre study in Germany

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OPEN ACCESS

Citation: Schröpel C, Festl-Wietek T, Herrmann-Werner A, Wittenberg T, Schüttelz-Brauns K, Heinzmann A, et al. (2024) How professional and academic pre-qualifications relate to success in medical education: Results of a multicentre study in Germany. PLoS ONE 19(3): e0296982. <https://doi.org/10.1371/journal.pone.0296982>

Editor: Ayse Hilal Bati, Ege University Faculty of Medicine, TURKEY

Received: September 4, 2023

Accepted: December 25, 2023

Published: March 8, 2024

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Data Availability Statement: There are legal restrictions on sharing this deidentified data set. Due to the high confidentiality of the data, the authors of the study received permission from the Medical Faculty of Tübingen to conduct the study and to collect these data only if they were not made publicly available without individual permission for specific questions (i.e. on request). Data requests may be sent to Prof. Dr. med. Stephan Zipfel, Medical University Hospital Tuebingen, Osianderstr. 5, 72076 Tuebingen/Germany

Abstract

Objective

Every year, many applicants want to study medicine. Appropriate selection procedures are needed to identify suitable candidates for the demanding curriculum. Although research on medical school admissions has shown good predictive validity for cognitive selection methods (undergraduate GPA, aptitude tests), the literature on applicants with professional and/or academic experience prior to entering medical school remains slim. In our study, we therefore aimed to examine the association between academic success in medical school and having previously completed vocational training in the medical field, voluntary service (≥ 11 months) or an academic degree.

Methods

Data were collected in a multicentre, cross-sectional study at five medical schools in Germany (Baden-Wuerttemberg) from students during medical school (i.e. 3rd-, 6th-, and 10th-semester and final-year students). Academic success was assessed according to scores on the first and second state examinations, the total number of examinations repeated and the number of semesters beyond the standard period of study. For the analysis we calculated ordinal logistic regression models for each outcome variable of academic success.

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Funding: The project was funded by the Ministry of Science, Research and the Arts of the State of Baden-Württemberg (AZ:23-0421.918-4(18)/UNI Tü, AZ: 0421.918-4/31/1, AZ: 23-0421.918-4/53/2) within the framework of "Studying Successfully in Baden-Württemberg - Funding Line 4 Aptitude and Selection". The funder had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

Competing interests: The authors have declared that no competing interests exist.

Results

A total of $N = 2,370$ participants (response rate: $RR = 47\%$) participated in the study. Having completed vocational training was associated with a higher amount of repeated examinations (small effect), while having an academic degree was associated with worse scores on the second state examination (medium effect). No significant association emerged between voluntary service and academic success.

Conclusion

The results indicate that professional and academic pre-qualifications pose no advantage for academic success. Possible associations with the financing of study and living conditions of students with pre-qualifications were analysed and discussed in an exploratory manner. However, the operationalisation of academic success from objective and cognitive data should be critically discussed, as the benefits of prior experience may be captured by personal qualities rather than examination results.

Introduction

Medical school admissions process

Professional and academic experience can shape people and influence how people think and act. Individuals who choose to pursue further education—for example, to study medicine after completing paramedic training—may begin that education with a different perspective and a broader range of experiences than ones without such prior experience. Prior practical experience may also be advantageous in getting admitted to medical school [1]. However, the literature addressing the role of professional and academic pre-qualifications in medical school admissions and their impact on medical students' academic success remains slim. Nevertheless, research on appropriate criteria for selecting students to admit into medical school is important. On the one hand, the pool of applicants is large; on the other, the aim of medical schools is to admit students who are suitable for the medical profession [2].

Reviews on such selection methods have shown that overall undergraduate grade point average (GPA) and grades are significant predictors of academic success in medical school [3,4]. *Academic success* has been defined as referring to examination scores and other data regarding academic performance [5–8], as well as the number of examinations passed [9]. However, GPA alone as a criterion for selecting students for medical school becomes problematic when too many applicants with excellent grades apply [10]. Aptitude tests can measure cognitive skills other than qualifications earned upon exiting school [11] and help schools to select appropriate applicants. Of course, different aptitude tests are used in different countries. In the United Kingdom, the UK Aptitude Test or Biomedical Admissions Test are used to select medical students, and scores on both are associated with academic success [12,13]. In the United States and Canada, another aptitude test, the Medical School Admission Test, has also been shown in a meta-analysis to have low to moderate predictive validity for performance in medical school and the results of licensing examinations [14]. Meanwhile, in Germany, the Test for Medical Studies (TMS) used in medical school admissions has also been shown to significantly predict performance in medical school [5,15]. Even so, aptitude tests or school grades do not capture personal skills that may be important for studying medicine, including social skills, resilience and adaptability [16].

The literature shows that non-cognitive factors such as self-efficacy, effort and grade goal setting are positively associated with academic success [17–19]. However, there are few validated measures of non-cognitive factors that are actually used in the medical admissions process. For the valid assessment of non-cognitive data, Mini Mental Interviews (MMI) are a more effective method than unstructured interviews [3]. In MMIs, the non-cognitive attributes of applicants are recorded at different interview stations, similar to an objective structured clinical examination (OSCE) [20], and the interview process can be adapted to the specific medical school's needs [21]. Other non-cognitive methods to assess personal qualities in the selection of medical students are Situational Judgement Tests (SJT) and tests assessing personality and emotional intelligence [3]. According to Patterson et al. [3], properly constructed SJTs are valid tools for medical selection, while the assessment of personality and emotional intelligence can be effective, but there may be a risk of faking or coaching. Internationally, medical schools continue to focus on cognitive performance in admissions rather than considering personal qualities [22]. Assessing prior qualifications may be an efficient way of identifying candidates who have already developed or tested their personal qualities through their previous experience.

Professional pre-qualifications and academic success

In Germany, practical experience assessed using a points system can increase the likelihood of gaining a place at medical school. The selection process for medical studies in Germany follows centralised regulations and criteria. These regulations have been changed several times in recent decades [23]. Since 2020, medical schools have been required to allocate 10% of the available places on the basis of criteria independent of grades including vocational training, professional experience in the medical field, voluntary service, awards in education-related competitions, results of validated aptitude tests, situational judgement tests and interviews [24]. A further 30% of all study places are allocated based on the best undergraduate GPA and for overall 60% of all places, medical schools have been individually able to prioritise both criteria based on school leaving grades and criteria independent of grades via the “university selection procedure” (in German: “Auswahlverfahren der Hochschule, AdH”) [24]. However, previous practical experience has already been considered, both directly and indirectly, in the selection before 2020. On the one hand, the AdH has been in place since the winter semester 2005/2006. Since then, medical schools have been able to decide individually for 60% of the available places whether and how to weight criteria independent of school-leaving grades, such as vocational training, voluntary work, etc. For a detailed description on the AdH and medical school selection process in Germany see [25]. On the other, until 2020 (transition period until 2022) Germany applied the so-called “waiting list quota”. This quota could increase the chances of admission to medical school for people who had waited a certain number of semesters for admission. From winter semester 2005/2006 onwards, 20% of all available study places were allocated according to this quota. During their waiting time, these applicants had often already completed a related vocational training (e.g. nursing, paramedics) [26].

To date, few studies have examined the relationship between prior professional or academic qualifications and academic success. In a review, Erschens et al. [25] summarised studies that examined how completing vocational training influences academic success. Although studies on the topic were too few to draw any clear conclusions, the authors did identify a trend, at least in the preclinical part of the study, of a slight disadvantage among students with vocational training in terms of data concerning academic performance and the number of examinations passed [9,27]. However, other evidence suggests the positive impact of prior vocational training on academic success. In a recent study, Amelung et al. [5] found that vocational

training positively affected performance on all examinations in the first two years of study. They thus suggested that such medical students may have acquired important skills during their training that led to better performance—for example, higher levels of stress resistance and medical knowledge. Still other evidence indicates that medical, nursing and physician associate's-degree students with previous experience in healthcare may have a clearer idea of the professional roles of healthcare professionals and therefore a better understanding of the needs and concerns of the different members on medical teams [28].

Similar to having completed vocational training, earning an academic degree indicates having already completed a full education. In admissions for medical study in Germany, applicants with a second degree are considered for a preliminary quota, along with other quotas for foreigners and cases of hardship [29]. Nevertheless, no research has produced results showing how studying before entering medical school affects the course of medical study. On a smaller scale, people who have completed voluntary service, similar to ones who have completed vocational training, have already been able to gain practical experience before attending medical school. In Germany, voluntary service of at least 11 months, including social and ecological service, is considered in the allocation of places for medical study. However, when Hampe et al. [9] examined that particular subgroup, they found no significant advantage of academic performance for medical students who had completed voluntary service before their studies.

Integration of findings

In our study, we focused on applicants who had already gained practical experience over a longer period or acquired knowledge or competence through study. Having completed an academic degree, voluntary service or vocational training in the medical field is summarised in our study as “professional and academic pre-qualifications”. On the one hand, applicants with professional and academic pre-qualifications have already acquired practical knowledge (e.g. in vocational training or voluntary service) or theoretical knowledge (e.g. in university), which may make it easier for them to study medicine. On the other, medical study is further education for applicants with prior vocational training or an academic degree. For this subgroup, some time has passed since they graduated from school and due to changed life circumstances (part-time job, family) other priorities than getting the best grades might be important. Furthermore, the experience of voluntary service may not be sufficient to influence performance in medical studies due to the short duration of one year.

However, because research examining how professional and academic pre-qualifications impact success in medical school remains slim [25], we sought to investigate this association in our study. To examine that relationship as broadly as possible we collected data from medical students in different semesters (i.e. 3rd-, 6th-, and 10th-semester and final-year students) at five medical schools using different outcome variables to assess academic success. The aim of our study was:

- To analyse the associations between professional and academic pre-qualifications (i.e. voluntary service, academic degree and vocational training in the medical field) and academic success of medical students (i.e. scores on the 1st and 2nd state examinations, the total number of examinations repeated and the number of semesters beyond the standard period of study).

Materials and methods

Design and sample

This cross-sectional, multicentric study was conducted at five medical schools in Germany. For the present study, at each school, medical students at different stages of their medical

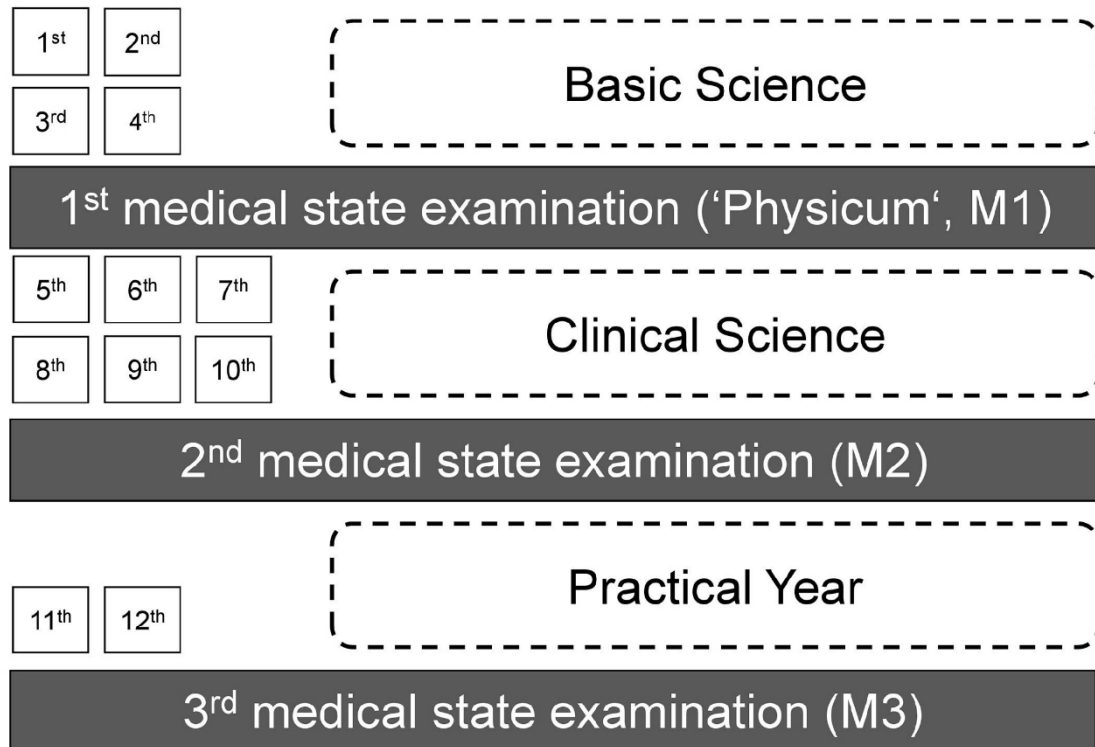
Semester:

Fig 1. Illustration of the structure of the medical curriculum with regard to the timing of the three major examinations in Germany (state examinations M1–M3) and semester levels. This figure is an adaption from Erschens [30].

<https://doi.org/10.1371/journal.pone.0296982.g001>

education—that is, students in their 3rd, 6th or 10th semester or in their final year of study—were invited to participate via email or recruited during lectures.

Setting

The standard duration of medical study in Germany is 12 semesters (i.e. 6 years). Along with the regular examinations in each semester, medical students need to pass three major examinations (i.e. state examinations M1–M3). Completing the so-called final year and passing the M3 marks the end of medical education and permits newly qualified doctors to begin additional specialty training. Fig 1 is a figure adapted from Erschens [30] and illustrates the different semester levels and timing of the state examinations.

Measures and procedure

The study was conducted as part of a collaborative research project titled “Pre-qualifications for Human Medicine” focused on the relationship between pre-qualifications, academic success and other study-related co-variables. The data presented here represent the main -analysis

of this project, focusing on variables that assess academic success. The overall questionnaire for the project included items addressing participants' socio-demographic background (e.g. age, living situation and parents who work in the medical field), admissions to medical school, how they were financing their studies and other study-related aspects. Sub-questions on secondary outcome variables including professional burnout, student satisfaction, preferences for speciality training and learning strategies will be published elsewhere. These sub-questions can be clearly distinguished from each other. The data collection took place between the winter semester 2019/2020 (beginning 1st of October) and the summer semester 2021 (30th of September). Data were collected from all relevant semesters at each of the five medical schools. The exact start and end dates of the survey varied between medical schools and semesters for organisational reasons (e.g. different timetables, different dates for presenting the study during lectures). At the end of the survey period, medical students in the same semester were grouped together, regardless of when they completed the questionnaire. The survey was anonymous, and participants provided their informed consent (written or online) to participate before completing the online or paper-and-pencil questionnaire.

Academic and professional pre-qualifications. In a team of experts, we developed a questionnaire addressing professional and academic pre-qualifications, including items on vocational training, studies and voluntary service prior to medical study. For all three types of pre-qualifications, questions inquired into the area in which the activity conferring the qualification was gained, whether the activity was completed, the final grade when applicable and, in the case of an academic degree or vocational training, whether the activity was followed by work in the same area of training or study. Because practical experience (e.g. voluntary work and vocational training) is and has been considered in admissions to medical school in Germany (the emphasis and weighting varies between medical schools), another question inquired into whether the activity was started in order to increase the likelihood of gaining a place at medical school. See [S1 Table](#) in the appendix for the full questionnaire. Based on the admissions criteria for medical school in Germany [24], we defined *vocational training* as completed professional training in the medical field. To create the variable vocational training (yes, completed vocational training in the medical field vs. no), only vocational training that was completed with a grade and that was completed in the medical field was included. Also based on the German admission criteria for medical school, *voluntary service* was defined as volunteer work lasting at least 11 months (yes, completed voluntary service of at least 11 months vs. no). As a voluntary service of less than 11 months is not considered for admission to medical school in Germany, it was therefore not included in the definition. Last, we defined an *academic degree* as a degree completed with a grade and made no distinction between bachelor's and master's degrees or the areas of study (yes, prior academic degree vs. no). We chose this definition because in Germany the preliminary quota allows second degree students to be considered regardless of the subject studied.

Academic success. To measure academic success, we examined four ordinal variables, shown in [Fig 2](#). Due to centralised examination dates in Germany, grades for the second state examination are only available in later semesters.

Ethics

The study was approved by the Ethics Committees of the Faculty of Medicine at Tübingen University Hospital (No. 534/2019BO1). All methods were carried out according to the Declaration of Helsinki Association (2013). Participation in the study was voluntary and participants gave their informed consent (written or online). Book vouchers were distributed to participants as compensation.

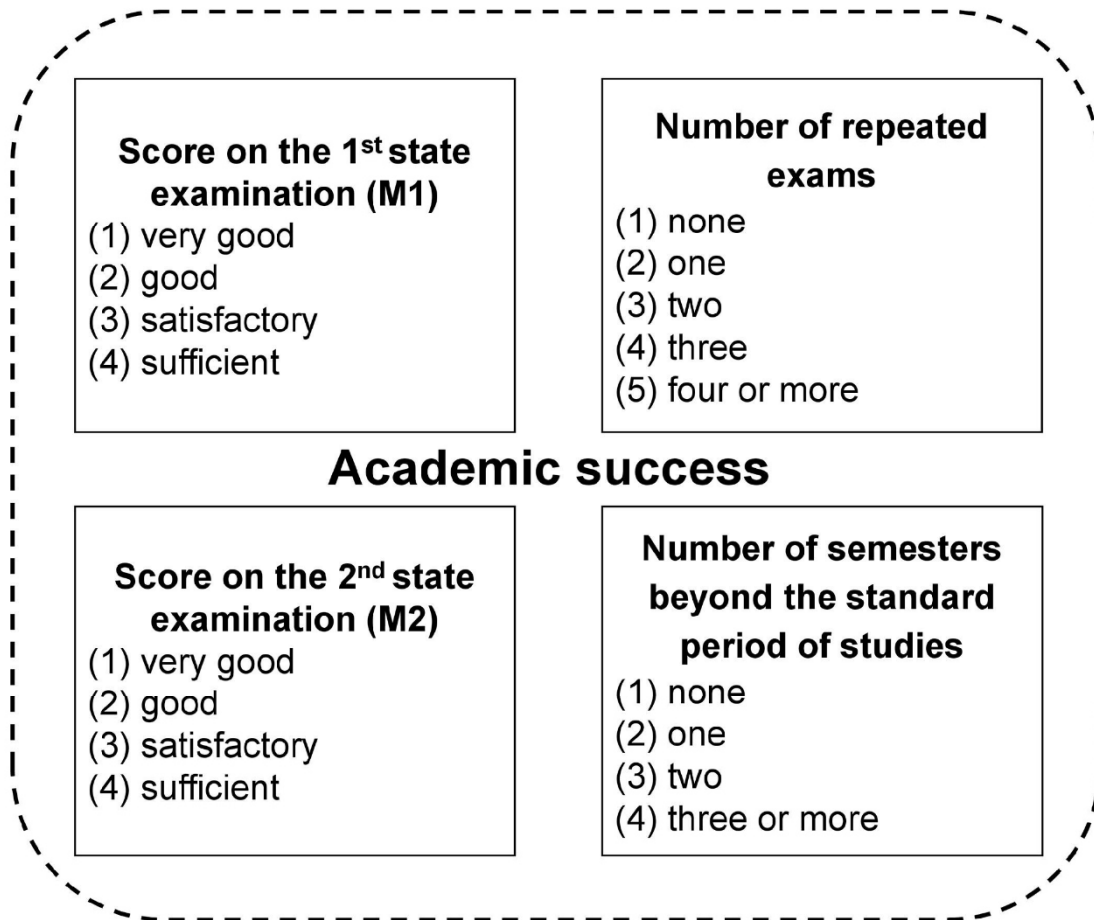


Fig 2. This figure illustrates the four dependent variables used in our study to assess academic success. Each variable has an ordinal response format, with higher numbers indicating lower academic success.

<https://doi.org/10.1371/journal.pone.0296982.g002>

Statistical analysis

For all analyses, we used SPSS version 28.0.0.0 (IBM, Armonk, NY, USA), and percentages were rounded to the nearest whole number. Given the cross-sectional design of the study, we did not perform a power analysis prior to the study. Due to the multicentre structure of the data, a multilevel approach with ordinal outcome was chosen for the analysis; the distribution function was multinomial, while the link was cumulative log odds. In an intercept-only model we tested for significant variations across the five different medical schools, and if no level 2 differences were found, then single-level models were conducted. For single-level ordinal regression analysis, we checked for multicollinearity and the proportional odds assumption; the higher the category of the four outcome variables, the worse the academic success. Meanwhile, the predictor variables were vocational training, academic degree and voluntary service (yes = 0, no = 1). For missing values, the corresponding case was excluded, and the level of

significance was set at $\alpha < .05$. We also calculated odds ratios (ORs) to determine the effect size, which we interpreted following Chen et al. [31] according to values of approximately 1.5 (small effect), approximately 3.0 or more (medium effect), and approximately 5.0 (large effect).

Control variables. We added gender (female = 0, male = 1) and undergraduate GPA (in German, 'Abitur', in which lower numbers indicate of better grades) to all four models. In the model to predict grades on the M2, we added score on the M1 as a predictor variable. In the models to predict the number of repeated examinations and the number of semesters beyond the standard period of study, we added a control variable, level of experience with medical school, as a metric predictor (i.e. levels 0–11, with each semester corresponding to one level); it was added to control for the potential accumulation of repeated examinations and semesters beyond the standard period of study as the number of semesters increased.

Results

Response rate and sample description

Altogether, $N = 2,370$ medical students (i.e. in their 3rd, 6th, or 10th semester or final year), participated in the study. The response rate was about 47%. As part of the survey was conducted online, we cannot confirm whether the respondents actually received the email with the invitation. If the response rate would have been calculated based on the number of people who actually read the email rather than the number of email addresses, it would probably be higher. It is possible that some recipients may not have opened the email, e.g. due to illness, parental leave, a semester abroad or similar. However, for technical reasons, we do not know the number of emails opened.

Most medical students were female ($n = 1,521$, 65%); participants' ages ranged between 18 and 45 years ($M = 24.40$, $SD = 3.78$). On average, medical students reported an undergraduate GPA of $M = 1.48$ ($SD = 0.53$). Descriptively, medical students in different semesters reported similar proportions of having completed vocational training in the medical field, with the highest percentage in the 6th semester (30%) and the lowest percentage in the final year (23%). The proportions of medical students who reported having completed an academic degree prior to medical school were also similar across semesters, with the highest percentage in the 6th semester (7%) and the lowest percentage in the final year (5%). Also, the proportions of medical students reporting having completed a voluntary service were similar across semesters, with the highest percentage in the 6th semester (26%) and the lowest percentage in the final year (19%). Table 1 provides an overview of the distinct characteristics of the different semester levels in the sample.

Professional and academic pre-qualifications

Overall, $N = 1,060$ participants (45%) reported having completed at least one of the three professional and academic pre-qualifications. The greatest overlap surfaced among participants who had completed vocational training and voluntary service; of all individuals who had completed vocational training, approximately 40% also completed a voluntary service. Fig 3 shows the numbers of participants with single, double and triple qualifications. Approximately 28% ($n = 655$) of all medical students reported having completed vocational training in the medical field prior to their studies. Training as a paramedic (43%, $n = 283$) or nurse (36%, $n = 238$) was most commonly reported, and most reported having completed vocational training to increase their chance of being admitted to medical school (67%, $n = 435$). Meanwhile, approximately 6% ($n = 145$) reported having an academic degree. Most students had a degree in a STEM subject (30%, $n = 44$; i.e. science, technology, engineering and mathematics) or in the medical field (28%, $n = 41$; i.e. dentistry, molecular medicine and human biology). Approximately 23% ($n = 546$) of

RESULTS AND DISCUSSION

Table 1. Overview on the characteristics of the different semester levels in the sample.

		semester				total sample
		3 rd	6 th	10 th	final year	
<i>N</i>	<i>n</i> (%)	635(27)	729(31)	485(20)	521(22)	2370 (100)
<i>age [years]</i>	<i>M</i> (<i>SD</i>)	22.17(3.58)	23.98(3.41)	25.66(3.34)	26.51(3.24)	24.40 (3.78)
	<i>range</i>	[18,43]	[19,45]	[21,41]	[19, 42]	[18, 45]
gender						
	female	<i>n</i> (%)	413(65)	464(64)	312(65)	1521(65)
	male	<i>n</i> (%)	218(34)	255(35)	167(35)	826(35)
	diverse	<i>n</i> (%)	1(<1)	2(<1)	0(0)	4 (<1)
undergraduate GPA ¹	<i>M</i> (<i>SD</i>)	1.48(0.54)	1.49(0.51)	1.48(0.54)	1.48(0.52)	1.48(0.53)
	<i>range</i>	[1.00,3.40]	[0.80,3.70]	[0.70,3.50]	[1.00,3.30]	[0.70,3.70]
professional and academic pre-qualifications						
	vocational training	<i>n</i> (%)	185(29)	218(30)	132(27)	655(28)
	academic degree	<i>n</i> (%)	37(6)	53(7)	28(6)	145(6)
	voluntary service	<i>n</i> (%)	161(25)	189(26)	97(20)	546(23)

Note. Percentages rounded to the nearest whole number.

¹undergraduate grade point average, in "German Abitur", lower numbers stand for better grades.

<https://doi.org/10.1371/journal.pone.0296982.t001>

all students reported engaging in voluntary service. Most had volunteered in the health sector (40%, $n = 215$) or in a sector not listed as an option on the questionnaire (42%, $n = 229$). A detailed description of the professional and academic pre-qualifications appears in Table 2.

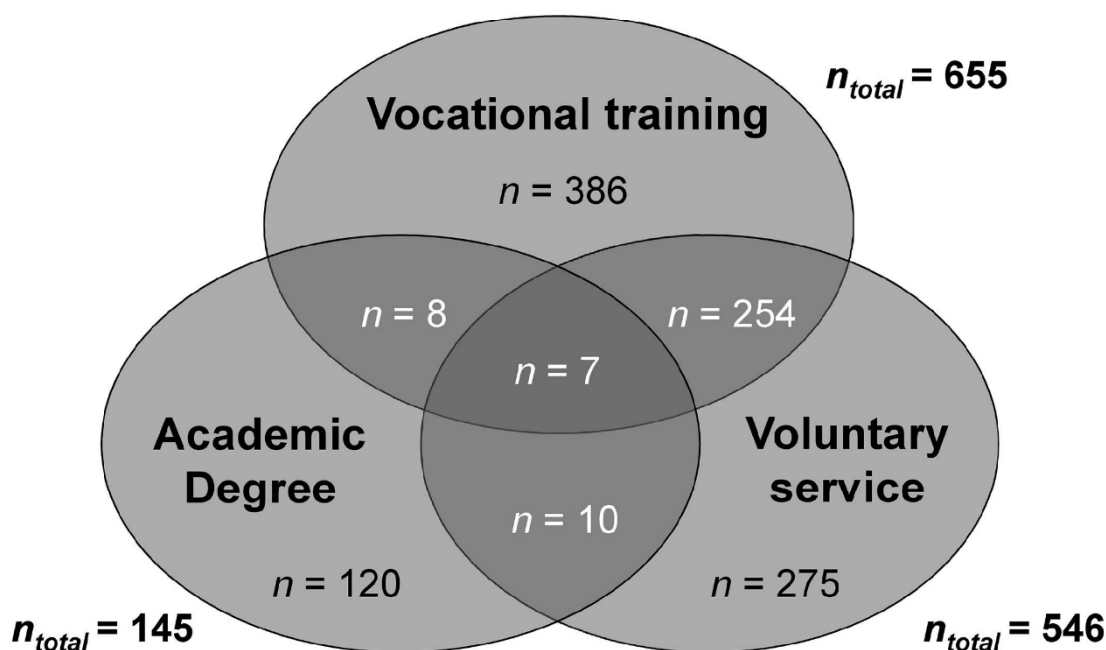


Fig 3. This figure illustrates the number of reported single, double and triple pre-qualifications. Overlaps are presented in a darker colour. The number of students who completed all three qualifications before medical school is shown in the centre of the three circles.

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Table 2. A detailed description of the type, extent and other characteristics of professional and academic pre-qualifications in the sample.

	total sample	
	<i>n</i>	%
vocational training in the medical field		
yes	655	28
no	1707	72
area		
paramedic	283	43
nurse	238	36
health sector ¹	128	20
pharmaceutical sector	4	1
geriatric care	2	<1
remedial care	0	0
completed training to increase chances of being admitted to medical school		
yes	435	67
no	214	33
final grade of the training		
<i>M(SD)</i>	1.62(0.53)	
range	[1.00,3.60]	
work experience in years		
<i>M(SD)</i>	2.99(2.53)	
range	[0.20,19.00]	
university degree		
yes	145	6
no	2214	94
area		
STEM ²	44	30
medical field ³	41	28
field of psychology	14	10
nursing and health sciences	5	3
pedagogy and educational sciences	3	2
home economics or nutritional sciences	3	2
pharmacy or pharmaceutical technology	1	1
social work, social education	1	1
other	33	23
final grade		
<i>M(SD)</i>	1.54(0.45)	
range	[1.00,2.80]	
voluntary service (≥ 11 months)		
yes	546	23
no	1813	77
area		
health care	215	40
child and youth welfare	55	10
care for the disabled	28	5
care of the elderly	16	3
welfare	1	<1
in another field	229	42

(Continued)

Table 2. (Continued)

	total sample	
	<i>n</i>	%
voluntary service to increase chances of being admitted to medical school		
yes	257	47
no	288	53

Note. n.a. = not available; percentages rounded to the nearest whole number.

¹including speech and language therapists, physiotherapists and medical assistant

²including mathematics, computing, biology, chemistry or physics

³including dentistry, molecular medicine, human biology.

<https://doi.org/10.1371/journal.pone.0296982.t002>

Professional and academic pre-qualifications and academic success

The intercept did not vary significantly across the five different medical schools for any outcome variables: score on the M1 ($z = 1.28, p = .201$), score on the M2 ($z = 0.84, p = .401$), number of repeated examinations ($z = 1.31, p = .189$) and number of semesters beyond the standard period of study ($z = 1.31, p = .191$). Thus, we conducted single-level models without controlling for medical school. The model's assumptions concerning proportional odds were met for all ordinal regression models, and no multicollinearity emerged between the independent variables with a variance inflation (VIF) factor between 1.01 and 1.81 [32]. All of the results of the ordinal regression are shown in Table 3.

None of the professional and academic pre-qualifications contributed significantly to the model with score on the M1 as dependent variable. However, both control variables contributed significantly to the model. The odds of having higher scores on the M1 increased with increasing undergraduate GPA ($OR = 3.54$). For female students, the odds of having higher scores on the M1 were higher than for male students ($OR = 2.01$).

The odds of having a higher score on the M2 were higher for students with than without an academic degree (medium effect, $OR = 3.29$); however, no effect emerged for having completed vocational training or voluntary service. All control variables except for the variable gender contributed significantly to the model. The odds of having a higher score on the M2 increased with increasing undergraduate GPA ($OR = 2.15$) and increasing M1 grades ($OR = 4.31$).

For students with prior vocational training, the odds of reporting more repeated examinations were higher than for students without prior vocational training (small effect, $OR = 1.61$); however, no effect surfaced for a prior academic degree or completed voluntary service. All control variables contributed significantly to the model. The odds reporting more repeated examinations were higher for female than for male students ($OR = 1.34$). With increasing undergraduate GPA ($OR = 2.63$) and level of experience ($OR = 1.11$), the odds of reporting more repeated examinations increased.

None of the professional and academic pre-qualifications contributed significantly to the model with the number of semesters beyond the standard period of study as the dependent variable. All control variables except for undergraduate GPA contributed significantly to the model. For female students, the odds of reporting a higher number of semesters beyond the standard period of studies were higher than for male students ($OR = 1.54$). With increasing level of experience the odds of reporting a higher number of semesters beyond the standard period of studies increased ($OR = 1.60$).

All significant p values would have survived Bonferroni correction for multiple testing ($\alpha_{adj} = \alpha/4$).

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Table 3. Results of the ordinal logistic regression models for the four variables measuring academic success.

Score on the M1, $\chi^2(5) = 230.82, p < .001$; $n = 1656$, Mc Fadden $R^2 = .06$						Score on the M1: very good = 24%, good = 45%, satisfactory = 25%, sufficient = 6%
	β	$SE(\beta)$	p	OR	95%CI(OR)	
predictors						
vocational training	0.24	0.13	.070	1.27	[0.98, 1.65]	
academic degree	0.22	0.19	.260	1.24	[0.85, 1.82]	
voluntary service	0.03	0.11	.810	1.03	[0.82, 1.29]	
undergraduate GPA	1.26	0.12	< .001***	3.54	[2.80, 4.47]	
gender	0.70	0.10	< .001***	2.01	[1.65, 2.45]	
Score on the M2, $\chi^2(6) = 182.84, p < .001$ $n = 409$, Mc Fadden $R^2 = .22$						Score on the M2: very good = 2%, good = 49%, satisfactory = 41%, sufficient = 8%
	β	$SE(\beta)$	p	OR	95%CI(OR)	
predictors						
vocational training	0.16	0.30	.599	1.17	[0.65, 2.09]	
academic degree	1.19	0.43	.005**	3.29	[1.42, 7.59]	
voluntary service	0.14	0.27	.595	1.15	[0.68, 1.95]	
M1 grades	1.46	0.15	< .001***	4.31	[3.20, 5.81]	
undergraduate GPA	0.77	0.27	.004**	2.15	[1.28, 3.63]	
gender	-0.09	0.22	.671	0.91	[0.59, 1.41]	
Number of repeated exams, $\chi^2(6) = 272.98, p < .001$ $n = 2289$, Mc Fadden $R^2 = .06$						Number of repeated exams: none = 66%, one = 16%, two = 8%, three = 5%, $\geq$ four = 5%
	β	$SE(\beta)$	p	OR	95%CI(OR)	
predictors						
vocational training	0.47	0.12	< .001***	1.61	[1.27, 2.03]	
academic degree	-0.12	0.19	0.539	0.89	[0.61, 1.29]	
voluntary service	0.05	0.11	0.631	1.05	[0.86, 1.29]	
undergraduate GPA	0.97	0.10	< .001***	2.63	[2.16, 3.21]	
gender	0.30	0.10	.002**	1.34	[1.11, 1.62]	
Level of experience	0.10	0.01	< .001***	1.11	[1.08, 1.14]	
Number of semesters beyond the standard period of studies, $\chi^2(6) = 878.12, p < .001$ $n = 2294$, Mc Fadden $R^2 = .19$						Number of semesters beyond: none = 63%, one = 18%, two = 15%, $\geq$ three = 4%
	β	$SE(\beta)$	p	OR	95%CI(OR)	
predictors						
vocational training	-0.23	0.14	.092	0.79	[0.60, 1.04]	
academic degree	-0.24	0.21	.254	0.79	[0.52, 1.19]	
voluntary service	-0.05	0.12	.694	0.95	[0.75, 1.21]	
undergraduate GPA	0.14	0.12	.247	1.14	[0.91, 1.44]	
gender	0.43	0.10	< .001***	1.54	[1.25, 1.88]	
Level of experience	0.47	0.02	< .001***	1.60	[1.54, 1.66]	

Note. For all dependent variables, the highest category was taken as reference category—higher categories indicate poorer academic performance; percentages rounded to the nearest whole number. The reference category for vocational training was “no vocational training”, for academic degree it was “no academic degree” and for voluntary service it was “no voluntary service”. The reference category for the control variable gender was “male”.

* $p < .05$

** $p < .01$

*** $p < .001$.

<https://doi.org/10.1371/journal.pone.0296982.t003>

Exploratory data analysis

In an exploratory analysis, associations between professional or academic pre-qualifications and selected socio-demographic characteristics were examined. The purpose was to provide ideas for future research on why pre-qualifications may not be an advantage for academic success. We calculated χ^2 -Tests to analyse the association between socio-demographic data and pre-qualifications. To test for significant differences in the mean undergraduate GPA, we calculated Welch *t*-tests. All results can be found in Table 4. Below we describe the associations that have become significant.

The proportion of medical students living in a partnership ($p < .001$), having own children who live in the same household ($p < .001$), or having no parent with tertiary education ($p < .001$) was higher among those with vocational training than among those without. The proportion of students with at least one parent with a degree in medicine or dentistry ($p < .01$) or at least one parent with a university degree in another subject ($p < .001$) was lower among those with vocational training than among those without. There was also a significant association between vocational training and having parents who work in the medical field ($p < .01$). Meanwhile, the proportion of students who financed their studies with the help of a partner or spouse ($p < .001$), BaföG ($p < .001$, German financial aid programme funded by the state) a loan ($p < .01$), their own earnings ($p < .001$) or savings ($p < .001$) was also higher among those who had completed vocational training than among those without. The proportion of students who reported financing their studies with the help of parents or relatives ($p < .001$), or a scholarship ($p < .001$) was lower among those with vocational training than among those without.

The proportion of students who reported financing their studies with the help of parents or relatives ($p = .016$), BaföG ($p < .001$), or a scholarship ($p = .030$) was lower among those with an academic degree than among those without. Meanwhile, the proportion of medical students who reported living in a partnership ($p = .004$) and financing their studies with a loan ($p < .01$) was higher among those with an academic degree than among those without.

The proportion of medical students who reported financing their studies with the help of a partner or spouse ($p = .047$) or through their own earnings ($p < .001$), and savings ($p < .001$), was higher among those with voluntary service than among those without. However, the proportion of students with at least one parent with a degree in medicine or dentistry ($p = .024$) and who reported financing their studies with a scholarship ($p < .01$) was lower among those with voluntary service than among those without.

For those with vocational training ($p < .001$), as well as for those with voluntary service ($p < .001$) or an academic degree ($p < .001$), the undergraduate GPA was on average worse than for those with no prior qualifications. Also, the proportion of medical students who graduated from school in Germany was higher among those with vocational training ($p < .001$) or voluntary service than among those without.

Discussion

In our study we aimed to investigate the relationship between professional and academic pre-qualifications and academic success for medical students in their 3rd, 6th or 10th semester or their final year ($N = 2,370$). Data were collected in a cross-sectional, multicentre study at five medical schools in Germany (Baden-Wuerttemberg). Academic success was operationalised by the scores obtained on the first and second state examination (i.e. M1 and M2), as well as by the number of repeated examinations and semesters beyond the standard period of study.

Having completed vocational training was associated with a higher number of repeated examinations (small effect); however, no such association emerged with score on the M1 or M2

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Table 4. Marital status, children, parents who work in the medical field, undergraduate GPA and financing of studies by professional and academic pre-qualifications.

		vocational training		<i>p</i>	academic degree		<i>p</i>	voluntary service		<i>p</i>
		yes	no		yes	no		yes	no	
Marital status and children:										
marital status				< .001			.004			.278
living in a partnership	<i>n</i> (%)	403(60)	728(44)		84(60)	1042(47)		271(50)	854(48)	
not living in a partnership	<i>n</i> (%)	265(40)	944(56)		56(40)	1155(53)		269(50)	943(52)	
own children (living in own household)				< .001			.813			.721
yes	<i>n</i> (%)	66(10)	24(1)		6(4)	83(4)		22(4)	67(4)	
no	<i>n</i> (%)	609(90)	1662(99)		139(96)	2130(96)		524(96)	1745(96)	
Parental education:										
at least one parent with a degree in medicine or dentistry				< .01			.979			.024
yes	<i>n</i> (%)	124(18)	420(25)		33(23)	506(23)		106(19)	436(24)	
no	<i>n</i> (%)	552(82)	1266(75)		112(77)	1708(77)		440(81)	1377(76)	
at least one parent with a university degree in another subject				< .001			.463			.413
yes	<i>n</i> (%)	329(49)	1010(60)		78(54)	1260(57)		318(58)	1020(56)	
no	<i>n</i> (%)	347(51)	676(40)		67(46)	954(43)		228(42)	793(44)	
no parent with tertiary education				< .001			.443			.395
yes	<i>n</i> (%)	258(38)	374(22)		43(30)	592(27)		154(28)	478(26)	
no	<i>n</i> (%)	418(62)	1312(78)		102(70)	1622(73)		392(72)	1335(74)	
parents who work in the medical field				< .01			.396			.998
one parent	<i>n</i> (%)	169(25)	322(19)		36(25)	453(20)		113(21)	376(21)	
both parents	<i>n</i> (%)	74(11)	239(14)		16(11)	294(13)		72(13)	240(13)	
no parent	<i>n</i> (%)	430(64)	1125(67)		93(64)	1464(66)		361(66)	1194(66)	
GPA:										
undergraduate GPA ¹	<i>M</i> (<i>SD</i>)	1.96(0.56)	1.29(0.36)	< .001	1.62(0.52)	1.47(0.52)	< .001	1.64(0.54)	1.43(0.51)	< .001
	<i>range</i>	[1.00,3.50]	[0.70,3.70]		[0.90,3.10]	[0.70,3.70]		[1.00,3.50]	[0.70,3.70]	
graduation (undergraduate GPA)				< .001			.117			< .001
in Germany	<i>n</i> (%)	660(98)	1525(91)		128(90)	2052(94)		540(99)	1641(91)	
other country	<i>n</i> (%)	13(2)	142(9)		14(10)	142(6)		3(1)	153(9)	
Financing studies by:										
parents/relatives										
yes	<i>n</i> (%)	448(66)	1544(92)	< .001	112(77)	1876(85)	.016	445(82)	1543(85)	.042
no	<i>n</i> (%)	228(34)	142(8)		33(23)	338(15)		101(18)	270(15)	
partner/spouse										
yes	<i>n</i> (%)	81(12)	41(2)	< .001	12(8)	110(5)	.081	37(7)	84(5)	.047
no	<i>n</i> (%)	595(88)	1645(98)		133(92)	2104(95)		509(93)	1729(95)	
BaföG ²										
yes	<i>n</i> (%)	127(19)	136(8)	< .001	4(3)	258(12)	< .001	72(13)	190(10)	.078
no	<i>n</i> (%)	549(81)	1550(92)		141(97)	1956(88)		474(87)	1623(90)	

(Continued)

RESULTS AND DISCUSSION

Table 4. (Continued)

			vocational training		<i>p</i>	academic degree		<i>p</i>	voluntary service		<i>p</i>
			yes	no		yes	no		yes	no	
own earnings											
	yes	<i>n</i> (%)	521(77)	963(57)	< .001	102(70)	1381(62)	.054	392(72)	1090(60)	< .001
	no	<i>n</i> (%)	155(23)	723(43)		43(30)	833(38)		154(28)	723(40)	
loan (e.g. student loan)											
	yes	<i>n</i> (%)	39(6)	45(3)	< .01	10(7)	74(3)	.025	21(4)	63(3)	.682
	no	<i>n</i> (%)	637(94)	1641(97)		135(93)	2140(97)		525(96)	1750(97)	
scholarship											
	yes	<i>n</i> (%)	86(13)	371(22)	< .001	18(12)	437(20)	.030	83(15)	373(21)	< .01
	no	<i>n</i> (%)	590(87)	1315(78)		127(88)	1777(80)		463(85)	1440(79)	
savings											
	yes	<i>n</i> (%)	307(45)	394(23)	< .001	51(35)	647(29)	.128	215(39)	485(27)	< .001
	no	<i>n</i> (%)	369(55)	1292(77)		94(65)	1567(71)		331(61)	1328(73)	
other											
	yes	<i>n</i> (%)	22(3)	50(3)	.993	13(9)	59(3)	na ³	14(3)	57(3)	.487
	no	<i>n</i> (%)	654(97)	1636(97)		132(91)	2155(97)		532(97)	1756(97)	

Note. Percentages rounded to the nearest whole number.

¹undergraduate grade point average = "Abitur" in Germany, low numbers stand for better grades.

²"Bundesausbildungsförderungsgesetz" is a common German student loan, funded by the state.

³na = no χ^2 -test could be calculated due to expected cell frequencies <5.

<https://doi.org/10.1371/journal.pone.0296982.t004>

or with the number of semesters beyond the standard period of study. Although having an academic degree before entering medical school was associated with worse scores on the M2 (medium effect), no such association occurred with score on the M1, the number of semesters beyond the standard period of study or the number of repeated examinations. Voluntary service before medical study was not associated with academic success. In an exploratory analysis, especially for medical students who completed vocational training before entering medical school, we found associations with responsibility for own children and type of student financing. The results of the exploratory data analysis are included in the following discussion of the findings.

Professional pre-qualifications and academic success

Similar to Hampe et al. [9], we found no association between volunteering before medical school and academic success. Although voluntary service provides important practical experience that may contribute to personal development, its duration may be too brief to impact success in medical school. In our exploratory analysis we found that individuals who had volunteered prior to medical school tended to report different financing of their studies. For example, the proportion of students who financed their studies through their own earnings and savings was higher among students with prior volunteering experience than among those without. However, students were able to indicate several ways of financing their studies (multiple choice), and it is not clear from our data what proportion of their studies are self-financed. In addition, the exploratory analysis showed that the undergraduate GPA of students who had completed voluntary service was worse than that of the group without voluntary service. This may be an indication of why this group could not start studying medicine directly after school.

Overall, the proportion of students with at least one parent with a degree in medicine or dentistry was lower among those with voluntary service than among those without. These findings may indicate that the interest or decision to study medicine may not have come from role models at home, but from personal experiences during voluntary service, which the majority of our sample undertook in the health sector.

To the best of our knowledge, no research has produced results showing how studying before entering medical school affects success in medical school. We did not find any association between variables of academic success and having an academic degree except for score on the M2. Because the second state examination is usually taken after the tenth semester, individuals who have studied another subject before studying medicine have studied for at least eight years. That group, due to other life circumstances, may have other priorities than achieving top scores on the M2. However, our exploratory analysis did not provide a clear picture of what these circumstances might be. Overall, however, more students with an academic degree reported living in a partnership. We could not find an association between having own children and an academic degree. At least the proportion of those who reported financing their studies with the help of parents or relatives, a scholarship or BaföG (German state-funded financial aid) was lower in the group with an academic degree than in the group without. However, the association between having an academic degree and lower scores on the M2 could also be mainly due to worse school leaving grades. In our exploratory analysis, the undergraduate GPA was worse for those with an academic degree than for those without. Further studies should examine other factors that may explain the association with worse scores on the M2.

We are not aware of any literature review, other than the review of Erschens et al. [25], that specifically examines individuals with both practical and academic experience prior to attending medical school. In particular, the authors investigated the associations of pre-qualifications with objective data, non-cognitive data and preference for specialty training. However, due to the small number of studies available on the topic, a trend could be identified for the objective data only. Erschens and colleagues concluded that students with vocational training tended to perform below average in the first years of study.

The findings of our study align with the results Hampe et al. [9,27], who also found no advantage for medical students who had completed vocational training. The operationalisation of academic success chosen by Hampe et al. [9] was similar to ours, and they found a lower number of passed examinations among students who had completed vocational training. Our exploratory analysis showed that students with vocational training often reported financing their studies with their own earnings, which suggests a possible additional burden and less time for studying due to having to work part-time jobs. Furthermore, the proportion of medical students with children living in the same household, who financed their studies with savings, with the help of a partner or spouse or with a (student) loan was higher among those with vocational training than among those without. The results of our exploratory analysis suggest that individuals with vocational training may differ from individuals without vocational training in terms of additional burden factors. These may be factors that influence the amount of repeated examinations. Beyond that, practical experience may not be able to compensate for the intensive memorisation required for written examinations. Among other results, we found no association between the number of semesters beyond the standard period of study and prior vocational training. Presumably, repeated examinations are compensated for by additional work so that the standard period of study can be adhered to. In addition, our exploratory analysis showed that the proportion of medical students with completed vocational training in the medical field, who reported not having a parent with a tertiary education, was higher than for those without vocational training. They were also

less likely to report that at least one parent had a degree in medicine, dentistry or another subject. As those with vocational training also reported lower undergraduate GPA, this may indicate a link between parents' educational background and children's educational opportunities. In their article, Becker and Hecken [33] discuss why working-class children are less likely to take the direct path to university after leaving school. Further studies should investigate this association in medical students.

However, there is evidence that medical students' practical experience may have a subjective effect on their performance in medical school [34]. Our results contrast with the findings of Amelung et al. [5], who found a positive influence of vocational training on the mean percentile rank over all performance data points in the first two years of study. However, we operationalised success by scores on the M1 and M2 and by the number of repeated examinations and semesters beyond the standard period of study. The different operationalisations of academic success not only complicate comparisons of the studies but also show the importance of discussing the concept of academic success, which according to Patterson et al. [3] is controversial in research on admissions in which performance outcomes should be predicted (i.e. a criterion problem). In medical school, other achievements may be more important than later in practice. Therefore, it is impossible to conclude from our data who will become a good doctor. By contrast, Simmenroth-Nayda et al. [35] and Heidmann et al. [36] examined neither grades nor other exam-related results but the results of MMIs. Both studies revealed that medical students with vocational training performed slightly better on a MMI and in an applicant interview than other students. The MMI consisted of different stations with medical situations such that the applicants' reactions and social skills could be recorded. When it comes to practical tasks, people with vocational training may outperform ones without such training. Thus, additional studies should explore the concept of academic success by covering it as broadly as possible and, whenever possible, including relevant soft skills in the assessment. A study by Tsikas and Afshar [37] who provides some initial insight into alternative examinations in medical school in association with pre-qualifications. They examined the relationship between work experience before entering medical school and scores on a clinical examination after the second year of medical school. The practical clinical examination (OSCE) consisted of nine stations covering the categories "physical examination", "medical skills", and "communication". The authors found, that medical students with prior practical experience scored higher on practical medical skills (e.g. drawing blood), but not on communication skills.

Professional pre-qualifications in the admissions process

Overall, we found a very high proportion of medical students in our sample with professional or academic pre-qualifications. A total of 28% reported vocational training, 6% an academic degree, and 23% voluntary service. Overall, it should be noted that these percentages are self-reported and do not necessarily reflect the objective percentages at German medical schools.

One possible explanation for the high proportions in voluntary service and vocational training could be, among other things, the German admission system. Until 2022 Germany applied the so-called "waiting list quota". This quota could increase the chances of admission to medical school for people who had waited a certain number of semesters for admission. It is possible that these individuals began vocational training or volunteer work during the waiting period and were able to begin medical school afterward. In addition, for some years now, a quota system in Germany has placed special emphasis on prior practical experience. In this context, medical schools could decide whether and how to weight certain criteria that are independent of grades. As a result, practical experience can increase the chances of being admitted to medical school.

However, our high percentages are in line with the results of DeWitt and Harrison [1]. The authors reported that 36% of all accepted applicants in their sample reported scribing experience in a healthcare setting. In the USA scribes help physicians with the documentation. Erschens et al. [25], who provide an overview of the frequency of previous vocational qualifications reported in studies in their review, reported heterogeneous rates ranging from 15% to 86.7%. Those results may be due to the varying emphasis that universities place on previous experience in the admissions process.

We could not find an advantage of professional and academic pre-qualifications for academic success. However, we were able to replicate the effect of undergraduate GPA on academic success [3,4] which we used as a control variable. The better the GPA the better the grades on the M1 and M2 and the lower the number of repeated examinations. In contrast, we did not find an association between undergraduate GPA and the number of semesters behind the standard period of study. Prior undergraduate performance still appears to be an important predictor of academic success. However, there are recommendations from selection research to consider personal qualities when selecting appropriate medical students [22]. It would also be conceivable to include non-academic attributes in the selection process that characterise good doctors [38]. Asking about previous professional or academic experience could be an efficient way of including personal qualities in the selection process.

Another advantage beyond the practical knowledge of the applicant group with professional or academic pre-qualifications could be a higher motivation to study and become doctors. Wouters et al. [39] found that medical students who experienced a more elaborate admissions process reported higher post-admission motivation than students who obtained placement due to undergraduate GPA or lottery. Applicants not directly admitted due to undergraduate GPA and who first engage in vocational training, voluntary service or studies may have to wait longer and invest more to be admitted to medical school. Studies have also shown that academic self-efficacy [17–19] and effort [19], which can be counted as motivational beliefs and behaviours [40], are positively related to academic success. In addition, grade goal setting can be associated with academic success [18]. However, in our study, prior practical experience did not lead to better academic performance. It may be that people with previous practical experience have higher self-efficacy in relation to practical tasks and patient contact. Motivational constructs such as effort and self-efficacy in relation to academic performance may be more pronounced in the group of those who already had good grades at school, regardless of previous academic and practical pre-qualifications. Further studies should investigate these non-cognitive variables in relation to prior practical or academic experience.

It is striking that approximately 40% of participants who had completed vocational training in the medical field in our study also reported having completed voluntary service. Possible explanations are that the group had to wait a long time for placement in medical school and decided to train in the meantime and that voluntary service motivated them to work in the medical field and convinced them to engage in training. Last, it should be noted that not only should medical students have the prerequisites to become good students and good doctors, but the curriculum is constantly being modified to best prepare students for the medical profession.

Strengths and limitations

A particular strength of our study was that we examined a very large sample of medical students in different semesters, with data collected at five medical schools in Germany. Our results make an important contribution to a topic that has been little explored. Moreover, a wide range of variables was chosen to operationalise success, including not only the results of

two state examinations but also adherence to the standard duration of study and the number of repeated examinations. However, our definition of academic success lacks an outcome that explicitly captures non-cognitive but practical skills. Further studies should examine professional and academic pre-qualifications e.g. in relation to results in MMI or OSCE. Within our study team we considered combining OSCE results with our data, but due to data restrictions (such as data privacy issues) this was not possible. Another limitation is that our cross-sectional study precludes investigating the progress of individuals over their course of study. As some medical students have completed more than one pre-qualification, these cannot be considered completely independent of each other. In addition, our data is not objective, but self-reported. Our operationalisation of completed voluntary service, previous vocational training in the medical field and previous academic degree as dummy variables excludes medical students who dropped out of voluntary service, vocational training or academic studies before completion. Another limitation is that the dummy-coding of previous professional and academic qualifications did not include information about the duration of any subsequent work experience. The duration of training, which is generally three years in Germany, was also not recorded. In Germany there is a training programme for paramedical assistants, which is often followed by work experience, but is much shorter. As we have not explicitly excluded this short programme, it is possible that some of the people who have indicated “paramedic” as their vocational training have only completed a short training programme. Future studies could examine the relationship between work experience and academic success in order to assess the importance of having many years of work experience. For such studies, we recommend also collecting qualitative data to better understand the importance of work experience.

Conclusion

We found no advantage of prior professional or academic qualifications for academic success in medical school. Nevertheless, it remains unclear how to best operationalise academic success and whether such success relates to professional success after graduation. Research on admissions can benefit from our findings, which derive from the assessment of the presence of different prior professional and academic experiences in relation to academic success. Admissions procedures should take into account that prior professional and academic experience may have had a beneficial effect on personal qualities, thereby enabling them to enter medical school with an advantageous perspective and experience that eventually cannot be captured by the results of examinations.

Supporting information

S1 Table.
(DOCX)

Acknowledgments

VSM-BW (‘Verbund Studierendenauswahl Medizin in BW’) is a collaborative project within the initiative FES-BW (‘Fonds Erfolgreich Studieren in Baden-Wuerttemberg’) and we would like to thank all our colleagues (in alphabetical order): Kerstin Ahlborn, David Ambiel, Dorothee Amelung, Tobias Boeckers, Ana-Maria Bordes, Marianne Giesler, Petra Hahn, Lutz Hein, Augustin Kelava, Natalie Petersen, Tim Schaffland, Regina Sticker and Thomas Wieland. We would also like to thank all the medical students, applicants and prospective students who took part in the study. We acknowledge support from the Open Access Publication Fund of the University of Tübingen.

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Supporting Information

S1 Table. Questionnaire on professional and academic pre-qualifications, including items on vocational training, studies and voluntary service prior to medical school, translated from German

Vocational training	
Did you start or complete any vocational training before starting medical school?	Yes
	No
If yes, which type of training did you start or complete?	... in nursing
	... in geriatric care
	... in remedial care
	... as a paramedic
	... in another health profession/health sector (e.g. speech and language therapy, physiotherapy, medical assistant)
	... in the pharmaceutical sector
	... in a technical field (e.g. automotive engineering, electrical professions)
	... in the field of creative work
	... in the craft sector
	... in another sector
The training was completed with the following overall grade:	[grade]
Did you start your training to increase the likelihood of being admitted to medical school?	Yes
	No
After you finished your vocational training, did you work in your trained profession? If yes, please indicate the duration (in years):	[years]
Academic degree	
	Yes

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Have you started or completed any other academic studies before medical school?	No
If yes, which study programme did you start or complete?	... in the medical field (e.g. dentistry, molecular medicine human biology)
	... in the field of nursing or health sciences
	... in the field of pharmacy or pharmaceutical technology
	... in STEM disciplines (e.g. mathematics, computing, biology, chemistry or physics)
	... pedagogy and educational sciences
	... in the field of psychology
	... in the field of social work or social education
	... in the field of home economics or nutritional sciences
... in another field	
You have completed your studies with the following overall grade:	[grade]
After you finished your study programme, did you work in the field of your studies? If yes, please indicate the duration (in years):	[years]
Voluntary service	
Did you do any voluntary service before medical school?	Yes
	No
If yes, in which area did you complete your voluntary service?	... health care
	... care for the elderly
	... care for the disabled
	... child and youth welfare
	... welfare
	... in another field
The duration of the voluntary service (in months):	[months]
Did you do the voluntary service to increase the likelihood of being admitted to medical school?	Yes
	No

3.2 Study 2: Pre-Qualifications, learning strategies, and study satisfaction among medical students

Schröpel, C., Herrmann-Werner, A., Festl-Wietek, T., Wittenberg, T., Herpertz, S.C., Schüttpelz-Brauns, K., Heinzmann, A., Böckers, T.M., Zipfel, S., and Erschens, R. (submitted) Pre-Qualifications, Learning Strategies, and Study Satisfaction among Medical Students: Insights from a Multicenter German Cohort.

Study satisfaction among medical students is important for both, students and medical schools. Due to the German admissions system, a substantial proportion of medical students already have professional or academic qualifications (Amelung et al., 2022; Schröpel et al., 2024). However, little is known about how pre-qualifications relate to students' satisfaction with their studies (Erschens et al., 2021). *Study 2* of this dissertation extends the focus of *Study 1* on rather objective outcomes by incorporating study satisfaction as a subjective variable. More specific, *Study 2* examines whether professional or academic pre-qualifications are associated with satisfaction with the study contents, conditions and coping of study loads, and whether these associations are explained by deep-processing learning strategies (elaboration and critical thinking) and financing studies through part-time employment. A structural equation model (SEM) with confirmatory factor analysis (CFA) was used to examine whether pre-qualifications (i.e. vocational training in the medical field or an academic degree) moderated the relationship between deep-processing learning strategies and satisfaction with the study contents (Moderation hypotheses), and whether part-time employment mediated the association between pre-qualifications and satisfaction with the study conditions and coping with study loads (Mediation hypotheses). The relationship between voluntary service and study satisfaction was explored, considering voluntary service as a less time-intensive pre-qualification than vocational training or an academic degree (Exploratory Research Question). Age, gender, undergraduate GPA, semester level and medical school were added as control variables. The results of the CFA indicated an overall good fit between the empirical data and the measurement model. The moderation hypotheses could not be confirmed, as the strength of the association between deep-processing learning strategies and satisfaction with the study content did not differ between students with vocational training in the medical field and those

RESULTS AND DISCUSSION

without, nor between students with and without prior academic degree. Regardless of students' pre-qualification, the learning strategy elaboration was positively associated with satisfaction with the study contents, whereas critical thinking showed a negative association. Part-time employment fully mediated the association of both prior vocational training and a previous academic degree with satisfaction with the study conditions and satisfaction with coping with the study loads. Medical students holding these pre-qualifications were more likely to finance their studies through part-time employment. Part-time employment was, in turn, negatively associated with satisfaction with study conditions, but positively associated with satisfaction with coping with study loads. Consequently, the indirect effects were negative for satisfaction with study conditions, whereas - contrary to the hypotheses of *Study 2* - the indirect effects were positive for satisfaction with coping with study loads. However, the effect sizes of these indirect effects were small. With regard to the association between voluntary service and study satisfaction, only a negative relationship was found with satisfaction with the coping of study loads. This suggests a potentially stressful contrast between the socially meaningful nature of volunteer work and the return to a highly theoretical academic environment.

Overall, the findings indicate that deep-processing learning strategies do not uniformly enhance students' satisfaction with the study contents. Elaboration - linking new material to existing knowledge was positively associated with satisfaction, regardless of students' pre-qualifications, suggesting that medical schools should actively promote this strategy through practice-oriented and experience-based teaching approaches. In contrast, the negative association of critical thinking indicated that actively questioning and challenging course content, although essential for learning (Wild, 2000), may not necessarily translate into higher satisfaction. In addition, while parental support remains the primary source of student funding in Germany (Kroher et al., 2023), this may be less feasible for medical students with prior vocational training or an academic degree, increasing their reliance on part-time employment. Although part-time employment alongside a dense curriculum may reduce satisfaction with study conditions, it may also function as a resilience factor in coping with academic demands, highlighting the need for flexible and inclusive curricular structures to support working students' well-being.

Pre-Qualifications, Learning Strategies, and Study Satisfaction among Medical Students: Insights from a Multicenter German Cohort

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RESULTS AND DISCUSSION

28 **Abstract**

29 **Introduction:** Although medical students with pre-medical qualifications (e.g., paramedic
30 training) may enhance diversity within the student body, they have received little attention in
31 international research. Their prior experience may influence study satisfaction, as they might
32 use different learning strategies or be more likely to work alongside their studies. This study
33 therefore investigates how pre-qualifications relate to three dimensions of study satisfaction
34 (content, conditions, and coping with study load) and examines whether deep-processing
35 strategies (elaboration and critical thinking) and part-time employment help explain these
36 associations.

37 **Method:** The authors conducted a cross-sectional survey at five German medical schools and
38 at different stages of study (3rd, 6th and 10th semester, final year). A structural equation
39 model tested (a) the moderation effect of pre-qualifications (i.e. academic degree, vocational
40 training in the medical field) in the relationship between learning strategies and study
41 satisfaction and (b) the mediation effect of part-time employment between pre-qualifications
42 and study satisfaction, controlling for age, gender, undergraduate GPA, semester, and medical
43 school.

44 **Results:** Links between learning strategies and satisfaction did not differ by pre-
45 qualifications. Regardless of students' pre-qualifications, elaboration was positively ($\beta=.51$)
46 and critical thinking negatively ($\beta=-.31$) associated with students' satisfaction with the study
47 contents. Students with vocational training or prior academic degree more often worked part-
48 time to finance studies; part-time employment was associated with lower satisfaction with
49 study conditions ($\beta=-.07$), but higher satisfaction with the coping of study loads ($\beta=.08$).
50 Indirect effects via part-time employment were significant but small.

51 **Discussion:** Encouraging elaboration – linking existing knowledge to new content – may
52 enhance satisfaction irrespective of pre-qualifications. Although part-time employment may

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53 affect satisfaction with study conditions, it may also help students to cope with the demands
54 of their studies. A flexible, inclusive curriculum that meets the needs of working students and
55 builds on existing experience may benefit learner well-being.

56

57 *Keywords:* vocational training, pre-qualifications, medical studies, study satisfaction, learning
58 strategies, part-time employment to finance studies

59

60 Introduction

61 Medical student's satisfaction with their studies is important not only for their
 62 personal development, but also for quality assurance in medical education. It is closely tied to
 63 student's mental health [1, 2], self-efficacy, and optimistic outcome expectations about their
 64 studies [3]. At the institutional level, higher satisfaction contributes to lower dropout rates and
 65 enhances the attractiveness of degree programs [4, 5]. Given these associations, a better
 66 understanding of the specific factors influencing study satisfaction in medical education is
 67 crucial. Meta-analytic findings could identify the university environment, service quality, and
 68 perception of the resources provided as possible antecedents of study satisfaction[5].
 69 Additionally, student factors such as intrinsic motivation for choosing the program of study
 70 and conscientiousness contribute to higher levels of satisfaction [6]. However, these findings
 71 are derived from non-medical student populations, highlighting the need for more research
 72 within medical education.

73 Internationally, standardized instruments have been developed to measure satisfaction
 74 across different educational contexts [7]. One prominent and validated instrument used in
 75 Germany is the Study Satisfaction Questionnaire [8]. Based on the context of job satisfaction,
 76 the authors defined study satisfaction as students' attitudes towards their studies [8, 9]. Factor
 77 analysis of the short version indicate three separate dimensions: satisfaction with the study
 78 contents, satisfaction with the conditions and satisfaction with the coping of study loads [8],
 79 enabling a differentiated assessment of satisfaction levels. Although reference values exist for
 80 medical students [8], they should not be viewed as a homogeneous group. Differences in prior
 81 practical experiences may influence satisfaction, yet little is known about the satisfaction
 82 levels of medical students with *professional or academic pre-qualifications*. In the present
 83 study, this includes students with (i) completed vocational training in the medical field, (ii)
 84 prior academic degree, or (iii) completed voluntary service. Germany's medical education

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85 system provides an interesting case in point. Although cognitive abilities are still the most
86 decisive admission criterion, a significant proportion of students with relevant prior practical
87 experience (e.g. vocational training in the medical field, voluntary service) are accepted [10-
88 12].

89 While such 'non-traditional' medical students can enrich classrooms through their pre-
90 experiences, they may also require different learning environments and might thus differ in
91 satisfaction compared to students entering directly after high school. Also, students with
92 vocational training or prior academic degree are typically older and may receive less financial
93 support from their parents, as medical studies represent a second educational pathway [10].
94 Although tuition fees are charged to second-degree students in only a few German federal
95 states, students must nevertheless cover their living expenses, and studies indicate lower
96 levels of academic performance and study satisfaction among those who are employed [13,
97 14]. Balancing financial demands through part-time employment alongside a demanding
98 curriculum may reduce students' satisfaction, particularly with study conditions and their
99 coping of study loads.

100 Conversely, prior professional experience may enhance satisfaction with the study
101 contents, as students tend to report higher satisfaction when they perceive the curriculum as
102 practically and professionally relevant [15, 16]. A factor that could influence the relationship
103 between prior qualifications and satisfaction with the study contents is the use of specific
104 learning strategies. For pre-experienced medical students, deep-processing strategies such as
105 elaboration and critical thinking may be particularly important. 'Elaboration' involves linking
106 new information and existing knowledge [17], whereas 'critical thinking' deepens
107 understanding by questioning content and evaluating content [18]. Learning strategies can be
108 assessed using standardized learning strategy questionnaires [19, 20], which serve as
109 established measures of self-regulated learning (SRL). SRL models emphasize learners' active

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110 role in the learning process by setting learning goals, planning, monitoring, evaluating and
111 adjusting the learning process [21-23]. SRL is a competence [24] and should be distinguished
112 from learning, where learners require a high degree of external regulation [25]. According to a
113 model by Wild and colleagues [18, 26, 27], deep-processing strategies are part of cognitive
114 learning strategies (see figure 1) and should be preferred over surface strategies [18]. We
115 hypothesize, that medical students with vocational training or prior academic degree should
116 possess more relevant prior knowledge – either practical experience in the medical field or
117 familiarity with learning in an academic setting. This background may enable them to
118 integrate and evaluate new content more effectively, thereby increasing their perception of the
119 professional relevance and meaning of the study content. Consequently, deep-processing
120 strategies could enhance their satisfaction with study content. This assumption is consistent
121 with SRL research showing that prior knowledge plays an important role in the learning
122 process [25] and that advanced learners tend to engage more frequently in SRL [28, 29].
123 Furthermore, evidence suggests that the use of SRL strategies is positively associated with
124 study satisfaction [30, 31].

125 Using a Germany as a case example, where practical pre-qualifications play an
126 important role in medical school admission, this study contributes to research on the
127 diversification of medical education. This study aims to analyze the associations between pre-
128 qualifications and study satisfaction, and to investigate the role of part-time employment and
129 deep-processing learning strategies in this relationship. As vocational training in the medical
130 field and an academic degree constitute longer and more substantial pre-qualifications, these
131 form the primary focus of our analysis on study satisfaction, while voluntary service is
132 examined exploratorily. The analyses further account for relevant control variables such as
133 age, gender, undergraduate GPA, semester and medical school. Based on our considerations,
134 the following hypotheses and research questions are investigated.

RESULTS AND DISCUSSION

135

136 1. Moderation Hypotheses:

137 The positive relationship between the learning strategies elaboration/critical thinking and
138 satisfaction with the study contents is stronger within medical students...

139 a. with *completed vocational training in the medical field* than in the group without.

140 b. with *prior academic degree* than in the group without.

141

142 2. Mediation Hypotheses:

143 Medical students...

144 a. with *completed vocational training* (compared to those without training)

145 b. with *prior academic degree* (compared to those without degree)

146 ...finance their studies more often through part-time employment and are thus less satisfied
147 with the study conditions and satisfaction with the coping of study loads.

148

149 3. Exploratory research question: How do medical students with *completed voluntary service*
150 differ in their study satisfaction?

151

152 #figure1 about here#

153

154 **Methods**

155 **Participants and Design**

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We conducted a cross-sectional, multicenter study at five medical schools in south-west Germany between the German winter semester 2019/2020 and summer semester 2021. Recruitment of medical students (3rd, 6th, 10th semester, final year) was via email or during lectures.

Measures

This study is a sub-analysis of the collaborative research project 'Pre-qualifications for human medicine', which examines medical students with completed pre-qualifications before beginning their medical studies. Three delineated sub-analyses have already emerged from this dataset, namely the relationship between prior qualifications and academic success [10], burnout [32], and specialist training [33]. The overall questionnaire assessed medical students' socio-demographic background and medical school-related questions such as current semester and undergraduate grade point average (GPA; in German 'Abitur', with lower numbers indicating better grades). Students were asked whether they finance their studies (in part) through part-time employment. The students were also asked about their *professional and academic pre-qualifications*, which we defined as the following dichotomous variables:

- (i) Completed *vocational training in the medical field*
- (ii) *Academic degree*, Bachelor's or Master's degree
- (iii) Completed *voluntary service* of at least 11 months

Study satisfaction

Study satisfaction was assessed by the Study Satisfaction Questionnaire – Short Form (FB-SZ-K; [8, 34]). Students rate their satisfaction on a graphical scale from 0-100. The questionnaire consists of nine items, which are evenly allocated to three scales (see table A1

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180 in the appendix for an overview of all items). Cronbach's α is reported from Westermann et al.
181 [34].

- 182 • *Satisfaction with the study contents*, $\alpha = 0.87$
- 183 • *Satisfaction with the study conditions*, $\alpha = 0.71$
- 184 • *Satisfaction with the coping of study loads*, $\alpha = 0.71$

185

186 **Learning strategies**

187 Deep-processing learning was assessed by using two scales *elaboration* (Cronbach's α
188 = .65-.72) and *critical thinking* (Cronbach's $\alpha = .73-.79$) from the Learning Strategies of
189 University Students questionnaire - short version (LIST-K [35]). Medical students rated their
190 strategy use on a five-point-scale from 1 (rarely) to 5 (often). All items (three per strategy) are
191 provided in table A1 in the appendix.

192

193 **Statistical Analysis**

194 We performed the statistical analysis using R4.5.1. The level of significance was set at
195 $\alpha=.05$. To test the hypotheses and the explorative research question, we calculated a structural
196 equation model (SEM) with prior confirmatory factor analysis (CFA) using the lavaan
197 package [36]. In the first step we calculated the CFA including all latent variables. The latent
198 variables were the three satisfaction scales and the learning strategies elaboration and critical
199 thinking. In preparation for the CFA, the satisfaction scales were brought to a comparable
200 value range as the learning strategy scales (0-10 instead of 0-100), in order to avoid
201 instabilities in the estimation. Model fit was evaluated based on common recommendations
202 [37].

In the second step we added the manifest variables and calculated the SEM. The manifest variables were the moderator variables vocational training in the medical field (0 = no, 1 = yes) and academic degree (0 = no, 1 = yes). Further manifest variables were voluntary service (0 = no, 1 = yes), the mediator variable *part-time employment* to finance studies (0 = no, 1 = yes) and the control variables age (mean-centered), undergraduate GPA (mean-centered) and gender (0 = female, 1 = male). Medical school (A, B, C, D, ref: E) and semester (3rd, 6th, 10th, ref: final year) were entered as dummy-coded variables. To build interaction terms with the moderator variables, factor scores for elaboration and critical thinking were estimated and extracted from the CFA. Factor scores were z-standardized before building interaction terms. Although this enabled us to model the interactions, it should be noted that factor scores are only estimates of latent variables and do not explicitly account for measurement errors. All dichotomous variables were modelled metrically. Figure 2 provides an overview of all variables in the structural model. Standardized regression coefficients were calculated to determine the strength of the associations between the variables, indicating how much the dependent variable changes (in SD units) when the predictor increases by one SD unit.

221

223 Sample description

10

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227 medical students, $n = 655$ (27.6%) had completed vocational training in the medical field (vs.
228 $n = 1,707$, 72.3% had not), most of them as paramedics or nurses. A total of $n = 145$, 6.1%
229 medical students stated that they had completed another academic degree prior to starting
230 their studies (vs. $n = 2,214$, 93.9% had not). The courses that were mentioned most frequently
231 were in STEM subjects or the medical field (e.g. dentistry, molecular medicine). A total of $n =$
232 546 (23.1%) students stated that they had completed voluntary service before starting their
233 studies (vs. $n = 1,813$, 76.9% had not), most of them in the health sector. Overall $n = 1,490$
234 (62.9%) medical students indicated part-time employment to finance their studies. Please refer
235 to Schröpel et al. [10] for a detailed description of the sample. Table 1 provides an overview
236 on the descriptive statistics of the learning strategies and satisfaction scales.

237

238 #Table1 about here#

239

240 **Results of the structural equation model**

241 Before running the analysis, we tested relevant assumptions. To account for missing
242 values in our data (<2%), we used the full information maximum likelihood (FIML)
243 approach. Overall, all assumptions were met. However, as we detected multivariate outliers in
244 our data and multivariate normality was not met, we used robust maximum likelihood
245 estimation (MLR) for the CFA to calculate an unbiased measurement model. For the SEM, we
246 used maximum likelihood estimation (ML) in combination with bootstrapping (2000
247 samples). Significance decisions in the SEM were based on the 95% bias-corrected and
248 accelerated Bootstrap (BCa) confidence intervals (CI). An effect was considered significant if
249 the CI did not include zero.

RESULTS AND DISCUSSION

250 The results of the CFA overall showed a good fit between the empirical data and the
251 measurement model, $\chi^2(80) = 914.613$, $p < .001$, CFI = .95, TLI = .93, RMSEA = .06,
252 90%CI [.06, .07], SRMR = .05. The model showed an AIC of 125570.31 and a BIC of
253 125887.63. All standardized factor loadings were significant and between 0.50 and 0.92, see
254 Table A1 in the Appendix.

255 In the second step we calculated the SEM, see table 2 for all results. Overall, the
256 model showed a good model fit. The R^2 for 'satisfaction with the study contents' was 0.15.
257 Higher satisfaction was associated with a more frequent use of 'elaboration' ($\beta = 0.51$) and a
258 less frequent use of strategy 'critical thinking' ($\beta = -0.31$), as well as a lower age ($\beta = -0.09$).
259 The medical school also affected satisfaction levels (A, C, D > E). However, we were unable
260 to identify any moderating effects or associations with vocational training, a prior academic
261 degree, voluntary service, gender, undergraduate GPA and semester level.

262 The variance in 'part-time employment to finance studies' ($R^2 = .04$) could not be
263 explained by age. However, medical students with vocational training ($\beta = 0.18$) and medical
264 students with academic degree ($\beta = 0.05$) more often indicated to finance studies through part-
265 time employment than medical students without training or without degree.

266 We identified an R^2 of 0.10 for 'satisfaction with the study conditions'. Medical
267 students financing studies through part-time employment ($\beta = -0.07$), and older students ($\beta = -$
268 0.12) were less satisfied. However, 3rd semester students ($\beta = 0.12$) reported higher
269 satisfaction (compared to final year students) and the medical school also had an effect on
270 satisfaction levels (A, B, C, D > E). No effects were observed for the variables vocational
271 training, academic degree, voluntary service and undergraduate GPA.

272 The R^2 for 'satisfaction with the coping with the study loads' was 0.07. Students
273 financing studies through part-time employment ($\beta = 0.08$), and male students ($\beta = 0.09$)
274 reported higher levels of satisfaction with the coping of study loads, whereas older students (β

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= -0.18), students with completed voluntary service ($\beta = -0.06$), and 3rd ($\beta = -0.27$) and 6th semester students ($\beta = -0.15$) (compared to final year students) reported lower levels. There were no effects of vocational training, academic degree, medical school, and undergraduate GPA.

Financing studies through part-time employment fully mediated the relationship between vocational training in the medical field and satisfaction with the study conditions, $ab_1 = -0.06$, 95%CI [-0.10, -0.03], $\beta = -0.01$, and between vocational training and satisfaction with coping with the study loads, $ab_2 = 0.08$, 95%CI [0.04, 0.13], $\beta = 0.01$. Also, part-time employment fully mediated the relationship between academic degree and satisfaction with the study conditions, $ab_3 = -0.03$, 95%CI [-0.08, -0.01], $\beta = -0.003$, and between academic degree and satisfaction with coping of study loads, $ab_4 = 0.04$, 95%CI [0.01, 0.09], $\beta = 0.004$. Figure 3 illustrates the effects of the mediation analyses.

#Table2 about here#

#Figure3 about here#

Discussion

This multicenter, cross-sectional study of medical students in different semesters aimed to analyze differences in study satisfaction (i.e. satisfaction with the study contents, with the study conditions and with the coping of study loads) between students with and without professional and academic pre-qualifications (i.e. vocational training in the medical field, academic degree, voluntary service). In this context, a structural equation modelling (SEM) approach was employed to examine the role of the learning strategies elaboration and

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critical thinking, and the financing of studies through part-time employment while accounting for relevant control variables.

300

301 **Deep-processing learning, pre-qualifications and satisfaction with the study contents**

302 The moderation hypotheses could not be confirmed. The strength of the association
303 between 'elaboration' or 'critical thinking', and 'satisfaction with the contents of studies' did
304 not differ between medical student with completed vocational training in the medical field and
305 students without (Moderation Hypothesis 1a), nor between students with a prior academic
306 degree and students without (Moderation Hypothesis 1b).

307 We have expected a stronger link between the deep-processing strategies and
308 satisfaction levels among pre-qualified students, as previous research indicates that citing
309 professional and content-related reasons for choosing a field of study [16], having a personal
310 interest in the subject, and perceiving the curriculum as vocationally relevant [15] are
311 positively related to satisfaction with the study contents. Regardless, of pre-qualification
312 status, elaboration was positively, and critical thinking negatively, associated with study
313 satisfaction. This suggests that connecting new material to prior knowledge generally
314 enhances satisfaction with the study contents. Accordingly, students should be encouraged to
315 relate course content to their existing experience, a process that can be supported through
316 practice-oriented teaching.

317 While the positive association between elaboration and satisfaction levels aligns with
318 previous findings on SRL strategies, the negative association of critical thinking stands in
319 contrast to this literature [30, 31]. Although critical thinking as a deep-processing learning
320 strategy can foster a deeper understanding of course content, it was associated with lower
321 satisfaction in our sample. A potential explanation is that critical thinking may make medical
322 students more aware of structural shortcomings in the curriculum, thereby reducing their

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323 satisfaction. The highly structured nature of medical training may also limit students' sense of
324 autonomy, making critical engagement feel less rewarding. Nevertheless, critical thinking
325 should not be viewed as negatively; learning-strategy research highlights its importance in
326 academic contexts [18]. Actively questioning and discussing course content remains essential
327 for learning and should be encouraged.

328 A study with a similar focus on elaboration and critical thinking, did not find a direct
329 connection between deep processing strategies and satisfaction with the study content;
330 instead, deep-processing strategies influenced satisfaction indirectly through increased self-
331 efficacy[38]. In that study, however, elaboration and critical thinking were merged into a
332 single scale, which may have neutralized opposing effects of the two strategies. This
333 interpretation remains speculative, as the studies differ methodologically and consider
334 different variables. Given that other research also points to a connection between SRL and
335 self-efficacy beliefs[39], future studies should examine the role of self-efficacy in the
336 relationship between deep-processing learning and satisfaction.

337 Our study suggests that deep-processing learning strategies do not necessarily lead to
338 higher satisfaction levels. Nonetheless, medical students and other higher-education students
339 must regulate their learning effectively to meet substantial academic demands [38, 40-42].
340 Given that SRL is related to academic achievement [29, 43-45], it remains a valuable
341 competence that should be actively supported in medical education. Further research is
342 needed to examine its effect on study satisfaction.

343

344 **Financing studies by own earning as mediating variable**

345 The mediation hypotheses were partly confirmed. Medical students who had
346 completed vocational training (2a) or had a prior academic degree (2b) financed their studies
347 more often through part-time employment than students without these qualifications, and

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348 were less satisfied with the conditions of their studies. However, contrary to our hypothesis,
349 they were more satisfied with the coping of study loads.

350 Studying at a public university in Germany is tuition-free and funded by taxes [46],
351 yet students must still cover their living expenses. Parental support is the primary source of
352 student funding in Germany [47], but for medical students who have already completed
353 vocational training or a degree, full financial support from parents may no longer be feasible.
354 As a results, students may depend on their own income from part-time employment.

355 Medical studies are highly demanding, combining traditional lectures with clinically
356 responsive activities [48, 49]. The dense schedule could make it difficult to maintain part-time
357 work, potentially leading to frustration. At the same time, part-time employment may function
358 as a resilience factor, helping students to cope with academic challenges. Other studies
359 suggest that employment alongside studying does not necessarily have a negative impact on
360 study satisfaction, but rather that its effects depend on the extent of working hours [50]. To
361 better support working students, structural concepts are needed such as asynchronous learning
362 formats and predictable periods that allow for reliable planning of part-time jobs.

363 The level of satisfaction of medical students with prior vocational training or academic
364 degree was fully mediated by financing their studies though their part-time employment.
365 However, the group affected by the results was relatively small, and only a few students in our
366 sample held a prior academic degree. The mediator effects and the explained variance were
367 very small. It is therefore possible that another variable not included in our analysis mediates
368 the relationships between pre-qualifications and study satisfaction. Our study makes an
369 important contribution here, as these relationships have hardly been researched to date.

370

371 **Other associations with study satisfaction**

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372 In an exploratory manner, we examined the associations between voluntary service
373 and the three satisfaction dimensions. Completion of voluntary service was only associated
374 with lower satisfaction with the coping of study loads. Volunteer work is typically practical
375 and socially meaningful. Returning to a highly theoretical academic environment with
376 substantial performance demands may therefore feel less rewarding and more stressful.

377 Among our control variables, we identified additional influencing factors. The medical
378 school attended was associated with satisfaction with the study contents and conditions, but
379 not with coping of study loads. While satisfaction with content and conditions varies across
380 schools, coping with workload remains relatively consistent. Older age was associated with
381 lower satisfaction across all three dimensions, possibly reflecting changing life circumstances.
382 Regarding semester level, third-semester students reported higher satisfaction with study
383 conditions than final-year students, consistent with evidence of inconsistent supervision and a
384 perceived lack of adequate preparation for clinical practice in the final year [51]. Conversely,
385 third- and sixth-semester students reported lower satisfaction with coping with study loads,
386 suggesting that experience and resilience may be greater in the final year. Overall, men
387 reported higher satisfaction with coping of study loads, consistent with literature on burnout
388 among medical students [52]. However, the variables we examined only explained only a
389 small amount of variance in satisfaction, indicating that unmeasured factors may also play a
390 substantial role, such as teaching variables [53-55].

391

392 **Strengths and Limitations**

393 A particular strength of our study is that it is a large, multicenter study conducted at
394 five public medical schools in Germany, at different semester levels. We chose an SEM
395 approach, which enabled us to simultaneously estimate several relationships between latent
396 and manifest variables while controlling for measurement errors. However, due to the cross-

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sectional design, no causal conclusions can be drawn. The internal consistency of the variable elaboration was low, which limits the interpretation of the results. The binary mediator did not record working hours or whether studies were financed solely through it. In addition, although the pre-qualifications may overlap, we vocational training, academic degree, and voluntary service as separate dichotomous variables; each should be therefore be interpreted independently of the other.

Conclusion

In our study, incorporating prior knowledge and personal experience into the learning process positively affected satisfaction with study content, regardless of whether students had completed vocational training or held an academic degree before entering medical school. Medical schools should therefore create opportunities for practical experience combining theoretical knowledge with real-world application. Although part-time employment was associated with lower satisfaction with study conditions, it was linked to higher satisfaction with coping of study loads. The results suggest that part-time work may be less compatible with the structural demands of the medical curriculum, but may serve as a protective factor that supports students in managing academic challenges. These results are not specific to Germany and may inform the development of more flexible structures that account for diverse backgrounds and life circumstances of medical students worldwide. Our study therefore makes an important contribution to the understanding of students with professional and academic pre-qualifications, thereby advancing efforts to widen participation and diversify the medical student population [56, 57]

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419 **Disclosures**

420 **Acknowledgments**

421 VSM-BW ('Verbund Studierendenauswahl Medizin in BW') is a collaborative project within
422 the initiative FESSt-BW ('Fonds Erfolgreich Studieren in Baden-Wuerttemberg'). The authors
423 would like to thank all participating medical students as well as everyone who supported on
424 site the members of the FESSt-BW study group (in alphabetical order): Kerstin Ahlborn,
425 David Ambiel, Dorothee Amelung, Ana-Maria Bordes, Marianne Giesler, Petra Hahn, Lutz
426 Hein, Augustin Kelava, Natalie Petersen, Tim Schaffland, Regina Sticker & Thomas Wieland.
427 For biometric support the authors would like to thank Marina Pumptow. The authors
428 acknowledge support by the Open Access Publishing Fund of the University of Tübingen.

429

430 **Declaration of interest statement**

431 The authors do not have any competing interests to declare.

432

433 **Ethics**

434 The study was approved by the Ethics Committees of the Faculty of Medicine at Tübingen
435 University Hospital (No.534/2019BO1). All methods were conducted according to the
436 Declaration of Helsinki Association (2013). Medical students gave their informed consent
437 before the start of the study and their participation was anonymous and voluntary. The authors
438 distributed book vouchers as an incentive for participation.

439

440 **Author Contributions**

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441 The study was designed by CS, RE, AH-W, SH, TB and SZ. Data collection was conducted
442 by CS, TF-W, TW, AH, KS-B and RE. CS analyzed the data, generated figures and tables, and
443 drafted the manuscript. CS and RE interpreted the results. AH-W, TF-W, TW, SH, KS-B, AH,
444 TB, SZ and RE edited and approved the drafts of the manuscript. SZ obtained funding for the
445 project. RE, AH-W and SZ supervised the project. All authors have commented on all
446 versions of the manuscript and approved the final version.

447

448 **Disclaimers**

449 none

450

451 **Previous Presentation**

452 Conference presentation: GMA - Gesellschaft für medizinische Ausbildung, Düsseldorf,
453 Germany (2025, 08.-10. August). The presentation was in German language and is not
454 publicly available.

455

456

457 **Funding**

458 The present study was conducted within the joint framework ‘Pre-qualification in Human
459 Medicine’; FES-BW funding line 4 ‘Aptitude and Selection’; VSM-BW (‘Verbund
460 Studierendenauswahl in der Medizin in Baden-Württemberg’). The project was funded by the
461 Ministry of Science, Research and Art Baden-Württemberg (AZ: 23- 0421.918-4(18)/UNI
462 TU/2). The funders had no role in study design, data collection and analysis, decision to
463 publish, or preparation of the manuscript.

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464

465 **Data availability statement**

466 The datasets presented in this article are not readily available because of the high
467 confidentiality of the data. The authors of the study received permission from the Medical
468 Faculty of Tübingen to conduct the study and to collect these data only if they were not made
469 publicly available without individual permission for specific questions (i.e. on request).
470 Requests to access the datasets should be directed to psychosomatik@med.uni-tuebingen.de.

471

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634

635 **Appendix**

636 **Table A1.** *(Standardized) factor loadings and explained variance for the items of the latent variables in the measurement model*

Factor	Items (translated from German)	Factor loadings	SE	Standardized factor loadings	p	R²
Satisfaction with the study contents	I really enjoy what I am studying	1.74	0.04	0.92	<.001	0.85
	Overall, I am happy with my current studies	1.70	0.05	0.83	<.001	0.69
	I find my studies really interesting	1.30	0.05	0.80	<.001	0.64
	The external circumstances in which my subject is studied are frustrating	2.34	0.05	0.76	<.001	0.58
Satisfaction with the study conditions	I wish the study conditions at the university were better	2.80	0.04	0.90	<.001	0.81
	Too little attention is paid to students' concerns at my university	2.50	0.04	0.84	<.001	0.70
	My studies are consuming me	2.63	0.05	0.90	<.001	0.81
	I find it difficult to combine my studies with other commitments	2.20	0.05	0.76	<.001	0.57
Elaboration	I often feel tired and exhausted because of my studies	2.66	0.04	0.89	<.001	0.79
	I try to relate new concepts or theories to concepts and theories I am already familiar with	0.54	0.03	0.57	<.001	0.32
	I think of specific examples for certain learning strategies	0.58	0.03	0.50	<.001	0.25
	I relate what I have learned to my own experience	0.60	0.03	0.58	<.001	0.34
Critical Thinking	I ask myself if the text I'm currently working on is really convincing enough	0.66	0.02	0.63	<.001	0.40
	I tend to take a critical approach to most texts	0.83	0.02	0.81	<.001	0.65
	I also think critically about what I have learned	0.73	0.02	0.72	<.001	0.51

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638 **Tables**

639 **Table 1.** *Descriptive statistics including Pearson's correlation coefficients between all metric*
640 *study variables*

	1	2	3	4	5
1 Elaboration					
2 Critical Thinking	.40				
3 Satisfaction with the study contents	.19	.06			
4 Satisfaction with the study conditions	.03	-.04	.38		
5 Satisfaction with the coping of study loads	.09	.07	.36	.44	
<i>n</i>	2353	2347	2356	2338	2330
<i>M(SD)</i>	8.63(1.68)	4.91(2.72)	6.3(2.65)	3.48(0.77)	2.98(0.84)
range	0-10	0-10	0-10	1-5	1-5
Skewness	-1.46	-0.03	-0.49	-0.23	0.06
Kurtosis	2.64	-1.07	-0.73	-0.28	-0.27
Cronbach's α	.88	.87	.89	.56	.76

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644 **Table 2.** *Results of regression paths between the study variables, significant effects in bold*

	<i>b</i>	<i>SE</i>	<i>p</i>	95%CI ¹	β^2
Satisfaction with the study contents ~					
elaboration	0.85	0.06	<.001	[0.73, 0.98]	0.51
critical thinking	-0.52	0.06	<.001	[-0.65, -0.4]	-0.31
vocational training in the medical field	-0.11	0.11	.325	[-0.33, 0.11]	-0.03
academic degree	0.12	0.17	.504	[-0.21, 0.48]	0.02
elaboration*vocational training	-0.06	0.13	.633	[-0.30, 0.19]	-0.02
critical thinking*vocational training	0.08	0.12	.522	[-0.16, 0.3]	0.02
elaboration*academic degree	0.41	0.36	.251	[-0.20, 1.21]	0.06
critical thinking*academic degree	-0.24	0.34	.478	[-0.996, 0.36]	-0.04
age	-0.04	0.02	.020	[-0.08, -0.01]	-0.09
male gender	0.03	0.07	.728	[-0.13, 0.17]	0.01
undergraduate GPA	0.14	0.1	.155	[-0.05, 0.33]	0.04
voluntary service	-0.14	0.08	.088	[-0.31, 0.02]	-0.04
medical school A ³	0.46	0.10	<.001	[0.25, 0.66]	0.13
medical school B ³	0.18	0.20	.368	[-0.22, 0.55]	0.02
medical school C ³	0.43	0.10	<.001	[0.22, 0.62]	0.12
medical school D ³	0.40	0.14	.005	[0.11, 0.67]	0.07
3 rd semester ⁴	0.17	0.14	.218	[-0.10, 0.43]	0.04
6 th semester ⁴	0.09	0.12	.439	[-0.13, 0.33]	0.02
10 th semester ⁴	0.16	0.11	.141	[-0.05, 0.38]	0.04
part-time employment to finance studies ~					
vocational training in the medical field	0.19	0.02	<.001	[0.14, 0.24]	0.18
academic degree	0.10	0.04	.020	[0.01, 0.17]	0.05
age	0.01	0.003	.145	[-0.002, 0.01]	0.04
satisfaction with the study conditions ~					
financing studies by own earnings	-0.33	0.10	<.001	[-0.52, -0.13]	-0.07
vocational training in the medical field	0.13	0.16	.426	[-0.19, 0.44]	0.02
academic degree	0.21	0.25	.406	[-0.30, 0.69]	0.02
age	-0.08	0.03	<.001	[-0.13, -0.03]	-0.12
male gender	0.02	0.11	.884	[-0.18, 0.25]	0.003

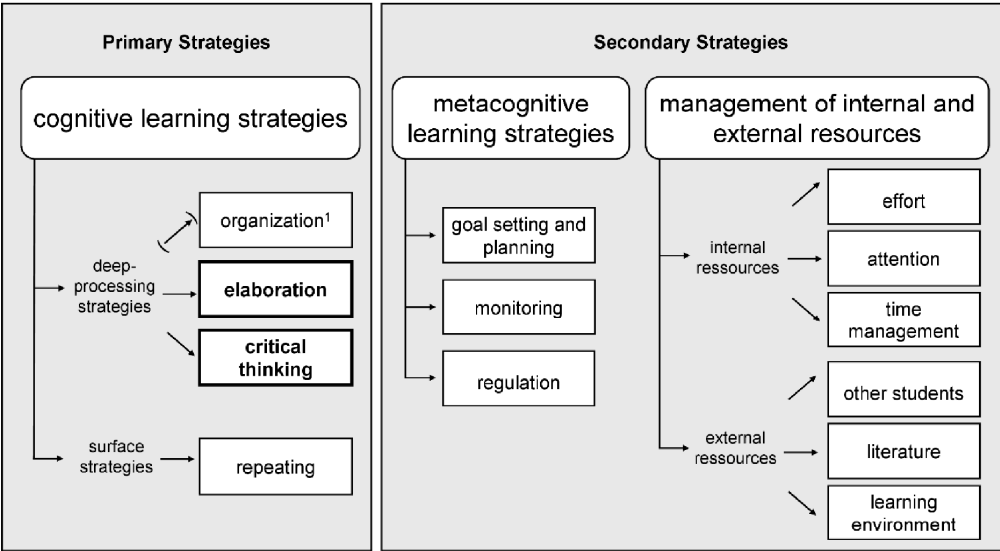
RESULTS AND DISCUSSION

undergraduate GPA	-0.07	0.15	.623	[-0.36, 0.21]	-0.02
voluntary service	-0.16	0.12	.183	[-0.42, 0.07]	-0.03
medical school A ³	1.23	0.14	<.001	[0.95, 1.50]	0.25
medical school B ³	1.27	0.26	<.001	[0.76, 1.76]	0.11
medical school C ³	0.49	0.14	<.001	[0.2, 0.75]	0.10
medical school D ³	0.57	0.20	.005	[0.16, 0.99]	0.07
3 rd semester ⁴	0.63	0.19	.001	[0.28, 1.01]	0.12
6 th semester ⁴	-0.20	0.16	.204	[-0.51, 0.12]	-0.04
10 th semester ⁴	-0.11	0.15	.471	[-0.42, 0.20]	-0.02
satisfaction with the coping of study loads ~					
financing studies by own earnings	0.41	0.11	<.001	[0.21, 0.63]	0.08
vocational training in the medical field	0.12	0.18	.493	[-0.21, 0.50]	0.02
academic degree	0.45	0.28	.103	[-0.09, 0.99]	0.04
age	-0.12	0.03	<.001	[-0.18, -0.07]	-0.18
male gender	0.49	0.12	<.001	[0.24, 0.72]	0.09
undergraduate GPA	0.16	0.17	.353	[-0.18, 0.49]	0.03
voluntary service	-0.36	0.14	.013	[-0.64, -0.08]	-0.06
medical school A ³	0.30	0.16	.067	[-0.02, 0.62]	0.05
medical school B ³	0.07	0.31	.821	[-0.50, 0.73]	0.01
medical school C ³	0.24	0.16	.129	[-0.07, 0.56]	0.04
medical school D ³	-0.35	0.24	.141	[-0.83, 0.11]	-0.04
3 rd semester ⁴	-1.60	0.22	<.001	[-2.05, -1.19]	-0.27
6 th semester ⁴	-0.85	0.18	<.001	[-1.22, -0.50]	-0.15
10 th semester ⁴	-0.05	0.18	.793	[-0.37, 0.32]	-0.01
X ² (173) = 1021.041, $p < .001$, CFI = .94, TLI = .92, RMSEA = .05, 90%CI[0.04, 0.05], SRMR = 0.03, AIC = 85641.07, BIC = 86110.44					

¹95% bootstrapping CI, ²standardized coefficients (SD units), ³ref: medical school E, ⁴ref: final year

648 **Figures**

649 **Figure 1.** *Overview of the classification of learning strategies according to Wild and*
650 *colleagues [26, 27], figure adapted from Wild [26]*



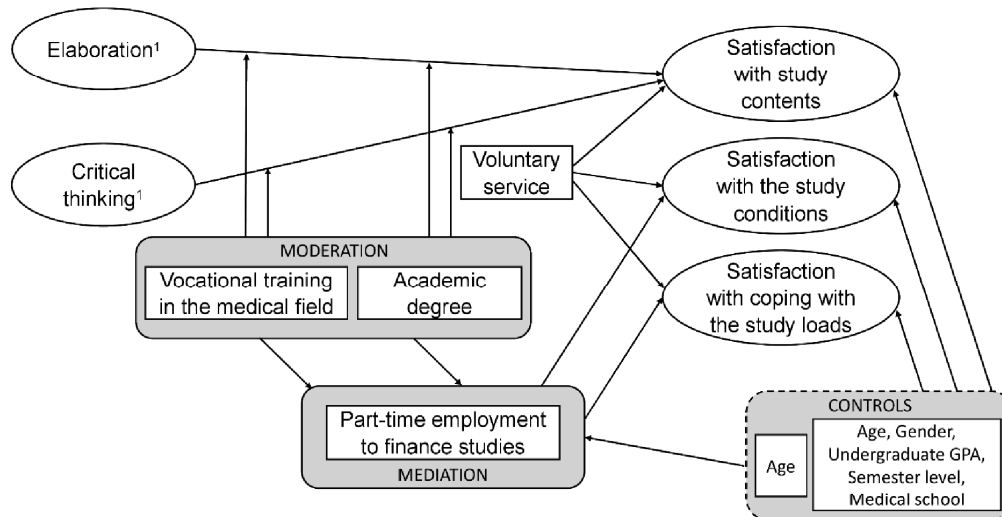
651

652 ¹ This study focused on deep-processing strategies, specifically elaboration strategies and
653 critical thinking. For completeness, it is acknowledged that organizational strategies are also
654 sometimes classified as deep-processing strategies, although they were not included in the
655 present analysis.

656

RESULTS AND DISCUSSION

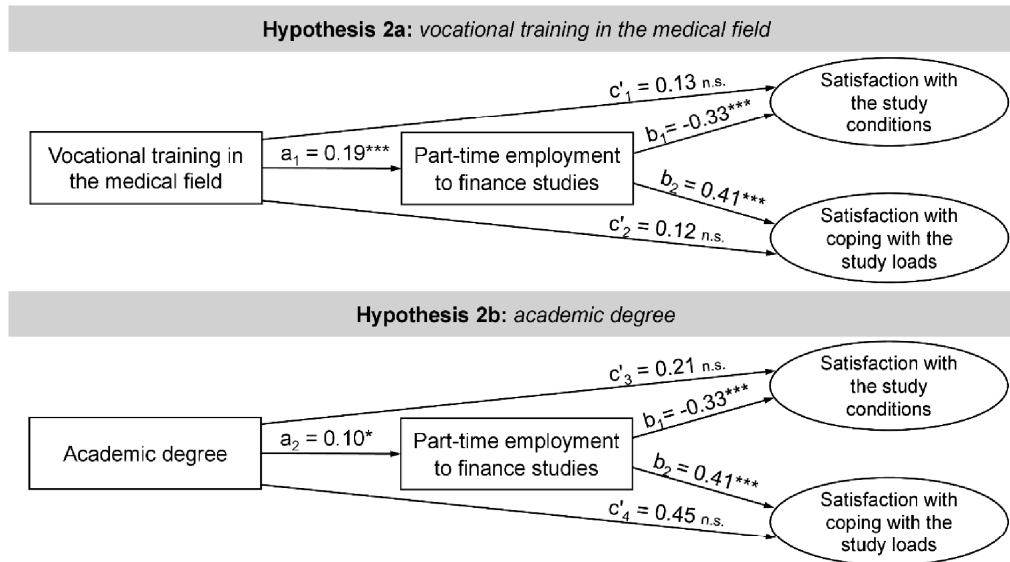
Figure 2. Overview on all latent (ellipses) and manifest (rectangles) variables in the structural model



¹Factor scores were estimated from the CFA and were entered as manifest variables in the model

RESULTS AND DISCUSSION

Figure 3. Illustration of the coefficients (unstandardized) of the mediation analysis with mediation paths a and b and the direct effect c'



Note. Latent variables (ellipses) and manifest variables (rectangles)
 $p < .05^*$, $p < .01^{**}$, $p < .001^{***}$

3.3 Study 3: Professional and academic pre-qualifications, career preferences and aspirations in working as a rural doctor

Schröpel, C., Festl-Wietek, T., Herrmann-Werner, A., Wittenberg, T., Pumptow, M., Herpertz, S. C., Heinzmann, A., Schüttpelz-Brauns, K., Böckers, T.M., Zipfel, S., & Erschens, R. (2025). Professional and academic pre-qualifications, career preferences and aspirations in working as a rural doctor. *Frontiers in Medicine*, 12, 1566303. DOI: doi.org/10.3389/fmed.2025.1566303

Prior practical and also academic experience may shape students' identity formation, career exploration, and specialty preferences. However, research on how these pre-qualifications relate to career aspirations, particularly intentions towards rural practice, remains limited, despite persistent physical shortages in rural areas (Erschens et al., 2021). Existing theories on the development of specialty training preferences and career decisions suggest that past experiences, and vocational interests may influence specialty choice (Bland et al., 1995; Holland, 1997; Mitchell, 1975). The limited available evidence further suggests that medical students with prior practical experience in the medical field show greater interest in general practice and rural work (Erschens et al., 2021; Leutritz et al., 2024; Selch et al., 2021). Against this background, this study therefore compared, in a rather exploratory approach, specialty interests between students with and without pre-qualifications (Research Question, RQ 1). Its primary aim was to examine how professional and academic pre-qualifications, as well as vocational interests according to Holland's RIASEC model (acronym for Realistic, Investigative, Artistic, Social, Enterprising, Conventional; Holland, 1997), were associated with interest in rural practice (RQ 2+3). To address RQ 1, medical students reported their interest in 15 specialty training programs, plus an "other" option, corresponding to the most common specialty training programs in Germany. Following the approach of Heinz and Jacob (2012), students were allowed to select up to three programs. Odds ratios (ORs) with corresponding 95% confidence intervals (CIs) indicated that pre-qualifications - particularly vocational training and voluntary service - were associated with differing specialty training preferences. Medical students with vocational training in the medical field more frequently reported interest in anesthesiology and general medicine, whereas they less frequently reported interest in ophthalmology, neurology,

RESULTS AND DISCUSSION

otorhinolaryngology, gynecology and obstetrics, psychiatry and psychotherapy, surgery, and radiology compared with students without prior vocational training. Medical students with a previous academic degree showed greater interest in “other” specialty programs and less interest in pediatrics. Students with prior voluntary service more frequently reported interest in anesthesiology, general medicine, radiology, internal medicine, and pediatrics than those without voluntary service. In contrast, they were less interested in ophthalmology, otorhinolaryngology, neurology, “other” specialties, and surgery compared with students who had not completed voluntary service. The strongest association was observed between vocational training and interest in anesthesiology (medium-large effect). In the sample of this dissertation, this may be explained by the high proportion of students with paramedic training, as both paramedics and anesthesiologists frequently work in emergency settings (Gräsner et al., 2013; Pajonk et al., 2011; Sorgatz et al., 2018).

Specialty preferences differed between medical students with and without professional or academic pre-qualifications and varied by type of pre-qualification. In line with the Community of Practice model (CoP) (Wenger, 2000, 2004), early participation in a CoP may shape professional identity and subsequently specialty training preferences. To address RQ 2 and 3 we applied a linear mixed model (level-2 variable: survey period*medical school) to predict interest in rural practice. Predictors included vocational training, academic degree, voluntary service, and six vocational interest orientations based on Holland's RIASEC model (Bergmann, 2003; Holland, 1997). Age, gender, semester level, general practice internship, rural origin, and interest in general medicine were included as control variables. Estimated marginal means (EMMs) were calculated to illustrate effects. Interest in rural practice was positively predicted by practical-technical (realistic, R-type) and social interests (social, S-type) and negatively predicted intellectual-research interests (investigative, I-type), while professional and academic pre-qualifications showed no significant effect. In contrast, higher age, rural origin, and interest or prior contact with general medicine were positively associated with rural practice interest, with interest in general medicine showing the strongest effect. These findings suggest that medical schools should foster interest in rural practice through targeted curricular strategies, such as rural placements, early emphasis on general practice, and the development of rural CoPs.



OPEN ACCESS

EDITED BY
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ACCEPTED 12 June 2025
PUBLISHED 09 July 2025CITATION
Schröpel C, Festl-Wietek T,
Herrmann-Werner A, Wittenberg T,
Pumtrow M, Herpertz SC, Heinzmann A,
Schüttelz-Brauns K, Boeckers TM,
Zipfel S and Erschens R (2025) Professional
and academic pre-qualifications, career
preferences and aspirations in working as a
rural doctor.
Front. Med. 12:1566303.
doi: 10.3389/fmed.2025.1566303COPYRIGHT
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Herpertz, Heinzmann, Schüttelz-Brauns,
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Professional and academic pre-qualifications, career preferences and aspirations in working as a rural doctor

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Introduction: Internationally, countries are struggling to provide health care in rural areas. In Germany, where the medical school's admissions system rewards prior experience, there are a significant number of students with professional experience (e.g., paramedics, nurses). To date, there has been little research on this pre-experienced subgroup. In a rather exploratory approach, preferences for specialty training were compared between students with and without pre-qualifications. The primary aim of the study was to analyze how pre-qualifications and career types according to Holland's RIASEC (acronym for realistic, investigative, artistic, social, enterprising, conventional) model contribute to interest in working as a rural doctor.

Methods: Overall, 2,370 medical students at different stages of their studies (i.e., 3rd, 6th, 10th semester, and final year) completed the questionnaire. Students indicated interest in working as a rural doctor on a 9-point scale, and expressed interest in up to three specialist training programs from a list of 16. In addition, students answered questions about professional and academic pre-qualifications (i.e., vocational training in the medical field, academic degree, voluntary service) and completed a 6-item questionnaire on vocational interests according to the RIASEC model. The study was a multicenter cross-sectional study conducted at all five medical schools in the federal state of Baden-Württemberg, Germany.

Results: Results show differences in career aspirations according to different pre-qualifications, especially for the pre-qualifications vocational training and voluntary service. The strongest association was found between having completed vocational training and interest in Anesthesiology, OR = 3.92 [3.22, 4.76]. A linear mixed model revealed that higher interest in practical-technical (realistic RIASEC type) or social activities (social RIASEC type), and lower interest in intellectual-research activities (investigative RIASEC type) predicted interest

in rural practice, whereas pre-qualifications did not contribute significantly to the model.

Discussion: The findings contribute to a better understanding of the career preferences of medical students with pre-qualifications. Previous experience may lead to the formation of a professional identity and community of practice (CoP) before medical school, which may also influence career preferences. To promote interest in rural medicine, medical schools could encourage interest in social and practical-technical activities within the curriculum and strengthen the profile of general practice.

KEYWORDS

specialty choice, rural doctor, professional and academic pre-qualifications, vocational interests, RIASEC

1 Introduction

Internationally, countries are facing a shortage of doctors in rural areas (1–4). Geographical isolation, fewer educational and career opportunities for their families, demanding working conditions or lower prestige can deter doctors from working in underserved rural areas (3, 5). To ensure rural medical care, factors that increase interest in rural practice need to be identified and promoted. In Germany, since the winter semester 2019/20 (start date depends on the federal state), some federal states have introduced a ‘rural doctor quota’ to ensure long-term care in rural areas. Each year, a number of study places are allocated to students who commit to working in an underserved area after graduating from medical school (6). While there has been little research into the effectiveness of this quota, several international studies have identified exposure to rural practice during medical training, e.g., through internships or rural placement programs (7–13) as a key factor, alongside rural background (6, 14–16) or schooling (17–19).

In addition to the practical experience gained during their studies, there may be a significant number of medical students who have gained practical experience prior to medical school, for example by working as a scribe or through vocational training in the medical field (20–22). In Germany, the chances of being accepted to medical school can be increased by having such practical experience (22, 23). However, there is little research on how professional or academic pre-qualifications relate to medical students’ career aspirations, particularly in relation to rural practice (22).

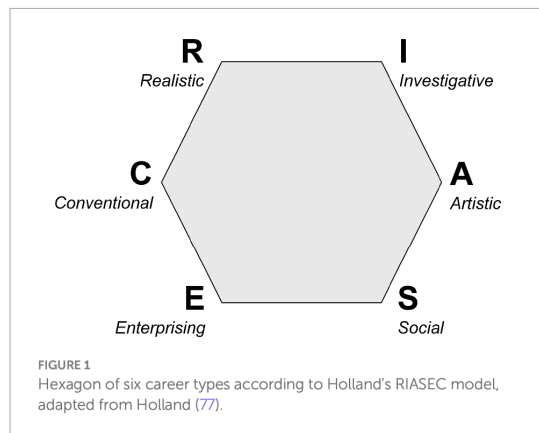
According to Flum and Blustein (24), a key element in making an informed career-choice is the process of vocational exploration, defined as the appraisal of internal attributes (e.g., interests, abilities) and the exploration of external options (e.g., from relevant vocational contexts). This lifelong process overlaps with Erikson’s phases of identity formation (25). Medical students with previous practical or academic experience may be more advanced in both identity formation and career exploration than those without. They may also develop career preferences based on past learning experiences. This is in line with Social Learning Theory (26), which suggests that career decisions result from multiple learning experiences shaped by a complex set of environmental factors and the cognitive-emotional responses to them.

Specialty choice is the product of complex interactions (27–29). When considering theories and models of the development of preferences for specialty training and decisions in general, the influence of past experience is usually taken into account in some

way. According to a theory by Bland (30), when choosing a specialty, it is important that there is a fit between the perceived characteristics of a specialty and the student’s career needs. The student’s value system plays a role, as do the expectations of others, experiences before medical school, the student’s own personality and background, and the culture and characteristics of the medical school. Other models also focus on the optimal fit between specialization and personal preferences. Mitchell (31) defines different domains in the decision-making process (personal characteristics, the cognitive lens, the medical school environment and the choice domain). The personal characteristics domain emphasizes the indirect influence of previous experiences (e.g., family background, previous practical experience) as socialization experiences on the choice of specialty, which may play an important role alongside other variables such as attitudes and values, personality and current life circumstances.

There are indications that individuals with completed vocational training in the medical field are more likely to be interested in general practice (6, 32) or anesthesiology (32). Vocational training in the medical field, e.g., for nurses or paramedics (in Germany these professions do not require a university degree), may share some aspects of anesthesia and general medicine, including intensive patient contact and emergency situations. But is there any evidence of a relationship between interest in rural medicine and previous practical experience? There is some indication that interest in or plans for general practice are associated with greater interest in working in rural areas (33, 34). Studies also show, that medical students with pre-qualifications, such as previous practical experience (35) or voluntary work (17), may be more interested in rural practice than those without. However, there is a paucity of research on the relationship between pre-qualifications and medical students’ career aspirations, particularly in relation to a career in rural practice (22).

In order to better understand the career decision-making processes of medical students, it may be beneficial to also consider models of career decision-making in general. Individuals seek professional environments that match their interests (36). In this context, vocational interest tests are a popular career guidance tool (37). A very influential and widely used theory in this context is Holland’s model of vocational interests (38, 39). Individuals and environments can be described by six broad career types, arranged in a hexagonal structure: Realistic, Investigative, Artistic, Social, Enterprising, Conventional - RISAEC (36), see Figure 1. The



RIASEC model can be used as an additional source of information in career counseling (40) but it can also provide important information in the decision-making process regarding further specialization within a profession. For example, there are a few studies that examine the RIASEC taxonomy in relation to different medical specialties (41–44). The RIASEC profile results from a letter code, the order of which is determined by the ranking of the values on the six scales. There is evidence that the Holland code for general practice/family medicine may include the social (S; e.g. helping, teaching) (41, 42, 45) and investigative (I; e.g. interest in research, intellectual tasks) components (41, 45). Other studies also suggest an association between a social orientation and career aspirations in general practice (46), including rural practice (17, 18). Although there may be similarities between the work environment of a general practitioner and that of a rural doctor, there is a need for research that explicitly examines the relationship between vocational interests and aspirations to work as a rural doctor.

Despite the increasing importance of rural health care in Germany and the associated support programs such as the rural doctor quota (6), there has been little research on the career aspirations of medical students with professional and academic pre-qualifications. The main focus of our study was to investigate how professional and academic pre-qualifications and vocational interests according to Holland's RIASEC model relate to interest in working as a rural doctor. Prior to this, a more exploratory approach was used to investigate interest in different specialties among medical students with and without professional and academic pre-qualifications. The present study aims to investigate the following research questions (RQ):

RQ1: Are there differences in the preference for different specialty training programs between individuals with and without professional and academic pre-qualifications (i.e. completed vocational training in the medical field, voluntary service or academic degree)?

RQ2: Do academic and professional pre-qualifications relate to interest in working as a rural doctor?

RQ3: How do different vocational interests relate to interest in working as a rural doctor?

2 Method

2.1 Design, sample and procedure

This study is a multicenter cross-sectional study conducted at all medical faculties in Baden-Württemberg, a region in south-western of Germany. Medical students at different stages of their studies (i.e., 3rd, 6th, 10th semester, and final year) were recruited via email or during lectures. The questionnaire took about 20 min to complete and was conducted between October 2019 and September 2021. Figure 2 illustrates the data collection process over the four different survey periods in the five medical schools.

2.2 Measures

This study is part of the collaborative research network 'Pre-qualifications for Human Medicine', examining professional and academic pre-qualifications in the context of medical studies based on clearly defined overarching research questions. Two subprojects analyzing pre-qualifications in relationship to academic success (47) and burnout experience (48) have already been published. The present study is a distinct analysis that examines specialty preferences and interest in rural practice. For this reason, the description of the sample and study procedure in this study may be similar to those in the other subprojects of the aforementioned research network. In the following, we refer to the other publications where necessary.

2.2.1 Sociodemographics and control variables

Medical students provided information about their age, gender and the number of inhabitants in their hometown (rural origin was defined as <5,000 inhabitants). They also indicated whether they had planned or completed an internship in general practice.

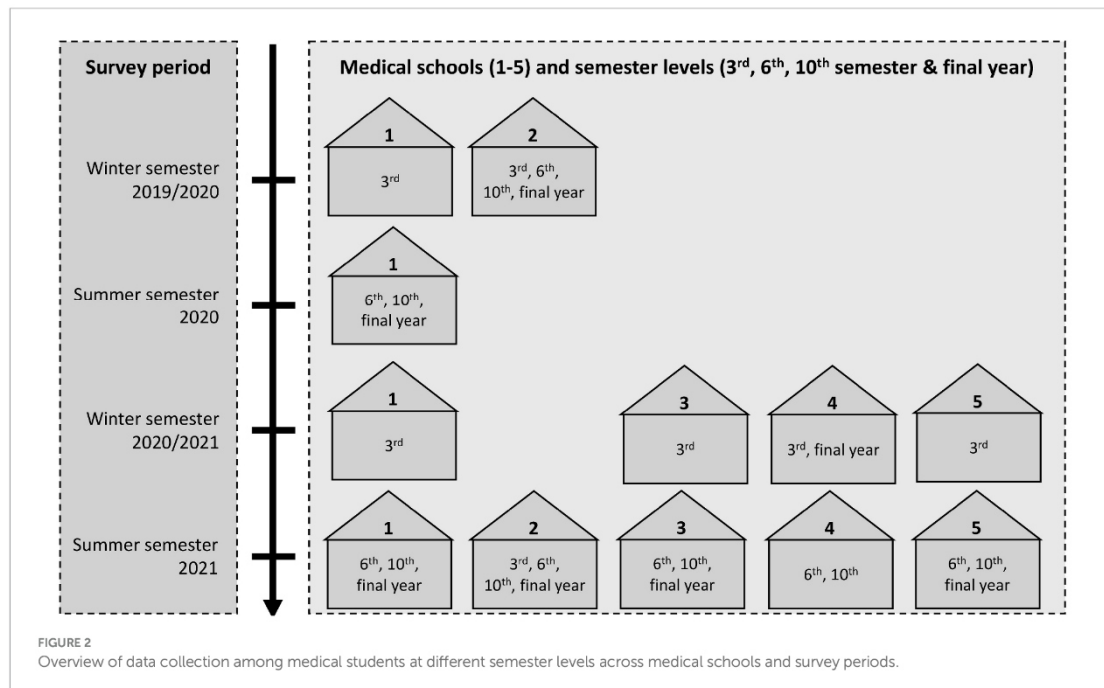
2.2.2 Professional and academic pre-qualifications

All medical students responded to questions about their pre-qualifications, namely vocational training in the medical field, an academic degree or voluntary service completed before medical school. We asked in which area the pre-qualification had been acquired and whether the pre-qualification had been completed or not. For a detailed overview of all items and corresponding response formats, please refer to a publication by Schröpel et al. (47). The following three dummy variables (0 = no, 1 = yes) were defined on the basis of the responses of the medical students, and are collectively referred to as 'professional and academic pre-qualifications':

- 1 Vocational training in the medical field, completed with a grade.
- 2 Academic degree (bachelor/master), completed prior to medical school.
- 3 Voluntary service (duration of ≥ 11 months).

2.2.3 Vocational interests

To assess vocational interests according to Holland's model (36), we utilized a brief scale developed by Bergmann (49). Participants rated their interest in six vocational activities (analogous to the RIASEC taxonomy) on a scale of 1–9, higher scores indicating greater



interest. Examples were given for each of the vocational activities (see Table 1).

2.2.4 Preference for specialty training and working as a rural doctor

Medical students could indicate their interest in 15 specialty training programs (plus an 'other' option), corresponding to common specialty training programs in Germany. Following the approach of Heinz and Jacob (50), medical students could select a maximum of three programs. To assess interest in working as a rural doctor, medical students indicated their interest on a scale from 1 (not interested at all) to 9 (very interested).

2.3 Statistical analysis

For all analyses we used SPSS (28.0.0.0) with a level of significance set at $\alpha = 0.05$. To analyze the associations between different medical specializations with professional and academic pre-qualifications (RQ1), we calculated odds ratio (OR) and corresponding 95% confidence intervals (CI). If the 95% CI for the OR did not include the number 1, we considered the OR to be statistically significant. An OR = 1 would indicate no association, an OR < 1 indicates greater odds in the first group and OR > 1 greater odds in the second group. OR can be an indication of the strength of an association with an OR of about 1.5 indicating a small effect, OR of about 3.0 or more a medium effect, and OR of about 5.0 a large effect (51). To interpret the effect size for OR < 1 and compare to reference values, the OR must be inverted (1/OR) (51).

TABLE 1 Items of Bergmann's vocational interests scale for measuring interest in six vocational activities according to Holland's RIASEC model.

Vocational activities	Examples
Practical-technical (R)	e.g., working with machines or technical equipment, working with wood, metal or other materials, repairing equipment or machines.
Intellectual-research (I)	e.g., carrying out experiments, reading scientific literature, solving abstract problems, developing new ideas, making accurate observations, analyzing.
Artistic-linguistic (A)	e.g., drawing, painting, making music, translating, engaging with art and literature, performing in a theater.
Social (S)	e.g., looking after others, teaching, advising, supporting, working with others, caring for others.
Entrepreneurial (E)	e.g., organizing, running a business, supervising others, influencing, leading, promoting something, selling.
Orderly-administrative (C)	e.g., documentation, compiling statistics, conducting correspondence, designing and applying laws and regulations, managing accounts.

The naming of Holland's RIASEC components (R, realistic; I, investigative; A, artistic; S, social; E, enterprising; C, conventional) slightly differs in Bergmann's scale.

We conducted a linear mixed model, to analyze how professional and academic pre-qualifications (RQ2) and vocational interests (RQ3) relate to interest in working as a rural doctor while accounting for the nested structure of our data. Figure 3 provides an overview of all predictors (including control variables) and their coding, as well as the reference categories of the dummy variables. All continuous predictors were grand mean centered. Estimated marginal means (EMMs) are provided to illustrate the effects. They represent mean values estimated from the regression model, while controlling for the other variables in the model. Before running the analysis, we first calculated intercept-only models and tested whether models with random intercept (random intercept for medical school, survey period or the combination of both) show better fit than the model with fixed intercept. As part of the model selection, we calculated the intraclass correlation coefficient (ICC) and also performed a likelihood ratio test (LRT) to compare the models. The Akaike Information Criterion (AIC) (52) and the Bayesian Information Criterion (BIC) (53), were used as additional parameters for the model selection. Smaller AIC/BIC values indicate a better model fit and are preferred when comparing models. Our study is based on a convenience sample, i.e., we wanted to include as many cases as possible, so no power analysis was calculated prior to the study. However, we conducted a *post hoc* sensitivity analysis using G*Power (54).

In total, 635 (26.8%) 3rd-semester students, 729 (30.8%) 6th-semester students, 485 (20.5%) 10th-semester students and 521 (22.0%) students in their final year participated in the study. In total 655 (27.6%) medical students reported having completed vocational training in the medical field (most of them as a paramedic or nurse), 546 (23.1%) students reported having completed a voluntary service (the majority in the health sector) and 145 (6.1%) students reported to have an academic degree (most in a STEM subject or in the medical field). Some medical students reported to have completed two pre-qualifications (vocational training & academic degree, $n = 8$ students; vocational training & voluntary service, $n = 254$ students; academic degree & voluntary service $n = 10$ students) and $n = 7$ students completed all three pre-qualifications. For a detailed description of the sample and medical students' pre-qualifications see (47).

Overall, 634 (26.8%) medical students reported growing up in a rural area (vs. $n = 1,732$, 73.2% in a larger town or city). A total of 905 (38.7%) students planned to undertake an internship in general medicine, while 1,011 (43.2%) had already completed one and 422 (18.0%) students indicated that they did not plan to do one. Medical students displayed a particular interest in social activities ($M = 7.30$, $SD = 1.67$), followed by intellectual-research ($M = 6.16$, $SD = 2.01$) and entrepreneurial activities ($M = 5.93$, $SD = 2.10$), see Table 2 for a detailed overview of all mean values.

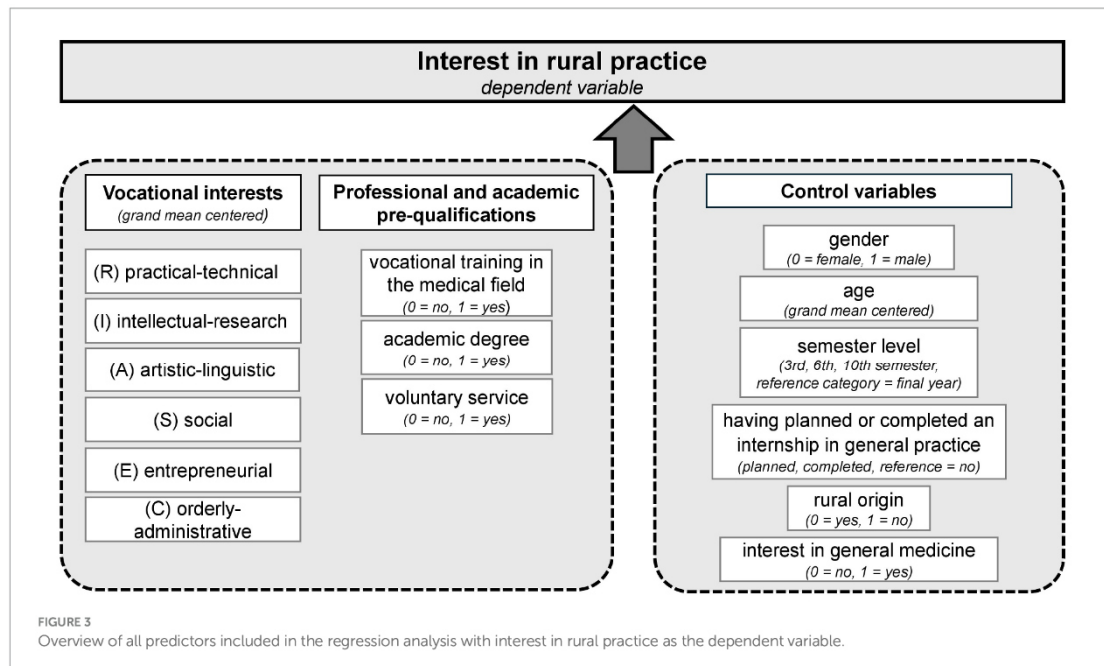
3 Results

3.1 Sample and response rate

Overall $N = 2,370$ medical students took part in our study (women: 64.7%, $n = 1,521$; men: 35.1%, $n = 826$, other: 0.2%, $n = 4$).

3.2 Preferences for specialty training

We excluded 21 cases for not specifying a specialty or for specifying more than the three allowed. Of all medical students included in the analysis ($N = 2,349$), the majority indicated an interest



RESULTS AND DISCUSSION

TABLE 2 Interest in the six different occupational activities of Bergmann's vocational interests scale, sorted by mean.

Vocational activities	<i>M</i> (SD)	<i>Mdn</i>
Social (S)	7.30 (1.67)	8
intellectual-research (I)	6.16 (2.01)	6
Entrepreneurial (E)	5.93 (2.10)	6
Artistic-linguistic (A)	5.56 (2.34)	6
Practical-technical (R)	5.23 (2.27)	6
Orderly-administrative (C)	4.83 (2.20)	5

The response format of each scale ranged from 1 to 9, with higher levels indicating greater interest in the corresponding vocational activity.

in Internal Medicine, followed by General Medicine, Pediatrics, Anesthesiology and Surgery, see [Table 3](#). Descriptively, it was found that interest in different specialty training programs varied slightly between semesters. For some specialties the differences were greater, e.g., descriptively, third semester students showed a higher interest in surgery than higher semesters (see [Supplementary Figure S1](#)). Medical students could indicate up to three specializations. On average they indicated $M = 2.63$ ($SD = 0.64$) preferences. Overall, $n = 445$ distinct specialization combinations were identified (see [Supplementary Table S1](#)). The most frequent combination was 'General Medicine–Anesthesiology–Internal Medicine' ($n = 84$, 3.6%).

To test for differences in the preference for different specialty training programs between individuals with and without professional and academic pre-qualifications (RQ 1), we calculated odds ratio (OR) and tested for significance. [Figure 4](#) shows the training preferences for medical students with completed vocational training (panel A), prior academic degree (panel B) and voluntary service (panel C). Specialty training programs above the dashed line and marked with an asterisk were significantly more interesting to medical students with the corresponding pre-qualification than to those without. On the other hand, medical students with the corresponding pre-qualification were less interested in training programs below the dashed line. All OR are sorted according to the strength of the association, and significant OR are marked with an asterisk. In the following, all significant associations are described separately for each of the three pre-qualifications.

The odds of being interested in Anesthesiology ($OR = 3.92$, medium-large effect) and General Medicine ($OR = 1.71$, small effect) were higher for medical students with prior vocational training than for those without. In contrast, the odds of being interested in Ophthalmology ($OR = 0.34$, medium effect), Neurology ($OR = 0.42$, small-medium effect), Otorhinolaryngology ($OR = 0.59$, small effect), Gynecology and Obstetrics ($OR = 0.60$, small effect), Psychiatry and Psychotherapy ($OR = 0.62$, small effect), Surgery ($OR = 0.68$, small effect), and Radiology ($OR = 0.69$, small effect) were lower for students with than without prior vocational training ([Figure 4A](#)).

When comparing students with a previous academic degree with those without, two significant differences in specialization preferences were found see ([Figure 4B](#)). The odds of being interested in 'other' specialty programs ($OR = 2.12$, small-medium effect), were higher for medical students with previous academic degree than for those without. However, the odds of being interested in Pediatrics ($OR = 0.37$, small-medium effect) were lower for students with previous degree than for those without.

TABLE 3 Interest of medical students in common German specialty training programs, sorted by relative frequency.

Specialty training program	Interest in specialty training program <i>n</i> (%)	
	Yes	No
Internal medicine	1,037 (44.1)	1,312 (55.9)
General medicine	792 (33.7)	1,557 (66.3)
Pediatrics	645 (27.5)	1704 (72.5)
Anesthesiology	635 (27.0)	1714 (73.0)
Surgery	602 (25.6)	1747 (74.4)
Gynecology and obstetrics	499 (21.2)	1850 (78.8)
Neurology	351 (14.9)	1998 (85.1)
Orthopedics	278 (11.8)	2071 (88.2)
Psychiatry and psychotherapy	227 (9.7)	2,122 (90.3)
Radiology	224 (9.5)	2,125 (90.5)
Psychosomatic medicine and psychotherapy	154 (6.6)	2,195 (93.4)
Dermatology	124 (5.3)	2,225 (94.7)
Urology	119 (5.1)	2,230 (94.9)
Otorhinolaryngology	117 (5.0)	2,232 (95.0)
Ophthalmology	102 (4.3)	2,247 (95.7)
Other	277 (11.8)	2072 (88.2)

Medical students could indicate up to three preferences, $N = 2,349$.

The odds of being interested in Anesthesiology ($OR = 1.96$, small-medium effect), General Medicine ($OR = 1.77$, small effect), Radiology ($OR = 1.57$, small effect), Internal Medicine ($OR = 1.35$, small effect), and Pediatrics ($OR = 1.27$) were higher for students with prior voluntary service than for those without, while the odds of being interested in Ophthalmology ($OR = 0.39$, small-medium effect), Otorhinolaryngology ($OR = 0.44$, small-medium effect), Neurology ($OR = 0.51$, small-medium effect), 'other' specialty ($OR = 0.69$, small effect), and Surgery ($OR = 0.77$, small effect) were lower for students with prior voluntary service than for those without ([Figure 4C](#)).

3.3 Interest in working as a rural doctor

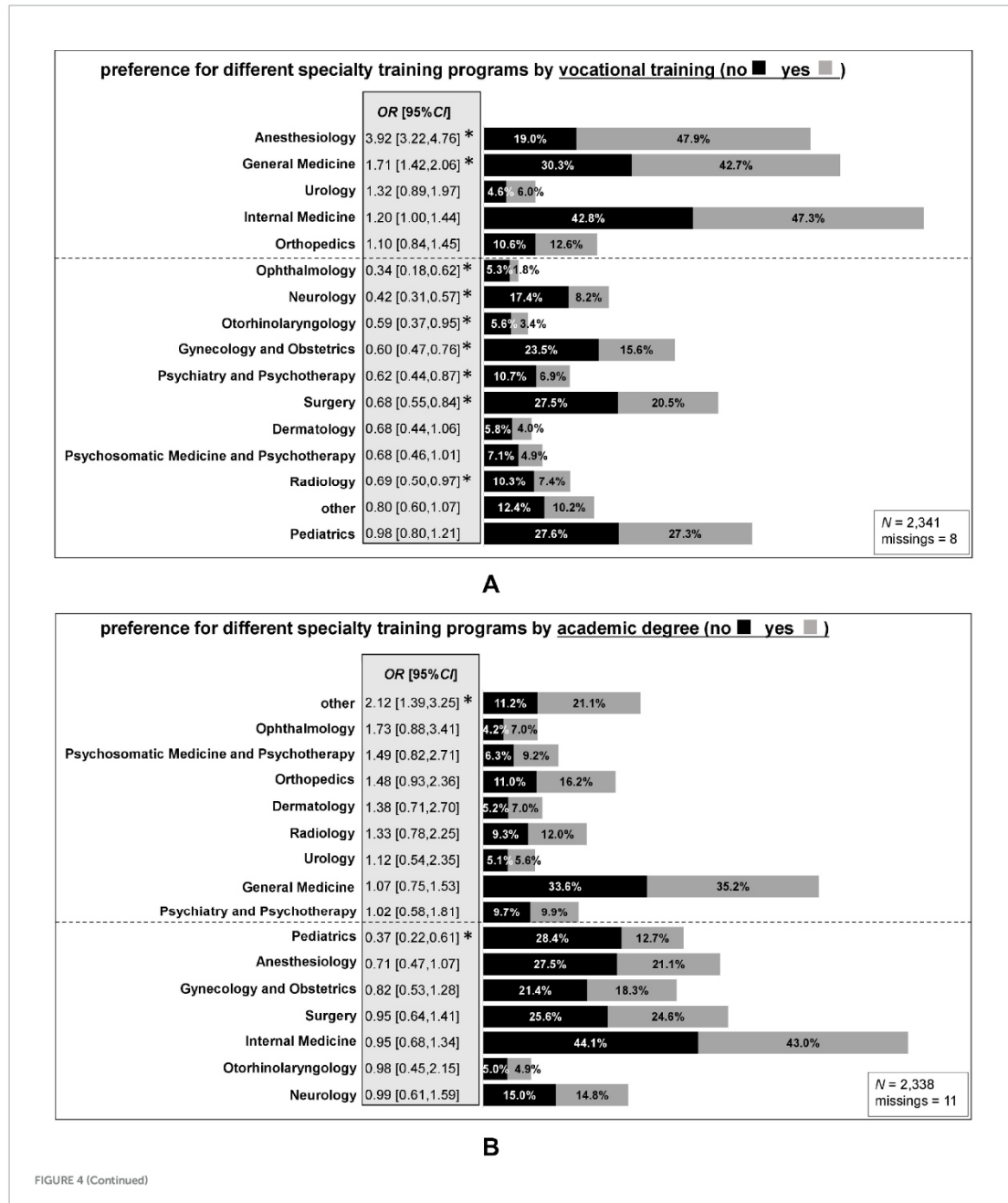
We calculated three multilevel null models (maximum likelihood estimation, ML) to test if the intercept of our dependent variable (level 1) was independent of the level 2 grouping variables 'survey period' and 'medical school' or their combination. All calculated ICC of the null models were close to zero (see [Table 4](#)), indicating only a small amount of variance in the dependent variable could be explained due to the variance between the subgroups of the respective level-2 variable (e.g., 4% survey period*medical school). However, the results of the Likelihood Ratio Test indicated that all three random intercept models had a significantly better fit than the intercept-only model with fixed intercept ($p < 0.001$). For the final selection of the model, we compared the information criteria AIC and BIC of the respective models. The intercept-only model with random intercept for the combination of survey period and medical school was found to be the model with the best fit. In the next step we added all predictors to the

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model and ran the analysis. The final model was estimated using restricted maximum likelihood estimation (REML).

The assumptions of linear mixed modeling were checked and overall met. However, the residuals plotted against the predicted values showed a negative linear trend. This likely reflects the limited, quasi-interval nature of the 9-point scale used for the dependent variable. As a result, the model may systematically overestimate high

values and underestimate low values of this variable. Interpretations therefore focus on the direction and significance of effects rather than on their precise magnitude. Professional and academic pre-qualifications (vocational training, voluntary service, academic degree) and interest in artistic-linguistic, entrepreneurial, or orderly-administrative activities did not contribute significantly to the model. However, medical students with a higher interest in



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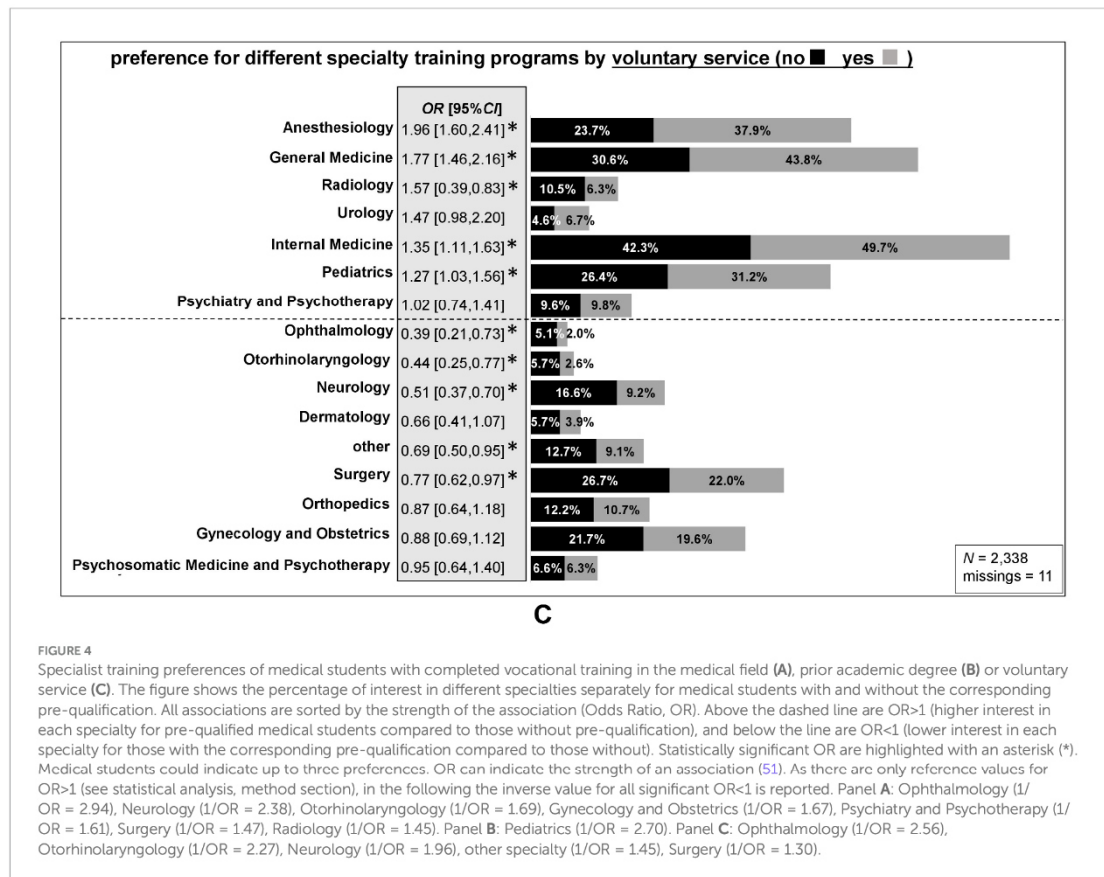


TABLE 4 Model selection, comparison of intercept-only model with fixed intercept and three models with random intercept for survey period, medical school or survey period* medical school.

Model	ICC	−2 LL	LRT	AIC	BIC
Fixed intercept ¹		10922.59		10926.59	10938.13
Random intercept for ²					
Survey period	0.01	10913.53	$\chi^2(1) = 9.06, p = 0.003$	10919.53	10936.84
Medical school	0.02	10867.23	$\chi^2(1) = 55.36, p < 0.001$	10873.24	10890.53
Survey period*medical school	0.04	10862.64	$\chi^2(1) = 59.95, p < 0.001$	10868.64	10885.94

¹ $n = 2,370$; ICC, Interclass correlation coefficient, −2 LL = restricted −2 Log Likelihood; LRT, Likelihood Ratio Test; AIC, Akaike Information Criterion; BIC, Bayesian Information Criterion.

² $Y_{ij} = \beta_0 + \epsilon_i + \epsilon_{ij}$.

practical-technical or social activities and with a lower interest in intellectual-research activities reported a significantly higher interest in working as a rural doctor. Of our control variables older medical students showed more interest in rural practice and having planned or completed an internship in general practice, interest in General Medicine and rural origin predicted interest in rural practice. The control variables gender and semester level showed no significant effect, see Table 5 for the results of the linear mixed model. Estimated marginal means (EMMs) were calculated to illustrate the effects of

the predictors. In particular, students with an interest in General Medicine ($M = 6.44$, $SE = 0.15$) were significantly more interested in working in rural medicine than students without such an interest ($M = 3.74$, $SE = 0.15$). The differences in the EMMs of interest in working as a rural doctor (scale from 1 to 9 points) between those with and without vocational training (difference = -0.14), between those with and without an academic degree (difference -0.04), and between those with and without voluntary service (difference = 0.08) were very small (see Table 6). As our sample includes medical

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TABLE 5 Results of the linear mixed regression analysis (random intercept for survey period*medical school) with interest in working as a rural doctor as dependent variable including coefficients, standard errors, *p*-values, confidence intervals, and fit statistics.

Predictors	B ¹	SE(B)	df	<i>p</i>	CI(B)	
					LL	UL
Vocational training (yes)	−0.14	0.12	2186.05	0.255	−0.37	0.10
Academic degree (yes)	−0.04	0.19	2201.98	0.810	−0.41	0.32
Voluntary service (yes)	0.08	0.10	2200.30	0.404	−0.11	0.27
Practical-technical activities	0.07	0.02	2201.18	<0.001***	0.03	0.11
Intellectual-research activities	−0.09	0.02	2202.12	<0.001***	−0.13	−0.05
Artistic-linguistic activities	0.03	0.02	2199.77	0.142	−0.01	0.06
Social activities	0.16	0.03	2197.06	<0.001***	0.11	0.21
Entrepreneurial activities	0.02	0.02	2200.76	0.396	−0.02	0.06
Orderly-administrative activities	0.01	0.02	2200.59	0.492	−0.03	0.05
Gender (male)	−0.17	0.09	2202.52	0.065	−0.35	0.01
Age	0.05	0.02	2199.51	0.003**	0.02	0.08
Semester level ¹						
3rd	0.30	0.19	356.75	0.107	−0.06	0.67
6th	0.27	0.15	2175.46	0.069	−0.02	0.55
10th	0.01	0.12	2188.11	0.964	−0.23	0.24
Internship in general practice ²						
Planned	0.57	0.12	2202.61	<0.001***	0.34	0.81
Completed	0.50	0.14	2191.66	<0.001***	0.22	0.78
Rural origin (yes)	−0.67	0.09		<0.001***	−0.85	−0.49
Interest in general medicine (yes)	2.70	0.09	2199.28	<0.001***	2.53	2.88
Intercept	3.38	0.19	200.94	<0.001***	3.02	3.75

AIC = 9116.54; BIC = 9127.94, −2LL = 9112.54; var.: level-1 residuals = 3.43; var.: random intercept = 0.04; ICC = 0.01.
 CI, confidence interval; LL, lower level; UL, upper level; AIC, Akaike Information Criterion; BIC, Bayesian Information Criterion; −2LL = restricted −2LogLikelihood.
¹The reference category = ‘final year’.
²The reference category = ‘no general practice internship planned or completed’.
 p* < 0.05, ** *p* < 0.01, * *p* < 0.001.

students who completed several prior qualifications before starting their studies, we calculated the EMMs for all possible combinations of pre-qualifications. [Supplementary Figure S2](#) in the Appendices shows that there was little difference in interest in rural practice between the groups.

TABLE 6 Estimated marginal means of interest in rural practice (scale from 1 to 9) for all categorical predictors of the model.

Predictors	<i>M</i>	SE	i-j	<i>n</i>
Vocational training				
Yes (i)	5.03	0.16	−0.14	617
No (j)	5.16	0.14		1,605
Academic degree				
Yes (i)	5.07	0.20	−0.04	136
No (j)	5.12	0.12		2,086
Voluntary service				
Yes (i)	5.14	0.16	0.08	520
No (j)	5.05	0.14		1702
Gender				
Male (i)	5.01	0.15	−0.17	777
Female (j)	5.18	0.14		1,445
Semester level = 3rd				
Yes (i)	5.24	0.14	0.30	569
No (j)	4.94	0.19		1,653
Semester level = 6th				
Yes (i)	5.22	0.18	0.27	687
No (j)	4.96	0.13		1,535
Semester level = 10th				
Yes (i)	5.10	0.17	0.01	687
No (j)	5.09	0.13		1,757
Rural origin				
No rural origin (i)	4.77	0.14	−0.65	1,620
Yes, rural origin (j)	5.42	0.15		602
Internship in general practice = planned				
Yes (i)	5.38	0.15	0.58	841
No (j)	4.81	0.15		1,381
Internship in general practice = completed				
Yes (i)	5.34	0.17	0.50	977
No (j)	4.84	0.13		1,245
Interest in general medicine				
Yes (i)	6.44	0.15	2.70	763
No (j)	3.74	0.15		1,459

M represent estimated marginal means with standard error (SE).

The *post hoc* sensitivity analysis indicated that given the large sample size ($N = 2,370$), $\alpha = 0.05$, power ($1 - \beta$) of 0.90 and 9 tested predictors within a model including 18 covariates, the minimum detectable effect size was $f^2 < 0.01$, corresponding to a small effect (55). This suggests that even subtle effects, accounting for less than 1% of the total variance in the dependent variable could have been detected. However, as the power analysis was based on a fixed-effects linear regression model, it does not fully account for the multilevel structure of the data. As such, the sensitivity estimation should be interpreted as an approximation. In our analysis, however, statistical significance was not equated with practical relevance. Interpretations focus on theoretically meaningful and consistent patterns.

4 Discussion

We conducted a cross-sectional study at five medical faculties in Baden-Wuerttemberg, Germany with an overall sample size of $N = 2,370$ (i.e., 3rd-, 6th-, and 10th semester and final-year students). To get an overview of which specialty training programs are generally of interest to different groups, we investigated the differences between medical students with and without professional pre-qualifications (i.e., vocational training in the medical field, academic degree or voluntary service) (RQ1). We found differences in preferences for different specialties, particularly among medical students who had completed vocational training (vs. not) or voluntary service (vs. not). The strongest association was between vocational training and interest in Anesthesiology, with trained students showing greater interest than those without training. The main focus of our study was to analyze how professional and academic pre-qualifications (RQ2) and different vocational interests according to Holland's RIASEC model relate to interest in working as a rural doctor (RQ3). We observed no association between having completed vocational training, an academic degree or voluntary service and interest in working as a rural doctor. However, higher interest in practical-technical and social activities and lower interest in intellectual-research activities were associated with a greater interest in rural practice. There were no associations with interest in artistic-linguistic, entrepreneurial or orderly-administrative activities.

4.1 Pre-qualifications and differences in specialty training aspirations

There has been little research into how professional and academic pre-qualifications relate to career aspirations (22). Overall, medical students expressed the greatest interest in Internal Medicine, which is consistent with previous findings from Germany (32, 50). In our study, medical students were able to indicate up to three preferences for different specialty training programs. This allows students who are still in the decision-making process to give a more realistic indication of their preferences, but limits the comparability of the frequencies with other studies. Based on this response format, we were able to identify the most frequently reported combination of medical specialties, which was 'General Medicine–Anesthesiology–Internal Medicine'.

To answer RQ1, the three pre-qualifications we defined were considered separately. In line with previous studies, medical students who had completed vocational training in the medical field were more likely to be interested in General Medicine (6, 32) or Anesthesiology (32). As a large proportion in our sample of students with completed vocational training completed paramedic training, this may explain the high interest in Anesthesiology, as both paramedics and anesthesiologists are exposed to emergency situations (56–58). This may be particularly relevant for Germany, where professional experience and vocational training in the medical field are highly valued in the admissions system compared to other countries (21). As a result, a relatively large number of people in Germany train as nurses or paramedics before studying medicine. In addition, the 'waiting list quota' was in place until 2020, and many students bridged the waiting period for a place at medical school with vocational training (59).

Our results show similar preferences for students with vocational training and those who have completed voluntary service (higher interest in Anesthesiology, General Medicine and lower interest in Ophthalmology, Otorhinolaryngology, Surgery). The higher interest

in General Practice that we found among this subgroup is consistent with studies linking volunteering or social/societal orientation to increased interest in general (rural) practice (17, 18, 46, 60). For medical students with a prior academic degree, only two significant associations emerged. They showed a higher interest in 'other' specialties and lower interest in Pediatrics than those without a prior degree. One possible explanation is that previous study experience may not have been specific enough to influence interest in different specialties, so that medical students with academic degree may differ only slightly from those without.

Our rationale for this study was that medical students who have completed professional or academic qualifications prior to medical school may have different career preferences to their peers who have not. We were able to identify such differences for some specialty training programs and depending on the type of pre-qualification. Based on Social Learning Theory (26) and theories of the development of specialty preferences (30, 31), it was hypothesized that prior learning experiences would influence identity and career formation. The Community of Practice (CoP) Model (61, 62) offers another possible theory of how experiences shape identity and thus influence life and career choices. The model emphasizes the social component of learning and describes a CoP as a group of people who share a common interest and knowledge and exchange ideas about it (61, 62). The three characteristics of a CoP are (1) the domain of interest which creates a common identity in the group, (2) the community for which the domain is relevant and (3) the practice as the knowledge and methods shared (61). Medical students who have completed vocational training in the medical field prior to medical school, or who have had other academic or practical experience, may have participated in a CoP (or in its periphery) even before entering medical school. Through practical experience and interactive learning processes, a CoP with a shared identity and a common understanding of the values and ways of working in its environment may have developed. The model may explain the differences we found. When students start their medical studies, they gradually become part of a (new) CoP, which is based on or influenced by previously existing CoPs.

4.2 Pre-qualifications, vocational interests and rural doctor aspirations

In our study, we found no association between professional and academic pre-qualifications and interest in working as a rural doctor (RQ2). Neither having completed a vocational training in the medical field, an academic degree nor a voluntary service could be associated with interest in rural practice. Our results contradict those of Kesternich et al. (35), who found an association between pre-study work experience and interest in rural practice. However, the authors only found small effects at a significance level of 10%.

We found no studies on the relationship between a previous academic degree and interest in rural practice, so our findings make an important contribution here. The fact that we found no differences between medical students who did and did not complete voluntary service contradicts the findings of Feldmann et al. (17), who found an association between having completed a voluntary service and a greater interest in rural medicine. While both interest in rural medicine and prior voluntary service/vocational training could be related to interest in General Medicine in prior studies (17, 35), we found no direct relationship between interest in rural medicine and professional and academic pre-qualifications. As part of our first

research question (RQ1), we were able to show that the specialty preferences of people with previous experience may differ from those of people without previous experience. However, this does not seem to be the case for interest in working as a rural doctor. The professional and academic pre-qualifications we have defined may be too imprecise to influence interest in rural practice, and further studies could explicitly analyze previous experiences in rural areas.

As part of our analysis, we also looked at different control variables. While previous studies have shown mixed results regarding the influence of gender (16, 63), we found no differences between men and women regarding interest in rural medicine. We also found no differences between the different semester levels in our sample. However, consistent with previous studies, our control variables (higher) age (16, 17), rural origin (6, 16), interest or contact with General Medicine (33) were positively associated with interest in rural practice. The relationship with interest in General Medicine was by far the strongest in the overall model and recommendations for medical education can be derived from this. Medical schools could strengthen their profile in General Medicine. In addition, specific courses and placements in rural areas could be offered to encourage interest in general practice and working in rural areas. Again, the COP model can provide important impetus for practical recommendations. Medical schools could specifically promote the development of CoPs in general and rural medicine as part of their curricula (64). Practical experience (e.g., through internships) plays a particularly important role here, as learning is not only about acquiring knowledge, but also about increased participation in CoPs (61, 65).

Regarding RQ3, higher interest in practical-technical activities, higher interest in social activities and lower interest in intellectual-research activities were associated with higher interest in working as a rural doctor. There were no associations with an interest in artistic-linguistic, entrepreneurial or orderly-administrative activities. Previous studies showed a link between the social (41, 42, 45) and investigative (41, 45) components of Holland's RIASEC model and interest in general practice. Based on these findings we expected similarities in the RIASEC profile for rural practice. Our findings on the social (S) Holland component are consistent with studies showing an association between social orientation and rural practice (17, 18). However, in our sample, interest in intellectual-research activities was negatively associated with interest in rural practice. This is consistent with a study of motivational factors influencing interest in rural medicine, which showed that students motivated by intellectual challenge were less interested in rural practice (33). Instead, we found a positive relationship with interest in practical-technical activities. A study on the RIASEC types and medical specialties shows that Holland's type R (realistic = practical-technical) can be mapped to the surgical discipline (43). The authors used the R component to describe surgeons as a group with high practical skills, craftsmanship and efficient outcomes. This may also be relevant for rural doctors. Far from larger cities with specialists for specific conditions, rural doctors may have to deal with a wide range of tasks and medical conditions that may require a more practical approach. Therefore, medical students who are more interested in practical-technical activities may be more interested in rural work, or vice versa. In order to stimulate interest in rural medicine, interest in social and practical activities could be encouraged within the medical curriculum or even made a priority for admission to medical school. Interestingly, our sample of medical students showed a high level of interest in social activities compared to the other RIASEC dimensions, which is in line

with other findings on vocational interests within medical students (42). Given the shortage of rural doctors, selection procedures could place more emphasis on social and communication skills (e.g., emotional availability) in the medical school admission process (66).

The findings of this study contribute to a more comprehensive understanding of the factors associated with interest in working as a rural doctor. However, most of the effects we found were small indicating important trends, but suggesting that there may be other influencing factors that were not investigated in our study. Career development and the choice of specialty program are complex and may be influenced by many factors, including personality traits (67), gender differences (68, 69), work and time-related aspects, career-related aspects and patient orientation (69), and also the specific home-country (68). Career paths taken by medical students, may also be significantly influenced by unplanned events, chance and the nonlinearity of change (70, 71).

Holland's RIASEC model (36) offers a way to match medical students' specialty preferences with their vocational interests. However, the model has its limitations. While individuals tend to seek a match between their interests and their environment (36), an optimal match is not always necessary. It is important that characteristics that are personally important to the individual are present in the work environment (72). Further research into the factors that may prevent medical students from considering working in rural areas, and how existing barriers can be overcome (3, 5).

4.3 Strengths and limitations

In the present large study, conducted at five medical schools in Germany, we examined professional and academic pre-qualifications and vocational interests in relation to the career aspirations of medical students. To our knowledge, no other study has examined these relationships in such a broad way. Our findings contribute to a better understanding of potential factors influencing interest in rural medical practice and to the crucial issue of securing primary care, especially in rural Germany (73).

However, there are some limitations to mention. First, there is no consistent definition of 'rural' in the literature. Rural practice in Central Europe has a different meaning than in large scale countries such as Australia or the USA. Second, our cross-sectional study only captures interests and not actual career choices, so further longitudinal studies are needed to identify factors that influence the process of specialty choice. Furthermore, when interpreting the results of the dichotomous variables 'vocational training', 'academic degree' and 'voluntary service', the following should also be taken into account: Firstly, the three variables do not include students who dropped out before completing the respective qualification. Secondly, each dummy variable should be interpreted independently, as it is also possible that a person with vocational training has previously done voluntary work before. Also due to the quasi-interval nature of our dependent variable 'interest in rural practice', interpretations of the linear mixed model results should focus on the direction and significance of the effects rather than on their precise magnitude. Finally, our study was conducted across all medical faculties in the German state of Baden-Württemberg and is not representative of medical schools in Germany in general, and as participation in the study was voluntary, potential selection bias cannot be ruled out.

5 Conclusion

Due to the German admissions system for medical studies, there is a relatively large group of medical students who have already gained practical experience before medical school (21, 22). However, there has been little research on this group of 'pre-experienced' medical students in general and their career aspirations in particular (22). Our study showed that specialty preferences may differ according to prior experience. This finding is relevant to researchers in the field of medical education, as it means that prior experience may lead to the formation of a professional identity and community of practice (CoP) even before starting medical school. However, we were also able to show that professional and academic pre-qualifications did not seem to have any influence on interest in working as a rural doctor. We were able to identify other influencing factors, such as rural origin, interest in or placements in general practice and interest in social or practical-technical activities. The results of this study suggest that medical schools should promote interest in rural medicine through targeted curricular adjustments, such as rural placements, and place more emphasis on general practice and encourage the development of rural practice CoPs at an early stage. Emphasizing interprofessional training and collaboration as part of a team approach to patient care is also important and should be encouraged in modern healthcare systems (74). In addition to the factors influencing interest in rural practice, we recommend longitudinal research into concepts such as the rural doctor quota introduced in Germany (6), the training of medical assistants (75) and telemedicine (75, 76).

Data availability statement

The datasets presented in this article are not readily available because of the high confidentiality of the data. The authors of the study received permission from the Medical Faculty of Tübingen to conduct the study and to collect these data only if they were not made publicly available without individual permission for specific questions (i.e. on request). Requests to access the datasets should be directed to psychosomatik@med.uni-tuebingen.de.

Ethics statement

The studies involving humans were approved by Ethics Committees of the Faculty of Medicine at Tübingen University Hospital. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

CS: Writing original draft, Conceptualization, Methodology, Project administration, Data curation, Formal analysis, Investigation, Software, Visualization. TF-W: Investigation, Methodology, Project administration, Writing – review & editing. AH-W: Conceptualization, Methodology, Supervision, Project administration, Writing review & editing. TW: Investigation, Methodology, Writing review & editing. MP: Formal analysis, Writing review & editing. SH: Methodology, Writing review & editing. AH: Investigation, Writing – review & editing. KS-B:

Investigation, Writing – review & editing. TB: Conceptualization, Writing – review & editing. SZ: Methodology, Resources, Supervision, Validation, Writing – review & editing. RE: Conceptualization, Data curation, Validation, Investigation, Methodology, Project administration, Software, Supervision, Writing – review & editing.

Funding

The author(s) declare that financial support was received for the research and/or publication of this article. The present study was conducted within the joint framework 'Pre-qualification in Human Medicine'; FEST-BW funding line 4 'Aptitude and Selection'; VSM-BW ('Verbund Studierendenauswahl in der Medizin in Baden-Württemberg'). The project was funded by the Ministry of Science, Research and Art Baden-Württemberg (AZ: 23-0421.918-4(18)/UNI TU/2).

Acknowledgments

VSM-BW ('Verbund Studierendenauswahl Medizin in BW') is a collaborative project within the initiative FEST-BW ('Fonds Erfolgreich Studieren in Baden-Wuerttemberg'). The authors would like to thank all participating medical students as well as everyone who supported on site the members of the FEST-BW study group (in alphabetical order): Kerstin Ahlborn, David Ambiel, Dorothee Amelung, Ana-Maria Bordes, Marianne Giesler, Petra Hahn, Lutz Hein, Augustin Kelava, Natalie Petersen, Tim Schaffland, Regina Sticker & Thomas Wieland. The authors acknowledge support by the Open Access Publishing Fund of the University of Tübingen.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Generative AI statement

The authors declare that no Gen AI was used in the creation of this manuscript.

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Supplementary material

The Supplementary material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/fmed.2025.1566303/full#supplementary-material>

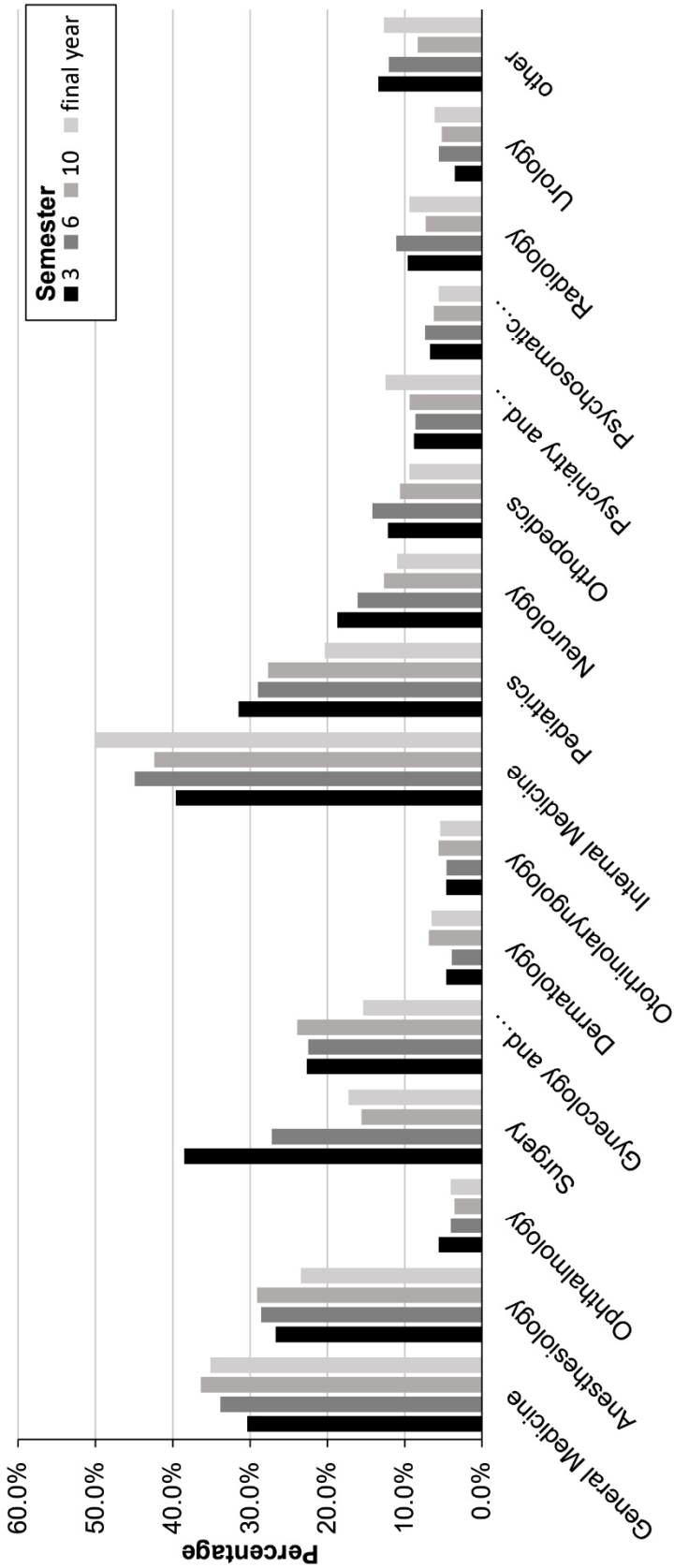
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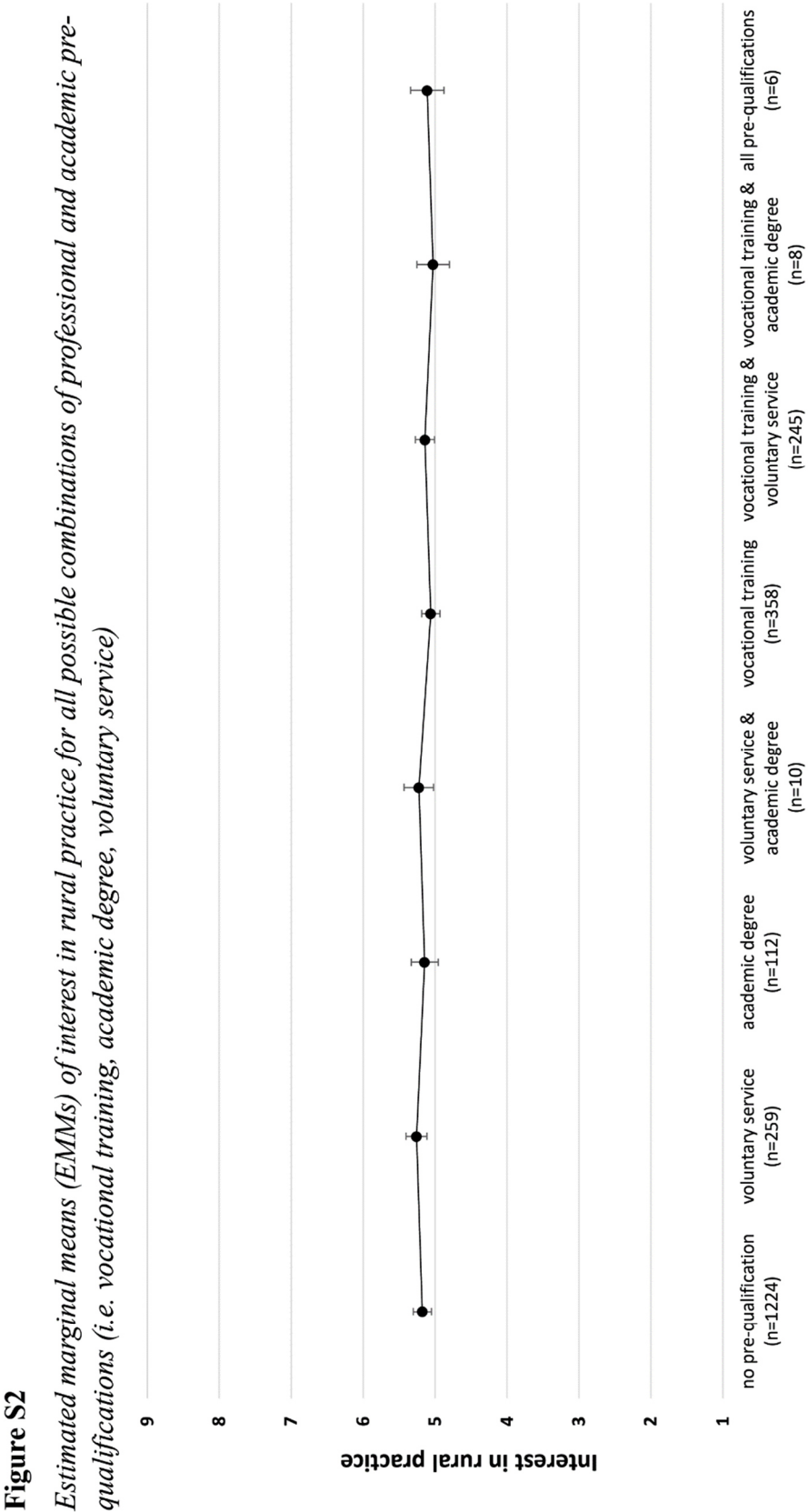
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Figure S1
Specialty preferences separately for each semester level in percentages



Note. For each semester, the percentage of students who expressed an interest in the 15 specialties (+ ‘other’ specialty) was calculated separately. Interpretation example: 30.4% of all students in the third semester expressed an interest in General Medicine (first bar, black). Medical students could list up to three preferences



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Table S1

List of the most frequently ($\geq 1.0\%$) indicated combinations of specialist training programs

no.	combination	<i>n</i>	%
1	General Medicine;Anesthesiology;Internal Medicine	84	3.6
2	General Medicine;Internal Medicine;Pediatrics	54	2.3
3	Anesthesiology;Internal Medicine	46	2.0
4	Anesthesiology;Internal Medicine;Pediatrics	42	1.8
5	General Medicine;Gynecology and Obstetrics;Internal Medicine	38	1.6
6	General Medicine;Gynecology and Obstetrics;Pediatrics	38	1.6
7	Pediatrics	38	1.6
8	Internal Medicine	36	1.5
9	General Medicine;Internal Medicine;Neurology	33	1.4
10	Anesthesiology;Surgery;Internal Medicine	32	1.4
11	Gynecology and Obstetrics;Internal Medicine;Pediatrics	27	1.1
12	Surgery	27	1.1
13	General Medicine;Internal Medicine	26	1.1
14	Anesthesiology;Surgery;Orthopedics	25	1.1
15	Surgery;Internal Medicine;Neurology	25	1.1
16	other	24	1.0
17	Surgery;Internal Medicine;Pediatrics	24	1.0
18	General Medicine;Anesthesiology;Pediatrics	23	1.0
19	Internal Medicine;Pediatrics	23	1.0
...	...	...	
445	Overall	2349	100.0

Note. Medical students were able to list up to three preferences.

4 Discussion

4.1 Core results

This dissertation addresses a research gap by examining medical students with professional and academic pre-qualifications (i.e., vocational training in the medical field, academic degree and voluntary service), a group that has received limited empirical attention in medical education research (Erschens et al., 2021). The overarching aim was to investigate how different types of pre-qualifications are associated with key outcomes in medical training, including academic performance, study satisfaction, and specialty preferences. *Study 1* systematically described the sample and distribution of pre-qualifications and found no academic advantage of professional and academic pre-qualifications. Vocational training was associated with more repeated examinations (small effect), while a prior academic degree was linked to poorer M2 grades (medium effect). Voluntary service showed no significant associations with any academic success outcomes (M1 and M2 grades, repeated examinations, semesters exceeding the standard period of study). Extending beyond objective success outcomes, *Study 2* examined study satisfaction as a subjective outcome (three dimensions: satisfaction with the study content, the study conditions, and with the coping of study loads). Vocational medical training did not moderate the relationship between deep-processing learning strategies and satisfaction with study content. However, learning strategy elaboration was positively and critical thinking negatively associated with satisfaction with study content. Part-time employment fully mediated the relationship between prior vocational training or an academic degree and satisfaction with study conditions and coping with study loads, however effect sizes were small. Specifically, students with these pre-qualifications were more likely to be in part-time employment, which was negatively associated with satisfaction with study conditions, but positively associated with coping with study loads. Finally, exploratory analyses indicated that prior voluntary service was linked to lower satisfaction regarding coping with study loads. *Study 3* extended the analysis to career-related outcomes. Pre-qualifications, particularly vocational training and voluntary service, were associated with different specialty preferences, with the strongest effect observed for vocational

training and interest in anesthesiology (medium-large effect). Professional and academic pre-qualifications did not predict interest in rural practice. In contrast, within Holland's RIASEC framework (Holland, 1997), stronger interest in practical-technical and social activities was associated with greater interest in rural practice, while stronger interest in investigative interests was associated with lower rural interest. Based on these findings, this dissertation suggests that key outcomes of medical education differ between medical students with and without three types of pre-qualifications. Although overall effect sizes were small to moderate, the findings make an important contribution to the limited body of admissions and medical education research on this pre-experienced group.

4.2 Integration of findings

In the following chapter, the results of the three studies included in this dissertation are compared with findings from previous research on professional and academic pre-qualifications among medical students. In particular, the results are contrasted with those of the scoping review by Erschens et al. (2021). The authors addressed research questions closely aligned with those investigated in this dissertation. Their scoping review was one of the foundational works that contributed to the conceptual development. The review examined whether medical students with and without pre-qualifications differed in terms of (1) objective and cognitive indicators of study success, (2) subjective outcomes, and (3) preferences for subsequent specialist training. In total, Erschens and colleagues included eleven studies published up to August 2021. They defined “pre-qualifications” as studies or training broadly related to medical education completed prior to medical school, which is comparable to the variables “vocational training in the medical field” and “academic degree” examined in this dissertation. However, the present dissertation additionally investigates voluntary service as a third pre-qualification variable and links the definition of “pre-qualifications” to the German medical admission quota system (Stiftung für Hochschulzulassung, 2026).

The findings from *Study 1* are largely consistent with the scoping review by Erschens et al. (2021), which also reported no positive effect of pre-qualifications on academic

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performance in medical school and even observed a tendency toward lower achievement among students with prior professional training during the early years of study. In the following, the results of *Study 1* are interpreted separately with regard to vocational training in the medical field, prior academic degrees, and voluntary service. Completed vocational training was associated with a higher number of repeated examinations, comparable to the findings of Hampe et al. (2009; 2008). Using a similar operationalization of academic success, Hampe et al. (2008) likewise reported fewer passed examinations among medical students who had completed vocational training in the medical field. In contrast, Amelung et al. (2022) showed that students with vocational training performed at least comparably well to those without training when they reported comparable school-leaving grades, defining overall performance as mean percentile ranks during the first two years of medical study. While Amelung et al. (2022) compared students with and without vocational training at similar undergraduate GPA levels, *Study 1* of this dissertation controlled for undergraduate GPA to examine whether vocational training had an effect beyond prior academic achievement. Differences in the operationalization of academic success and the inclusion of students from higher semesters in *Study 1* may also help explain the divergent findings. Although *Study 1* identified a higher number of repeated examinations among medical students with completed vocational training, no associations were observed with the other three indicators of academic success (M1 and M2 grades and the number of semesters beyond the standard period of study). Accordingly, the results suggest that completed vocational training confers no advantage for academic success in *Study 1*.

Exploratory analyses in *Study 1* offered possible explanations for these findings. Students with vocational training more often financed their studies through personal income, suggesting greater engagement in part-time employment and less time available for studying. They also more frequently lived with children and relied on savings, partner or spousal support, or (student) loans. Together, these factors indicate a higher external burden, which may contribute to the increased number of repeated examinations observed in this group. Furthermore, exploratory analyses indicated that students with completed vocational training were less likely to have parents with a tertiary education. Combined with their lower undergraduate GPA, this finding may reflect structural educational inequalities, suggesting that students from working-class

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backgrounds may be less likely to transition directly to university (Becker & Hecken, 2008). Finally, it is noteworthy that despite the higher rate of repeated examinations, no association was found between prior vocational training and the number of semesters exceeding the standard period of study. This may indicate that students compensate for repeated examinations through increased effort or workload to remain within the standard duration of study. However, future research should also consider semesters taken off for the completion of a doctoral thesis when examining study duration.

The results of *Study 1* are of particular novelty, as no prior research was identified that explicitly examined medical students with a prior academic degree in relation to academic performance in medical education. The present study therefore makes an important exploratory contribution to this field. Overall, in *Study 1*, holding a prior academic degree was unrelated to most indicators of academic success, with the exception of poorer performance on the M2 examination. This finding should be interpreted cautiously, as only a subset of the sample (409 of 2,370 students) could be included in the model predicting M2 grades, given that the M2 is typically taken after the tenth semester. For medical students with a prior degree, their generally higher age and extended time in higher education make shifts in life circumstances and academic priorities plausible. Exploratory analyses suggested that students with a prior academic degree more often lived in partnerships and were less likely to rely on familial or institutional financial support. Further research is needed to clarify the mechanisms underlying this association.

Regarding prior voluntary service, findings of *Study 1* are consistent with those of Hampe et al. (2008), who likewise reported no association between prior voluntary service and academic performance. Although voluntary service may promote personal development and provide practical experience, its duration may be too limited to yield measurable academic advantages during medical training. Exploratory analyses of *Study 1* indicated that students with prior voluntary service differed in several background characteristics. They more often reported financing their studies through personal income or savings and had lower undergraduate GPAs, which may partly explain delayed entry into medical school. Additionally, these students were less likely to have parents with a degree in medicine or dentistry. This suggests that their motivation to pursue medical studies may have been shaped more by personal experiences than by

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familial role models, given that most voluntary service in *Study 1* was completed in the healthcare sector. While such experiences may influence career aspirations, they do not appear to confer any academic advantages or disadvantages.

Overall, *Study 1* could replicate the positive association between undergraduate GPA and academic success in medical school (Patterson et al., 2016; Schwibbe et al., 2018), which was included as a control variable. Higher undergraduate GPA was consistently associated with better M1 and M2 performance and fewer repeated examinations. In contrast, undergraduate GPA was unrelated to the number of semesters exceeding the standard period of study. One possible explanation is that some medical students extend their studies to undertake doctoral work. This issue warrants further investigation.

Taken together, these findings underscore prior academic performance as a robust predictor of academic success in medical education. Overall, the results of *Study 1* can only be compared to previous research to a certain extent due to the different ways in which academic success is defined in literature. This highlights the issue of a “criterion problem” in admissions research (Patterson et al., 2016). There is ongoing debate about which performance outcomes should be predicted, particularly since the competencies required during medical training may differ from those needed in later clinical practice (Hampe et al., 2009). Therefore, selection research increasingly focuses not only on cognitive outcomes, but also on practice-oriented outcomes. Simmenroth-Nayda et al. (2014), and Fleck et al. (2025), for example, showed, that students with prior practical experiences in healthcare settings performed better in MMIs than medical students without these experiences. Further support comes from a study by Tsikas and Afshar (2023), who found that medical students with prior work experience in health-care settings achieved higher OSCE (Objective Structured Clinical Examination) scores in practical skills after their second year. This distinction between academic performance and clinically relevant competencies is also reflected in the subjective experiences of medical students. A student with prior vocational training who had also completed voluntary service, interviewed in preparation for a conference presentation described this transition as follows: *“It was only after the preclinical phase that you really noticed having a major advantage from vocational training, because you know how to talk to people, because you bring a certain level of social competence, and because you may also have a few more years of life experience than students who start medical school*

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straight after high school” (translated from German, see original quote below). Such accounts highlight that practical and interpersonal skills may become particularly important beyond the early, theory-driven stages of medical education.

„Und dann hat man es tatsächlich erst nach der Vorklinik gemerkt, dass man einen großen Vorteil hat mit der Ausbildung, weil man einfach mit Menschen reden kann, weil man eine gewisse Sozialkompetenz mitbringt, weil man vielleicht auch ein paar Jahre mehr Lebenserfahrung hat als Abiturienten, die direkt starten“.

Medical student (29 years, final year), vocational training (physiotherapist) and voluntary service (healthcare/nursing), Schröpel et al. (2025a)

Study 2 extends the findings of *Study 1* by including study satisfaction as a subjective outcome, encompassing satisfaction with study content, study conditions, and coping with study loads (Westermann et al., 1996). Contrary to expectations based on earlier research, in *Study 2* neither a prior academic degree nor vocational training in the medical field moderated the relationship between deep-processing learning strategies and satisfaction with study content. Because previous studies have shown that vocational and content-related reasons for choosing a field of study, as well as the perceived relevance of the curriculum for the future profession, are positively related to satisfaction with the study content (Hiemisch et al., 2005; Schiefele & Jacob-Ebbinghaus, 2006), a stronger association had been anticipated for students with relevant pre-qualifications. However, in *Study 2*, satisfaction with study content was unrelated to prior vocational or academic background. Consistent with the scoping review by Erschens et al. (2021), the results of *Study 2* revealed no relationship between professional or academic pre-qualifications and satisfaction with study content. The review by Erschens et al. (2021) could identify two relevant studies supporting this conclusion: Paulmann et al. (2016) and Hiemisch et al. (2005). Paulmann and colleagues reported the results of a graduate survey as a conference abstract, finding no difference in study or career satisfaction between medical students with and without prior vocational training in the medical field. Similarly, Hiemisch and colleagues examined how reasons for choosing a field of study and study goals relate to the three dimensions of study satisfaction defined by Westermann et al. (1996). In their analyses, completed vocational training was excluded due to its negligible contribution to

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explaining variance in satisfaction outcomes, indicating a limited impact of such pre-qualifications.

Beyond content-related satisfaction, *Study 2* identified associations between pre-qualifications and satisfaction with study conditions and coping with study loads. Students with vocational training or a prior academic degree were more likely to finance their studies through part-time employment. This, in turn, was associated with lower satisfaction with study conditions but higher satisfaction with coping with study loads. In the context of German medical education, which is largely tuition-free (Zavlin et al., 2017) (except for second-degree students, who are charged tuition fees in some federal states such as in Baden-Württemberg, where this research project was conducted) but still requires students to cover living expenses, this pattern appears plausible. Given that parental support remains the primary source of student funding in Germany (Kroher et al., 2023), students with pre-qualifications may rely more heavily on their own income. Medical education is characterized by a highly demanding curriculum (Haider et al., 2022). Balancing these demands with part-time employment may reduce satisfaction with study conditions due to time pressure and inflexible schedules. At the same time, employment may foster practical skills, self-efficacy or resilience, potentially explaining higher satisfaction with coping levels in *Study 2*. This interpretation is supported by Erschens et al. (2024), who reported a positive association between completed vocational training and burnout resilience, moderated by self-efficacy. Together, these findings highlight the importance of structural support measures, such as predictable schedules and asynchronous learning formats, to facilitate compatibility between medical studies and paid employment. *Study 2* makes an important contribution by emphasizing the need for a differentiated analysis of the relationship between student employment and satisfaction levels. While some studies suggest a negative association between part-time employment and study satisfaction (Brandstätter & Farthofer, 2003), other evidence indicates that a limited number of working hours per week may even have a positive effect (Tessema et al., 2014).

In contrast, students with prior voluntary service reported lower satisfaction with coping with study loads. Voluntary service often involves hands-on and socially meaningful activities, which may contrast sharply with the theoretical and performance-oriented

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demands of medical studies, making the transition back to an academic environment particularly challenging. Although part-time employment fully mediated the relationship between vocational training or academic degree and satisfaction with study conditions and coping with study loads, the effects were small, and explained variance was low. Additionally, given the relatively small number of students with prior academic degrees, other unmeasured factors may also contribute to these associations.

Beyond pre-qualifications and part-time employment, *Study 2* identified additional predictors of study satisfaction. The deep-processing learning strategy “elaboration” was positively associated with satisfaction with study content, whereas “critical thinking” showed a negative association. This pattern suggests that actively linking new material to existing knowledge and experiences generally enhances how students perceive the content of their studies, suggesting that teaching approaches encouraging such connections (e.g. practice-oriented formats) could be beneficial. While the findings regarding “elaboration” aligns with previous findings on self-regulated learning, the negative association with “critical thinking” diverges from much of the literature (Li, 2019; Wang et al., 2013). Critical thinking does not appear to be conducive to students' personal satisfaction with the content of their studies. Although critical thinking supports deeper understanding (Wild, 2000), it may also increase awareness of curricular shortcomings, particularly in the highly regulated context of medical education, thereby reducing satisfaction. Future research should investigate the potential mechanisms underlying these associations. For medical education it is particular important that students feel to be taken seriously when engaging in critical thinking and open discourse. These findings of *Study 2* differ from those of Spörer and Brunstein (2005), who did not identify a direct association between deep-processing strategies and satisfaction with the content of studies. This discrepancy may be explained by methodological differences, as Spörer and Brunstein combined elaboration and critical thinking into a single scale, which could have masked any opposing effects. Overall, the results suggest that deep-processing learning strategies may not automatically translate into higher satisfaction.

Several control variables were also associated with study satisfaction. Older students reported lower satisfaction across all dimensions, possibly reflecting changing life circumstances and maybe greater external responsibilities. In addition, *Study 2* found

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that men reported higher satisfaction regarding coping with study loads. This finding is consistent with gender differences observed in burnout research, which has shown that male medical students tend to report lower levels of burnout than their female counterparts (Erschens et al., 2018). Moreover, medical schools differed regarding satisfaction with study content and conditions and students in the third semester reported higher satisfaction with study conditions than those in their final year, aligning with reports of insufficient supervision and preparation for clinical practice towards the end of training (Lauterjung et al., 2021). At the same time, third- and sixth-semester students reported lower satisfaction with coping, suggesting that resilience may increase in later stages of study.

Overall, the results of *Study 2* indicate that pre-qualifications influence study satisfaction primarily through financial and structural pathways rather than learning-related mechanisms. Limited access to parental financial support may mean that students have to rely more on work alongside their demanding medical studies. This situation is reflected in the perspective of a medical student, who described the financial strain as follows: *“It is indeed an extreme financial burden, because we have to pay €650 in tuition fees plus the enrollment costs. On top of that, you’re older, and from the age of 25 onwards you also have to pay for health insurance yourself”* (translated from German, see original quote below).

***„Das ist schon eine extreme finanzielle Belastung, weil wir zahlen eben 650 €
Studiengebühren plus die Immatrikulationskosten. Plus, man ist halt älter und ab 25
zahlt man dann noch die Krankenversicherung selbst“.***

Medical student (26 years, 6th semester), academic degree (social work), Schröpel et al. (2025a)

Study 3 extends the findings from *Study 1* and *Study 2* and provides a perspective on future pathways of medical students with professional and academic pre-qualifications. In the following section, the findings of *Study 3* are reported separately for the three types of pre-qualifications and discussed in the context of the existing literature. In line with previous research, *Study 3* showed that students with completed vocational training in the medical field demonstrated a stronger preference for general medicine (Leutritz et al., 2024; Selch et al., 2021) and anesthesiology (Leutritz et al., 2024). The scoping

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review by Erschens et al. (2021) also identified a trend towards increased interest in anesthesiology, although the authors could only identify one relevant study. That study, a congress paper by Paulmann et al. (2016), reported a preference for anesthesiology among graduates who had completed vocational training prior to medical school. While most associations analyzed in *Study 3* showed small to medium effect sizes, the association between vocational training and interest in anesthesiology was particularly pronounced, with a medium to large effect size. This finding from *Study 3* may be explained by the high proportion of paramedics within this subgroup, as paramedicine and anesthesiology both involve exposure to emergency situations (Gräsner et al., 2013; Pajonk et al., 2011; Sorgatz et al., 2018), which may foster early identification with this specialty.

Study 3 found no association between vocational training and interest in rural medical practice. Using a multilevel modeling approach that included professional and academic pre-qualifications, RIASEC types, and control variables as predictor variables, a post-hoc sensitivity analysis demonstrated that even subtle effects could have been detected, supporting the robustness of the findings. These results stand in contrast with the scoping review by Erschens et al. (2021), which suggested a higher interest in rural practice among students with pre-qualifications. However, “pre-experience” was inconsistently defined across the reviewed studies, most of which focused on practical experiences in rural settings during medical education (Henry et al., 2009; Rourke, 2008)), limiting the comparability with *Study 3*. Only the study by Kesternich et al. (2017) was directly comparable. Although the study reported an association between prior work experience and interest in rural practice, this was based on a liberal significance threshold ($\alpha = 0.10$). This calls into question the strength of the association between the two variables.

Although an academic degree meets the definition of “pre-qualification” in Erschens et al. (2021), their scoping review did not identify any studies examining the association between a prior academic degree and preferences for specialty training, including interest in rural practice. In this context, *Study 3* makes an important contribution to admission research. Medical students with a prior academic degree differed from their peers without a degree in their interest in only two specialties. They reported higher interest in “other specialties” and lower interest in pediatrics. There was no association

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between a prior degree and interest in rural practice. One possible explanation for this is that the area of study was not specified, in line with the preliminary quota which allows second-degree applicants to apply regardless of their field of prior study. Consequently, the pre-qualification “academic degree” may be too heterogenous. Future studies therefore examine specific prior degree programs and their associations with medical specialty preferences more explicitly.

Prior studies have shown associations between a social or societal orientation, as well as volunteer work in a developing country, and interest in general practice or general rural practice (Arshad et al., 2021; Feldman et al., 2008; Mitra et al., 2018; Scott et al., 2011). These findings partly contradict the results of *Study 3*, which identified a higher preference for general medicine among medical students with prior voluntary service, but found no association with interest in rural practice. In *Study 3*, medical students with prior voluntary service, similar to medical students with completed vocational training, reported greater interest in general medicine and anesthesiology. This pattern may, in part, be explained by the substantial overlap between medical students having completed both forms of pre-qualifications, an issue that is addressed in greater detail in the “strengths and limitations” section of this dissertation.

Overall, significant differences were identified across 16 specialty preferences, particularly between students with prior vocational training in the medical field or voluntary experience and those without such qualifications. These findings support theories of specialty choice development which emphasize the impact of prior learning experiences on career preferences (Bland et al., 1995; Mitchell, 1975). The Community of Practice (CoP) model (Wenger, 2000, 2004) provides an interesting framework for interpreting these findings and drawing implications for practice. It identifies three core characteristics of a CoP: (1) the *domain*, which presents the shared area of knowledge; (2) the *community*, which refers to the group of people who interact; and (3) the *practice*, which is the shared practical knowledge (Wenger, 2004). Through prior vocational training or voluntary service, individuals may have already become part of a CoP, sharing common values, norms and collective knowledge, before entering medical school. They may have already developed a professional identity, which could affect the types of work context they consider as suitable for themselves and the areas in which they feel a sense of professional belonging. This CoP may accompany students

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throughout their medical training, contributing to the formation of their professional identity. Conversely, medical schools could actively foster the development of a CoP centered on rural medical practice. This would address the shortage in rural areas by providing sustained exposure to rural clinical work from an early stage in medical education (*legitimate peripheral participation*), and by building a shared network of rural physicians and medical students (Longenecker & Schmitz, 2017; Smith et al., 2017; Wenger, 2004). This would enable students to become active members of such a CoP through practical learning experiences.

In *Study 3*, both rural origin and interest in or prior contact with general medicine were positively associated with interest in rural medical practice. This further highlights the importance of (practical) exposure to professional fields intended for promotion.

Regarding Holland's RIASEC model (1997), a greater interest in practical-technical and social activities, as well as lower interest in investigative activities, predicted greater interest in rural medical practice. These findings differ slightly from those of previous RIASEC studies on general practice, which reported higher levels of social (Borges et al., 2004; Gottfredson & Holland, 1996; Guntern et al., 2016) and investigative (Borges et al., 2004; Gottfredson & Holland, 1996) interests among individuals interested in general practice. Overall, *Study 3* suggests that professional and academic pre-qualifications are linked to preferences for medical specialty training, but do not appear to influence interest in rural practice. In this context, vocational interest orientations, rural origin, interest in general medicine, and general medicine internships seem to be more relevant. However, the findings also suggest that outcomes may depend more on the field in which the pre-qualification was obtained and on the personal experiences that shaped students' professional orientations. This suggestion is illustrated by a quote from a medical student who had studied social work prior to entering medical school: “*I want to work with people, and I want my profession to involve building and maintaining relationships, which is basically the core of social work. That's why, for me, something like Internal Medicine or General Practice is really the only option*” (translated from German, see original quote below)

“Ich möchte mit Menschen zusammenarbeiten und ich möchte auch Beziehungsarbeit haben in meinem Beruf, was eben auch in der sozialen Arbeit ja

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eigentlich so das A und O ist. Dementsprechend kommt für mich halt eigentlich nur so was wie Innere [Medizin] oder Allgemein[medizin] in Frage“.

Medical student (26 years, 6th semester), academic degree (social work), Schröpel et al. (2025a)

Overall, this dissertation demonstrates a high prevalence of medical students with professional or academic pre-qualifications, highlighting the relevance of studying this cohort in greater detail. In total, 28% of the sample reported having completed vocational training before medical school. A review by Erschens et al. (2021) reports highly variable proportions ranging from 15% to 86.7%. In contrast, Amelung et al. (2022) found proportions similar to this dissertation at one medical school (around 20%), but substantially lower at another (approximately 4%). A possible explanation for these heterogeneous findings is that in Germany, medical schools differ in how strongly they weight practical experience in admissions. The proportion of students with prior voluntary service was also relatively high (about 23%), whereas fewer participants reported prior university studies (6%). This figure nevertheless exceeds the official proportion of applicants admitted via the second-degree quota (3%), possibly because, at the time of data collection, the waiting-time quota was still in place. During prolonged waiting periods, applicants may have pursued vocational training or alternative degree programs in healthcare-related fields (Herbst & Müller-Hilke, 2019).

Taken together, the three studies in this dissertation suggest that medical students with professional and academic pre-qualifications differ from those without such backgrounds in several respects. In this context, the three pre-qualifications can be differentiated in terms of their duration (longer vs. shorter) and their type (practical vs. academic). Longer pre-qualifications, such as vocational training or prior academic degree, tended to be associated with slightly poorer academic success and, to some extent, differences in study satisfaction. These differences in satisfaction levels appear to be driven less by specific learning strategies than by contextual factors, such as financing studies through part-time employment. In contrast, as a shorter pre-qualification, voluntary service was not associated with academic success and was linked to differences only in one dimension of satisfaction. Regarding specialty preferences, the two practical pre-qualifications of vocational training in the medical

field and voluntary service showed substantial differences, whereas an academic degree as a pre-qualification showed only minor differences.

4.3 Strengths and limitations of the dissertation

A major strength of this dissertation is its large and diverse sample of 2,370 medical students recruited from all five medical faculties in Baden-Württemberg and from different semesters, which enhances the generalizability of the findings. This dissertation addresses a research area that has received little attention to date, thereby making a valuable contribution to the small amount of existing literature (Erschens et al., 2021). In *Study 1*, academic success was operationalized in a particularly comprehensive manner. Grades from the centralized state examinations (M1 and M2) were assessed, thereby enhancing comparability across medical schools. In addition, adherence to the standard duration of study as well as the number of repeated examinations were taken into account. This multidimensional approach enabled a more nuanced assessment of academic outcomes. *Study 2* employed an SEM approach, enabling the simultaneous estimation of complex relationships between latent and manifest variables while accounting for measurement error. In doing so, professional and academic pre-qualifications as well as further influencing factors could be systematically and differentially captured in relation to study satisfaction. Finally, *Study 3* provides differentiated insights into factors associated with interest in rural medical practice, thereby making an important contribution to research on securing primary care in rural Germany. This study is one of the first to examine professional and academic pre-qualifications in this context alongside vocational interests (RIASEC, Holland, 1997). Moreover, comparisons of different specialty preferences between medical students with and without different prior qualifications make an important contribution to a comprehensive understanding of the impact of professional and academic pre-qualifications on medical education and career orientation.

Despite these strengths, several limitations should be considered when interpreting the findings. First, the cross-sectional design of the study precludes causal inferences, and the reliance on self-reported data may have introduced response bias. Future longitudinal studies are needed to examine developmental trajectories and causal

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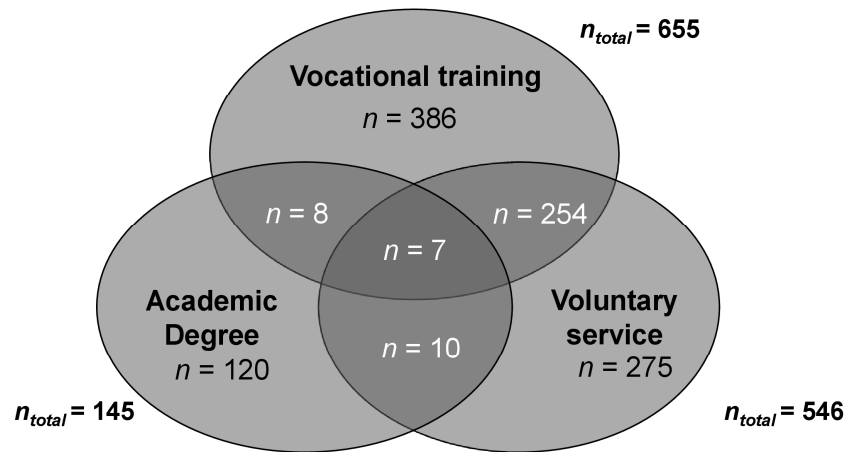
relationships. Second, although data were collected across all medical faculties in the state of Baden-Württemberg, the sample is not representative of medical students in Germany as a whole. Moreover, participation was voluntary, so the possibility of selection bias cannot be ruled out. Further limitations concern the interpretation of the dichotomous variables “vocational training,” “academic degree,” and “voluntary service”. These variables did not capture individuals who started but did not complete the respective qualification. In addition, each dummy variable must be interpreted independently, as multiple pre-qualifications may coexist (see figure 5). We deliberately chose this dichotomous coding because the German medical school admission process similarly considers pre-qualifications as either fulfilled or not fulfilled within different admission quotas. However, this approach means that comparisons should be understood as, for example, “vocational training versus no vocational training”, rather than “vocational training versus no prior experience at all”. Finally, the duration of vocational training was not recorded. While most vocational training programs in Germany last approximately three years, shorter training programs exist (e.g. “Rettungssanitäter” $\approx$ emergency medical assistant), particularly in the paramedical field. As these shorter programs were not explicitly excluded, it is possible that some participants who reported paramedical vocational training had completed only this short program, which may have affected the interpretation of this variable. Regarding the variable “academic degree”, it should be noted that it encompasses a range of different fields of study. As with the other variables, this definition was deliberately chosen for this dissertation in alignment with the criteria used in the German admission quotas. However, future research would benefit from distinguishing between specific fields of prior study, given that the extent to which they provide medicine-related knowledge can vary considerably.

In addition to these overarching limitations, each individual study has specific constraints that should be acknowledged, but these also open up specific avenues for future research. *Study 1* primarily addressed academic success and did not include outcome measures that explicitly assess non-cognitive or practical competencies. Future studies could therefore extend this work by examining professional and academic pre-qualifications in relation to performance in assessments such as MMIs (Fleck et al., 2025; Lin et al., 2022) or OSCEs (Harden et al., 2015). For *Study 2*, it should be noted

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that data collection occurred during the COVID-19 pandemic, which may have influenced participants' study satisfaction and, consequently, limits the generalizability of the findings. A limitation of *Study 3* is that there is no uniform definition of “rural” in the international literature. This means that results from different scientific studies can only be compared with restrictions. In addition, the cross-sectional design captures stated interests rather than actual career trajectories, emphasizing the importance of longitudinal approaches to better understand the development of specialty preferences over time.

Figure 5. Venn diagram illustrating single, double, and triple pre-qualifications in the sample of this dissertation (absolute numbers)



Note. The figure was cited from Schröpel et al. (2024)

4.4 Practical implications

The findings allow for carefully derived practical implications for medical school admissions and medical education to be drawn. *Study 1* demonstrates significant differences in study-related and sociodemographic characteristics between students with and without professional or academic pre-qualification. Medical students with prior qualifications were not found to have an advantage in terms of academic success, despite the fact that the majority of these qualifications were in the medical field. Therefore, their comparatively poorer academic performance stands in contrast to

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students' existing medical and practical knowledge. These findings highlight the importance for medical schools to use additional, alternative measures to assess study success. Such measures should place less emphasis on the mere memorization of theoretical knowledge and more on practical skills that are directly relevant to future medical practice. In this regard, practical assessments such as OSCE (Harden et al., 2015), as well as social and interprofessional competencies (Fleck et al., 2025), could be given greater weight. In doing so, medical schools could ensure that assessment formats reflect the competencies required in clinical practice more accurately. Individuals with prior professional and academic qualifications may contribute to diversifying the student body (Gröne et al., 2023; Müller-Hilke et al., 2024), and medical schools could develop teaching concepts that deliberately integrate the practical prior experience of some students into lessons. Approaches such as peer tutoring could be particularly promising, as prior experience plays an important role in becoming an effective tutor (Schmidt & Moust, 1995). Moreover, both tutors as well as tutees benefit from these formats (Loda et al., 2019; Stephens et al., 2016).

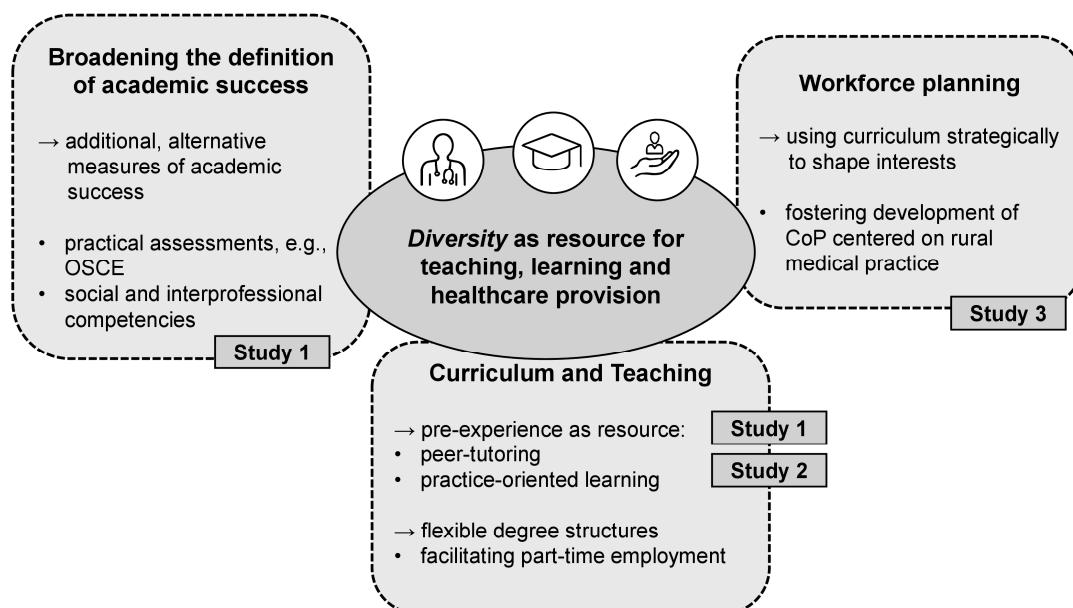
Studies 1 and *2* suggest that medical degree programs should be designed more flexibly, for example through part-time options or modular structures, in order to better support students with diverse educational and life trajectories. In particular, opportunities for part-time employment should be facilitated, both to enable students to finance their studies more easily and because *Study 2* indicates that part-time employment may enhance students' perceived ability to cope with the demands of medical training. In this context, academic advising and mentoring programs could be more explicitly tailored to the needs of heterogenous student groups by providing targeted support (Buddeberg-Fischer & Herta, 2006). From an admissions perspective, these findings suggest that, if medical schools take prior qualifications into account during the selection process, they should also adapt their institutional structures accordingly to meet the needs of these groups adequately.

The results of *Study 3* suggest that individuals with different prior qualifications may also differ in their specialty preferences, highlighting the lasting influence of previous (practical) experiences on medical career aspirations. In this context, students may have already developed a Community of Practice (CoP) prior to entering medical school,

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which may continue to shape their professional perspectives throughout medical training. This provides an important starting point for curriculum development. Rather than addressing the needs of the healthcare workforce through admission quotas or selection procedures, medical schools could use their curricula more effectively by setting specific themes and experiential focuses. Practical experiences in specific disciplines may foster a sustained interest in these fields. With regard to the shortage of rural physicians, medical schools could therefore deliberately promote clinical placements in rural practices or in general medicine (Barthen et al., 2016; Connell et al., 2022; Delport & Beckett, 2019; Rhee et al., 2018), thereby fostering the development of a CoP “rural medicine”. Overall, the findings suggest that the heterogeneity of medical students with regard to prior experiences should be viewed as a resource for teaching, learning and future healthcare provision. Figure 6 illustrates the practical implications that can be derived from the findings of this dissertation.

Figure 6. *Practical implications of the findings.*



Note. OSCE = Objective Structured Clinical Examination, CoP = Community of Practice

4.5 Conclusion and further direction

Overall, the present dissertation, comprising three studies, makes an important contribution to a field of research that has received little attention, namely professional and academic pre-qualifications and the association with study success, study satisfaction and specialty choice as key outcomes in medical education (Erschens et al., 2021). The findings of this dissertation indicate that professional and academic pre-qualifications tended to be associated with poorer academic performance, although this was limited to specific outcomes. Specifically, a small effect was observed for a higher number of repeated examinations among students with prior vocational training, and a medium effect was found for worse grades on the M2 among students with a prior degree. The study therefore demonstrates how professional or academic pre-qualifications are related to objective, performance-related variables. At the same time, the findings of this dissertation highlight the “criterion problem“ in admissions research (Patterson et al., 2016) and underscore the importance of critically reflecting the concept of academic success. In this context it is essential to consider alternative success criteria in medical education, such as social and practical skills, which can be assessed through OSCEs (Harden et al., 2015).

Students with professional and academic pre-qualifications did not differ from those without such qualifications in their satisfaction with the content of medical studies. However, individuals with prior vocational training or an academic degree, more frequently reported financing their studies through part-time employment. This, in turn, was associated with lower satisfaction with study conditions but higher satisfaction with coping of study loads, although these effects were rather small. These results highlight the relevance of more flexible structures in medical education facilitating part-time employment alongside studies. Moreover, the findings suggest that part-time employment may function as a potential resilience factor by fostering students’ resilience, an assumption that should be examined in future research.

Finally, professional and academic pre-qualifications were not associated with interest in rural practice. However, in particular, students with prior vocational training as well as students with completed voluntary service differed in their preferences for specific medical specialties compared with those without such backgrounds. The strongest

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association was found between completed vocational training and interest in anesthesiology. However, rather than professional and academic pre-qualifications, vocational interest orientations, rural background and interest for or practical contact with general medicine predicted interest in rural practice. Future research should further investigate the role of pre-qualifications in shaping professional identity formation prior to and during medical training, including the early development of communities of practice (CoPs) (Wenger, 2000, 2004). In addition, factors influencing interest in a rural practice warrant closer examination, particularly among students admitted through the rural doctor quota (Geier et al., 2025) and with respect to the impact of rural clinical placements during medical school. Overall, there is a need for longitudinal studies systematically examining students with pre-qualifications throughout medical training and also subsequently assess their actual specialty choices after graduation.

The present findings demonstrate consistent differences between students with and without pre-qualifications. In conclusion, if specific groups are intentionally admitted through selection procedures, medical education must adapt accordingly by becoming more flexible and by explicitly integrating prior experiences. This will allow all students to benefit from one another. In this context, the targeted admission of applicants with prior vocational experience can also be understood as part of broader efforts toward *widening participation* and the diversification of the medical student body, with the long-term aim of fostering a more diverse physician workforce and promoting fair access to medical education for underrepresented groups (Gröne et al., 2023; Müller-Hilke et al., 2024).

5 Summary

Every year, significantly more individuals apply for places to study medicine than there are places available. To identify suitable applicants, selection procedures are used internationally. Within Germany's quota-based admission system, practical pre-qualifications are taken into account alongside cognitive criteria. However, little is known about their significance for the further course of study. This cumulative dissertation comprises three studies and aims to contribute to this research gap by examining relevant indicators in medical education (academic success, study satisfaction and specialty preferences) among medical students with professional and academic pre-qualifications.

As part of the dissertation project, the term “professional and academic pre-qualifications” is defined as (1) completed vocational training in the medical field, (2) a completed academic degree, and (3) voluntary service lasting at least 11 months. The data for this dissertation is based on a cross-sectional survey of all five medical faculties in Baden-Württemberg. A total of $N = 2,370$ medical students from various semesters (3rd, 6th, and 10th semester as well as practical year) participated. Around 28% of the study participants state that they had completed vocational training before their studies (mainly as paramedics or nurses). A total of 6% previously completed an academic degree, mostly in STEM subjects (science, technology, engineering, mathematics) or in other medical degree programs, and 23% state that they had completed voluntary service (mainly in healthcare).

Study 1 examines the relationship between these three pre-qualifications and academic success, which is operationalized using various success parameters (grades in the first and second state examinations, exam retakes, adherence to the standard period of study). *Study 2* complements these objective, performance-related indicators with subjective academic satisfaction. A structural equation model (SEM) is used to examine differences between medical students with and without professional and academic pre-qualifications, and to analyze associations with the application of deep-processing learning strategies and the financing of studies through part-time employment. *Study 3* focuses on future prospects, examining the career aspirations of medical students with

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different pre-qualifications. A linear mixed model is applied to examine the contribution of professional and academic pre-qualifications and career interests to interest in rural medical practice.

The results of *Study 1* indicate that prior professional qualifications do not confer an advantage in terms of academic success. However, post-hoc exploratory analyses suggest a particular association between professional and academic pre-qualifications and the type of study financing. These findings are expanded upon in *Study 2*, where analyses show that, although financing studies through part-time employment is associated with lower satisfaction with study conditions among medical students with prior vocational training or academic degree, it is associated with higher satisfaction regarding coping with study loads. This points to the importance of part-time employment as a potential resilience factor. Finally, *Study 3* shows differences in preferences for various specialist training programs, particularly for students with vocational training in the medical field or voluntary service, compared to students without these pre-qualifications. The greatest effect size is found among medical students with vocational training in terms of increased interest in specialist training in anesthesiology. However, there is no association found between professional and academic pre-qualifications and interest in working as a rural doctor.

Overall, this dissertation makes an important contribution to research on a group of medical students who are specifically considered in the admissions process under the quota system, but for whom there has been little scientific research on their course of study, so far. This dissertation therefore contributes to research into fair admission procedures and the diversification of the medical student population.

6 Zusammenfassung

Jedes Jahr bewerben sich signifikant mehr Personen um einen Medizinstudienplatz, als Plätze zur Verfügung stehen. Um geeignete Bewerberinnen und Bewerber zu identifizieren, kommen international Auswahlverfahren zum Einsatz. In Deutschland werden im Rahmen eines quotenbasierten Zulassungssystems neben kognitiven Kriterien unter anderem auch praktische Vorqualifikationen berücksichtigt. Bislang ist jedoch wenig darüber bekannt, welche Bedeutung sie für den weiteren Studienverlauf haben. Die vorliegende kumulative Dissertation zielt darauf ab, in diesem Bereich einen Beitrag zu leisten, indem in drei Studien Medizinstudierende mit berufspraktischen Vorqualifikationen hinsichtlich zentraler Indikatoren der medizinischen Ausbildung (Studienerfolg, Studienzufriedenheit und Facharztpräferenzen) untersucht werden.

Dabei werden im Rahmen des Dissertationsprojekts unter dem Oberbegriff „berufspraktische Vorqualifikationen“ (1) eine abgeschlossene Berufsausbildung im medizinischen Bereich, (2) ein abgeschlossenes Studium und (3) ein Freiwilligendienst mit einer Minstdauer von 11 Monaten definiert. Die Datengrundlage bildet eine Querschnittsbefragung an allen fünf medizinischen Fakultäten in Baden-Württemberg. Insgesamt nahmen $N = 2370$ Medizinstudierende verschiedener Semesterstufen (drittes, sechstes und zehntes Semester sowie Praktisches Jahr) teil. Rund 28% der Studienteilnehmenden geben an, vor dem Studium eine Berufsausbildung absolviert zu haben (überwiegend im Rettungsdienst oder in der Krankenpflege). Insgesamt 6% haben zuvor ein Studium abgeschlossen, mehrheitlich in MINT-Fächern (Mathematik, Informatik, Naturwissenschaften, Technik) oder anderen medizinischen Studiengängen und 23% geben einen absolvierten Freiwilligendienst an (v.a. in der Gesundheitspflege).

Studie 1 untersucht den Zusammenhang zwischen den drei berufspraktischen Vorqualifikationen und Studienerfolg, der anhand verschiedener Erfolgsparameter operationalisiert wird (Note im Ersten und Zweiten Staatsexamen, Prüfungswiederholungen, Einhaltung der Regelstudienzeit). *Studie 2* ergänzt diese objektiven, leistungsbezogenen Indikatoren um die subjektive Studienzufriedenheit. Dabei werden Unterschiede zwischen Medizinstudierenden mit und ohne berufspraktischen Vorqualifikationen untersucht und Zusammenhänge mit der

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Anwendung tiefenorientierter Lernstrategien, sowie der Studienfinanzierung durch Teilzeittätigkeiten in einem Strukturgleichungsmodell (SEM) analysiert. *Studie 3* richtet den Blick auf zukünftige Perspektiven und befasst sich mit den Karrierewünschen von Medizinstudierenden mit verschiedenen berufspraktischen Vorqualifikationen. In einem linear gemischten Modell wird dabei untersucht, welchen Beitrag berufspraktische Vorqualifikationen und berufliche Interessenorientierungen hinsichtlich des Interesses an einer landärztlichen Tätigkeit leisten.

Die Ergebnisse von *Studie 1* zeigen, dass berufspraktische Vorqualifikationen keinen Vorteil in Bezug auf den Studienerfolg mit sich bringen. Post-hoc durchgeführte explorative Analysen weisen jedoch auf Zusammenhänge zwischen berufspraktischen Vorqualifikationen und der Art der Studienfinanzierung hin. Diese Befunde werden in *Studie 2* erweitert, wobei die Analysen zeigen, dass die Finanzierung des Studiums durch Teilzeittätigkeiten bei Medizinstudierenden mit vorheriger Berufsausbildung oder abgeschlossenem Studium zwar mit einer geringeren Zufriedenheit mit den Studienbedingungen einhergeht, jedoch mit einer höheren Zufriedenheit bezüglich der Bewältigung von Studienbelastungen. Dies unterstreicht die Bedeutung von beruflichen Tätigkeiten als potenziellen Resilienzfaktor. In *Studie 3* zeigen sich hinsichtlich der Präferenzen für verschiedene Facharztweiterbildungen insbesondere für Studierende mit einer Berufsausbildung im medizinischen Bereich, beziehungsweise einem Freiwilligendienst, Unterschiede zu Studierenden ohne die entsprechende Vorqualifikation. Die größte Effektstärke besteht für Medizinstudierende mit einer Berufsausbildung in Bezug auf ein gesteigertes Interesse an einer Facharztweiterbildung im Bereich Anästhesiologie. Die Studie kann jedoch keinen Zusammenhang zwischen berufspraktischen Vorqualifikationen und dem Interesse an einer landärztlichen Tätigkeit feststellen.

Insgesamt leistet diese Dissertation einen wichtigen Beitrag zur Erforschung einer Gruppe von Medizinstudierenden, die im Rahmen des Quotensystems im Zulassungsverfahren gezielt berücksichtigt wird, zu deren Studienverlauf jedoch bislang nur wenige wissenschaftliche Befunde vorliegen. Damit trägt diese Dissertation zur Weiterentwicklung der Forschung zu fairen Zulassungsverfahren und zur Diversifizierung der Studierendenschaft in der Medizin bei.

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Declaration of contribution of others

This dissertation was conducted at the Department of Psychosomatic Medicine and Psychotherapy under supervision of PD Dr. Rebecca Erschens and Prof. Dr. Stephan Zipfel. This dissertation consists of three manuscripts that have already been published or submitted.

Study 1

Schröpel, C., Festl-Wietek, T., Herrmann-Werner, A., Wittenberg, T., Schüttpelz-Brauns, K., Heinzmann, A., Keis, O., Listunova, L., Kunz, K., Böckers, T., Herpertz, S.C., Zipfel, S., & Erschens, R. (2024). How professional and academic pre-qualifications relate to success in medical education: results of a multicentre study in Germany. *PLoS One*, 19(3), e0296982. DOI: 10.1371/journal.pone.0296982

Contribution: The study was conceptualized by CS, RE, and AH-W. Data collection was conducted by CS, TF-W, TW, AH, OK, LL, KK, KS-B and RE. CS analyzed the data, generated figures and tables, and drafted the manuscript under supervision of RE. CS, and RE interpreted the results. TF-W, AH-W, TW, SH, KS-B, AH, OK, LL, KK, TB, SZ and RE edited and approved the drafts of the manuscript. SZ obtained funding for the project. RE, AH-W and SZ supervised the project.

Study 2

Schröpel, C., Herrmann-Werner, A., Festl-Wietek, T., Wittenberg, T., Herpertz, S.C., Schüttpelz-Brauns, K., Heinzmann, A., Böckers, T.M., Zipfel, S., and Erschens, R. (submitted). Pre-Qualifications, Learning Strategies, and Study Satisfaction among Medical Students: Insights from a Multicenter German Cohort.

Contribution: The study was conceptualized by CS, RE, and AH-W. Data collection was conducted by CS, TF-W, TW, AH, KS-B and RE. CS analyzed the data, generated figures and tables, and drafted the manuscript. CS and RE interpreted the results. AH-W, TF-W, TW, SH, KS-B, AH, TB, SZ and RE edited and approved the drafts of the

DECLARATION OF CONTRIBUTION

manuscript. SZ obtained funding for the project. RE, AH-W and SZ supervised the project. For the statistical analysis, the authors received biometric consulting from the Institute of Clinical Epidemiology and Applied Biometry, University Hospital Tübingen.

Study 3

Schröpel, C., Festl-Wietek, T., Herrmann-Werner, A., Wittenberg, T., Pumptow, M., Herpertz, S. C., Heinzmann, A., Schüttpelz-Brauns, K., Böckers, T.M., Zipfel, S., & Erschens, R. (2025). Professional and academic pre-qualifications, career preferences and aspirations in working as a rural doctor. *Frontiers in Medicine*, 12, 1566303. DOI: doi.org/10.3389/fmed.2025.1566303

Contribution: The study was conceptualized by CS, RE, and AH-W. Data collection was conducted by CS, TF-W, TW, AH, KS-B and RE. CS analyzed the data with support from MP. CS generated figures and tables, and drafted the manuscript. CS, MP, and RE interpreted the results. TF-W, AH-W, TW, MP, SH, KS-B, AH, TB, SZ and RE edited and approved the drafts of the manuscript. SZ obtained funding for the project. RE, AH-W and SZ supervised the project.

ChatGPT and DeepL were used for translations and for grammar, spelling, and stylistic refinements. For Study 2, ChatGPT was used to assist in generating R code for data analysis. I confirm that I have carefully reviewed all AI-generated output before incorporating it into the manuscript. I further confirm, that I independently wrote the manuscript and used no sources other than those cited.

Tübingen, 09.03.2026

Carla Schröpel

Ein herzliches Dankeschön!

Vielen herzlichen Dank an Sie, Prof. Dr. Stephan Zipfel, für Ihre Unterstützung und Betreuung dieser Dissertation und die Möglichkeit in der Abteilung für Psychosomatische Medizin und Psychotherapie promovieren zu können.

Mein ganz besonderer Dank gilt Dir, PD Dr. Rebecca Erschens, für die Betreuung meiner Dissertation, für Deine Unterstützung und unermüdlichen Einsatz für mich. Ich durfte sowohl fachlich als auch für meine persönliche Entwicklung unglaublich viel lernen! Vielen Dank, dass ich in unserer Arbeitsgruppe die Möglichkeit hatte, Teil vieler verschiedener, bereichernder Forschungsprojekte zu sein und meine Fähigkeiten in den vielseitigen Aufgaben austesten und entwickeln durfte. Ich danke Dir und der gesamten AG Erschens, insbesondere meinen Kolleginnen Sophia Adam und Lea Maurer, für die lustigen und „schaffigen“ gemeinsamen Stunden.

Ich danke herzlich Prof. Dr. Anne-Herrmann-Werner und Dr. Teresa Festl-Wietek aus dem TIME - Tübingen Institute for Medical Education für den fachlichen Input im SamBaWü-Projekt und die Unterstützung, sowie allen anderen VSM-BW Ko-Autoren und Ko-Autorinnen für die wertschätzenden und hilfreichen Rückmeldungen zu den Manuskripten.

Außerdem möchte ich Prof. Dr. Katrin Giel danken für die wissenschaftliche Begleitung, wie durch das Forschungskolloquium und den damit verbundenen sehr bereichernden wissenschaftlichen Austausch. Außerdem danke ich herzlich meinen Kolleginnen Anne Herschbach, Astrid Günther, Bea Klos, Jana Heinen, Jana Throm, Melissa Daugelat, Tatjana Korbanka, und allen Kollegen und Kolleginnen für die unterstützende und schöne Arbeitsatmosphäre im Büro und das gemeinsame Mitfiebern auf dem Weg der jeweiligen Dissertationsschriften.

Und zuletzt möchte ich aus tiefsten Herzen meinen Eltern Andrea und Martin sowie Elisa und Till danken. Ich bin sehr froh und dankbar, dass ich euch in meinem Leben weiß, dass ihr immer ein offenes Ohr habt und mich seit jeher begleitet und unterstützt.