



Factors associated with interpersonal skills in medical students training for standardized medical consultations

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Année 2018-2019

FACTORS ASSOCIATED WITH INTERPERSONAL SKILLS IN
MEDICAL STUDENTS TRAINING FOR STANDARDIZED
MEDICAL CONSULTATIONS

THÈSE
PRÉSENTÉE POUR L'OBTENTION DU TITRE DE DOCTEUR EN MÉDECINE
DIPLOME D'ÉTAT

Alexandre BELLIER

[Données à caractère personnel]

THÈSE SOUTENUE PUBLIQUEMENT À LA FACULTÉ DE MÉDECINE DE GRENOBLE

Le 10/05/2019

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RESUME

Introduction — De la qualité de la relation médecin-patient dépend la qualité des soins. Le développement des compétences relationnelles est primordial en formation initiale pour établir cette relation, mais les déterminants sont peu connus. Nous avons donc évalué les facteurs associés aux compétences relationnelles lors de consultations médicales simulées.

Méthodes — Nous avons réalisé une étude transversale sur des étudiants en quatrième année de médecine, participant à des consultations simulées vidéo-enregistrées avec patients standardisés. Les compétences relationnelles de chaque étudiant ont été évaluées à l'aide de l'échelle standardisée : 4-Habits Coding Scheme. Nous avons recueilli ensuite leur genre, l'ensemble de leurs données de scolarité des trois premières années de médecine, ainsi que les stages cliniques ou non effectués dans la suite de leur cursus.

Résultats — Notre échantillon comprenait 165 étudiants. Les facteurs significativement associés aux compétences relationnelles dans les modèles de régression multiple étaient le genre ($\beta=-4.79$, $p=0.012$), la réalisation d'un stage ERASMUS ($\beta=6.16$, $p=0.002$) ou d'un stage de recherche ($\beta=6.48$, $p=0.006$). Les résultats académiques des étudiants au cours des trois premières années de médecine n'étaient pas significativement associés au niveau de compétences relationnelles, tout comme le nombre de stages cliniques de médecine ou de chirurgie effectués.

Conclusion — Le profil type d'un étudiant avec un haut niveau de compétences relationnelles était une femme, ayant réalisé un stage à l'étranger ou un stage de recherche, sans influence du niveau académique de l'étudiant ou de son expérience clinique hospitalière.

Mots-clés : compétences relationnelles ; relation médecin-patient ; pédagogie ; simulation ; évaluation

ABSTRACT

Background — The quality of care depends on the quality of the doctor–patient relationship. The development of interpersonal skills is an essential part of establishing this relationship, but the determinants are poorly understood. We therefore assessed the factors associated with interpersonal skills in medical students during simulated medical consultations.

Methods — We conducted a cross-sectional study of 4th-year medical students participating in simulated consultations with standardized patients. The interpersonal skills of each student were evaluated using a standardized scale: the 4-Habits Coding Scheme. We then collected their gender, all of their academic data from the first 3 years of medical school, as well as the clinical and nonclinical placements in the continuation of their studies. Finally, we evaluated the association between interpersonal skills and these different academic factors with multiple regression models.

Results — Our analytical sample included 165 students for analysis. The factors significantly associated with interpersonal skills were gender ($\beta=-4.79$, $p=0.012$), completion of an ERASMUS internship ($\beta=6.16$, $p=0.002$) or a research internship ($\beta=6.48$, $p=0.006$). The academic results of the students in the first 3 years of medical school or the number of clinical placements in medicine and surgery were not significantly associated with the level of interpersonal skills.

Conclusion — The typical profile of a student with a high level of interpersonal skills was a woman, who had completed an internship abroad or a research internship, without influence of student's academic results or hospital clinical experience.

Keywords: interpersonal skills; doctor–patient relationship; pedagogy; simulation; evaluation

Physician–patient relationship

Physician communication skills are key components of effective medical consultations [1] and represent physician core competences that are most desired by patients [2]. There is abundant literature showing that the quality of the interaction between physician and patient during a consultation is a major determinant of patient satisfaction, adherence to the plan of care and health outcomes [3–6]. Physician–patient relationship is associated with patient outcomes and contributing to a better state of health [7, 8].

It has now been recognized that, in addition to academic ability, physicians' skills depend on a range of personal qualities such as responsibility, trustworthiness, ethical behavior and interpersonal skills [9]. Medical schools have a duty to society to select and educate as students those individuals most likely to graduate as physicians with such attributes [10].

While medical practice is increasingly centered on the technical aspects of care, interpersonal skills, such as communication and empathy, are of considerable importance in establishing the unique relationship between physician and patient [11–14]. The place of the patient is central in the care relationship. A patient should be known by name, profession, life style, and not only by disease [15]. More than half a century ago, Eron was the first to find that student cynicism tended to increase and humanitarianism to decrease during the medical school experience [16]. Several studies have since corroborated these results and have published alarming reports on declines in empathy during medical school and residency. These findings compromise striving toward professionalism and may threaten healthcare quality [17–19]. In order to develop educational program to improve physicians' interpersonal skills during medical school or continuing education it is important to define those skills.

Communication is one of the main determinants of an effective physician–patient relationship, along with empathy and consultation organization [20]. Communication is considered a central component of patient-centered care and patient-centered communication is recognized as one of the competencies required to effectively practice medicine as an ideal style of medical interview [21–23]. Therefore competent physician communication with patients is one of the cornerstones of patient-centeredness, a recurrent topic in healthcare fields [11, 24]. Patient-centeredness is a multifaceted construct with different theoretical perspectives that can be selectively adopted

according to the context and nature of problems in the patient–physician relationship that a particular study aimed to explore [24].

According to Candib, good communication competence is defined by the presence of effective verbal and nonverbal behaviors within the context of individual interactions with patients or their families [25, 26]. This can be explained in particular by the duality of physician–patient communication. In the terms of a conceptual approach, physician–patient communication is both a skill and a state of mind of "being in relation" to the other [27]. Nonverbal messages tend to override verbal messages. Mehrabian and Ferris demonstrated that the dual impact of a message is a linear function of verbal, vocal and facial expression: total impact = .07 verbal + .38 vocal + .55 facial [28].

A second major skill associated with the doctor–patient relationship is empathy. Empathy is a complex multidimensional concept that has moral, cognitive, emotive and behavioral components [29]. Physicians who express empathy in patient encounters by acting in a warm, friendly and reassuring way seem to be more effective in reaching patients' satisfaction than those who keep consultations formal and do not offer reassurance. Empathy is of great significance for better healthcare outcomes [30].

Finally, another skill that comes into play in the physician–patient relationship is the structure of the medical interview. Indeed, having good communication and showing empathy should not overshadow the context of the medical interview. As in any relationship, but even more so in a medical interview with the specificity of collecting sensitive information about the patient, it is important to consider the beginning and the end of the consultation [20, 31].

Therefore, physician's interpersonal skills can be considered as a whole by including communication, empathy and the structuring of the medical consultation. This multifaceted aspect of the physician–patient relationship makes assessing interpersonal skills difficult.

Assessment scale of interpersonal skills

Yet due to the importance of the relational skills between the doctor and her/his patient, it is necessary to use standardized, valid and reliable instruments to evaluate physicians' interpersonal skills for training purposes. Over the past five decades the physician–patient relationship has been studied extensively through the development of a considerable number of scales that measure clinical competencies, most particularly communication skills [21, 32]. Several articles reviewing the literature on the topic of the physician–patient relationship have focused on specific areas like communication or empathy [6, 33–36]. Many of these scales have been used in the context of real

consultations or in simulated consultations using standardized patient profiles [36–38]. When video-recording such consultations is ethically possible, interpersonal skills were readily assessed using one of the scales and debriefed with the physician or medical student [39, 40].

We conducted a systematic review of the literature on measurement tools of physician–patient relational skills with an assessment of the quality of the design, methods and the psychometric properties of the scales identified (data unpublished, manuscript in preparation). The objective was to identify the most appropriate tools for assessing relational skills during video-recorded consultations performed in the context of initial medical training or continuing medical education. Based on the content validity of the scale and its psychometric properties, the Four Habits Coding Scheme (4-HCS) scale [20] was the most appropriate. This scale has four subscales: Invest in the Beginning (Habit1), Elicit the Patient’s Perspective (Habit2), Demonstrate Empathy (Habit3) and Invest in the End (Habit4). For each of the 23 items, the rating uses a 5-point Likert scale. By adding up the points, the scale produces a composite score from 23 to 115 points, as well as specific scores for each subscale. The 4-HCS relies on the conceptual framework of the “Four Habits Model”, a training program that has been developed within the US Health Maintenance Organization Kaiser Permanente and implemented for teaching effective communication to thousands of clinicians in this organization over the two last decades [41]. Since its original development and preliminary validation, the 4-HCS has been used in several different countries [42–46] outside the Kaiser Permanente system [41, 47–50]. Cross-cultural adaptations of the 4HCS have been published in different languages, including Norwegian [42], German [51], and Brazilian Portuguese [52]. Given the potential of the 4-HCS [41], there is a need for a French version that can be used with medical students during the four-year competency-based communication curriculum. To our knowledge, there are only three studies examining the psychometric properties of the 4-HCS [42, 51, 53].

Associated factors of interpersonal skills

The assessment of interpersonal skills with simulation programs makes it possible to work on the skills of medical students. However, it would be interesting to determine whether these skills are associated with various factors. Identifying the predictors of these behaviors is necessary, because traditional tests used in medical admissions offer limited predictions of attributes of a good practicing physician. Several studies have shown the link between interpersonal skills and certain characteristics of students or characteristics of their medical curriculum. Some factors studied are

unchangeable like the gender, but it is possible to modify other factors after identification such as hospital placements.

The first factor described by several authors is the student's gender [26, 54–56]. Female medical students were often more patient-centered, and patient-centeredness was positively associated with primary care practice [54]. In the same way, female students developed better nonverbal communication skills, which is correlated with verbal communication and empathy [26]. Female doctors also thought that one of the most important skills was communication [56, 57], and they were more favorably inclined toward caring for the medically indigent [55], unlike men.

The medical curriculum is another factor related to interpersonal skills. Indeed, a study showed a significant relationship between academic examination results undertaken over the first 2 years of a medical school course and the performance in each year's Objective Structured Clinical Examinations (OSCEs) [10]. The OSCEs included stations covering practical skills and communication skills. Conversely, poor interpersonal skills can have a negative impact on the clinical results [58]. In addition, it has been demonstrated that early nursing attachments in the hospital can influence these skills [57]. Later, it would appear that the desired medical specialty or undergraduate medical curriculum influenced performance, with different perceptions in the essential physician's skills between surgeons and internists or between a consultant and a department director [56].

Finally, a number of student-specific factors determine the future physician–patient relationship. Adam showed that the student's personal qualities such as conscientiousness and confidence predicted OSCE skills. However, noncognitive characteristics such as narcissism and irrational thinking did not predict these skills [10]. In the same way, the students' preclinical attitudes toward biopsychosocial aspects of medical care were a potential predictor for their humanism [59]. The ability to regulate emotions, one of the dimensions of emotional intelligence, can also predict performance in courses on communication and interpersonal sensitivity [60].

Moreover, professional skills can be improved through international exchanges. No studies have focused on medical students or on the improvement of interpersonal skills, but examples for nursing and midwifery studies have shown interesting results in terms of the progression of technical skills [61, 62].

Aims

However, these different factors are poorly documented, particularly concerning the academic results. We have no details on the precise level of academic results or the type of discipline that is associated with relational skills. Likewise, the clinical hospital placement experience and the type of internship performed (medical or surgical department, for example) has not been studied.

Our students have varied profiles at the time of their assessment of interpersonal skills due to their hospital placements, clinical experience, and because of their differing success at previous university exams. This is why, with our experience and a large number of students, we can study these behaviors.

The main objective was to identify the factors associated with interpersonal skills as assessed by the French version of the 4-HCS for fourth year medical students, among academic, clinical and demographic factors.

A secondary objective was identifying the same factors with the 4-HCS scale transformed into a binary variable.

Finally, we studied the association between the different dimensions of the original 4-HCS scale and student characteristics.

Study design and setting

We conducted a cross-sectional study in the field of medical pedagogy. The study took place from October 2016 to April 2018 at Grenoble Alps University. The data were analyzed from June 2018 to February 2019. This manuscript complies with the STROBE (STrengthening the Reporting of OBservational studies in Epidemiology) international guidelines [63].

Participants

Fourth-year medical students from two consecutive classes — 2016–2017 and 2017–2018 — enrolled in the Grenoble Alps University School of Medicine were eligible to participate in the study. Students in the first class were recruited on a voluntary basis. Students in the second class were required to participate in the exercise as part of their curriculum. Each medical student participated in only one simulated consultation.

We excluded students not available at the time they were contacted. Then we excluded from the analysis the students who undertook medical studies after the 1st year (starting higher education in a discipline other than medicine), students with no data for their 1st year of medicine and students arriving from other medical schools.

The students were informed by an official communication from the medical school. The volunteers registered in response to the investigator and for those participating on a mandatory basis, their convocation was sent by email.

Consultations with standardized patients

For simulated consultations, we established an original partnership with the Department of Performing Arts of Grenoble Alps University. This interdisciplinary partnership was intended to benefit both medical students and performing arts students. As part of improvisation courses, performing arts students had to play the role of a patient in a medical consultation. One goal was to assess the interpersonal skills of medical students during this simulated consultation. The objective was not to evaluate the medical knowledge of the medical student. We defined 7 clinical scenarios that could be encountered in general practice. Preparatory sessions with the actors worked on simulation of these clinical cases. Then the actors worked with their improvisation instructor on the different personalities proposed. In addition to different clinical scenarios, we proposed a list of 9 personality types or character traits. The goal was to place the medical student

in a realistic clinical situation with stereotyped typical patients. The “physicians” were medical students who were starting their clinical placements. All the simulated consultations were video-recorded and videos were stored in a secure cloud-database for subsequent remote access. The video allowed for one or more assessments of interpersonal skills after the consultation, without the need for the physical presence of a rater during the consultation, which could distort the behavior of the medical student [64].

In 2017-2018, the simulated consultations took place in two parts: a first half in the first semester and a second half in the second semester, with 6 months of additional clinical experience.

Measurement of interpersonal skills

The simulated consultations were conducted in October 2017 and April 2018 at Grenoble Alps University Hospital. Twenty performing arts students played the patients. Each consultation was viewed by two different raters: an experienced professor of medicine and a resident in medicine with experience in simulation and interpersonal skills. The raters evaluated the videos independently of each other during the same time period. Raters were randomized to start on different shooting dates. The raters performed the assessments at home, usually in sessions of up to 2 consecutive hours. Raters completed an online form in which all items of the 4-HCS scale were mandatory, so there could be no missing data.

We validated a French translation of the 4-HCS. It was translated into French according to recommended standards with forward, then backward translation and conciliation by experts [65]. The quality translation of the 4-HCS gave a 23-item scale in French with semantic equivalence (**Figure S1**). The overall inter-item correlation was 0.42, while the overall item-rest correlation was 0.63. The Cronbach alpha coefficient was 0.94 for the scale, ranging from 0.72 to 0.88 for the four subscales. Finally, the inter-rater correlation was 0.60 (ICC) while the test-retest correlation was 0.72 (**Table S1**) (data unpublished, manuscript submitted). The psychometric properties obtained were satisfactory.

In accordance with the source version of the 4HCS, each item was rated on a 5-point Likert scale, ranging from 1 to 5, with higher scores indicating better performance. The midpoint (i.e., 3) and the two endpoints (i.e., 1 and 5) were anchored, with specific behavioral descriptions [11]. The raters were encouraged to use the midpoint and endpoint categories, with other categories (i.e., 2 and 4) to be used only if they thought that communication skills fell in between [11]. This approach ensured a full use of the 5-point Likert scale and produced an overall interpersonal skill score ranging from 23 (i.e., less effective) to 115 (i.e., more effective). Four subscale scores were also

computed by summing ratings for the items comprising each habit (Habit1, Habit2, Habit3 and Habit4).

Data sources

Academic data from the Grenoble Medical School were collected after the consultation and the assessment of interpersonal skills. We anonymously retrieved the exam results for the first 3 years of medicine through student ID numbers.

For the 1st year of medicine, we kept only the results of the most recent academic year. Consequently, for those who repeated their 1st year, we kept the results of the 2nd year. Nevertheless, we identified all the 1st-year students who had taken examinations twice. We collected grades for each discipline in the 1st and 2nd semester, the average grade at the end of the academic year, and the final ranking. The disciplines were chemistry-biochemistry, physics-biophysics, cellular biology-histology, mathematics-biostatistics, physiology, anatomy, initiation to the knowledge of the drug, and humanities-social sciences.

For each participant, we collected grades for each discipline in the 2nd year of medicine: locomotor system, pharmacology, radiology, pathology, endocrinology, digestive system, urinary system, neurology, genetics-reproduction-development, biostatistics and biochemistry. We also collected grades for each discipline in the 3rd year of medicine: public health-critical article reading-forensic medicine, cardiology, pneumology, infectiology-dermatology, cancerology, immunology and the Master's unit.

At the beginning of the 2nd semester of the 3rd year, medical students have clinical placements at the hospital. We therefore collected all the placements completed up to the date of the simulated consultation. We then ranked these placements according to whether they belonged to a medical or surgical department. We also detailed whether the placements were in a specific-organ department, a nonclinical department, an emergency or resuscitation department, a psychiatry department and finally in a pediatrics or geriatrics department. ERASMUS internships (international exchanges) and laboratory research internships were also identified. In addition, demographic data such as the participants' gender were collected.

Statistical Methods

Sample size — Considering an alpha risk at 5% for the gender comparison for example, a total of 165 subjects divided into 111 female subjects and 54 male subjects, as in our sample, made it

possible to objectify a difference of 4.39 points on the 4-HCS score (SD: 10.57) with a power of more than 80%.

Scoring and descriptive analysis — Scores for each of the four subscales, representing different “habits,” were calculated by summing the marks of all the items in the subscale; the total score was the sum of the scores on the subscales. The final scores were the means of the two raters’ scores for the same student, as is recommended in several studies [66, 67].

The total score was then cut based on the average of the variable after verification of the normality of the distribution. This division of the sample defined two modalities according to the score levels on the 4-HCS scale: low level or high level. This was done to facilitate the interpretation of the results by comparing the two groups obtained.

Participants inclusion characteristics were described for the entire sample and for each level of the 4-HCS (i.e., low versus high) score. An analysis by gender was also conducted. The usual descriptive statistics were used for the continuous quantitative variables (mean and standard deviation, or median and 25th–75th percentiles in case of an asymmetric distribution viewed on the histogram) and qualitative variables (numbers and percentages of modalities). The level of significance was set at 5% except for multiple analyzes where a Bonferroni correction was applied.

Multidimensional analysis — Due to the large number of variables available and their diversity, we started the analyses with a multidimensional analysis to have a preliminary idea of the relation between the different variables. A principal component analysis was therefore performed with all the variables of interest: discipline scores, overall scores, clinical placements, other internships, gender and total score on the 4-HCS scale. We then performed principal component analyses focused on each of the four dimensions of the 4-HCS scale. We always included the main variables of interest in the analyses for exploratory purposes.

Regression models — We conducted regression models. We performed a linear regression with the 4-HCS score as a continuous variable.

To select the best subset of predictors, we used two variable selection procedures. The first procedure was based on Bayes information criterion (BIC). We selected the model to minimize BIC with a stepwise regression. Each model calculated was graphically represented to facilitate the reading of the results. This method is based on Furnival and Wilson’s algorithm [68].

Then the best model obtained was compared with the results of a second method to confirm the selection of the variables. We used a forward method with a partial F-test. At each iteration, we

selected the variable with the most significant test to include it in the regression model. We continued iterations until the test was no longer significant at the 5% threshold.

Finally, the few variables described in the literature as having an influence on interpersonal skills were included in the regression model.

Once the explanatory variables of the model selected by the previous methodologies, we sought interactions. We successively included an interaction term for each pair of variables in the regression model. An interaction was retained when the interaction term was significant at the 5% threshold and the potentially confounding variable did not result from exposure (intermediate step) [69]. If an interaction was retained, the interaction term was included in the definitive regression model from the previous steps.

Then we verified the validity conditions of the definitive multiple linear regression model using a histogram of the residuals of the regression model. If the normality of the distribution was verified, the model was considered valid. Finally, we graphically represented the effects of each variable included in the definitive linear regression model.

For the evaluation of score levels (nominal variable), a logistic regression model was used. The same methodologies for selecting variables and searching for interactions were performed. To verify the model's validity conditions, we made sure that at least five to ten observations were present for each explanatory variable [69].

Classification and Regression Tree (CART) — To construct prediction models from data, we used CART with data mining, following the two main stages of tree construction presented by Breiman et al. [70]. The first phase is the construction of a maximal tree, which defines the family of models inside which the best one is selected. The second phase, called pruning, builds a series of optimal subtrees pruned from the maximal tree. The optimal pruned tree was especially selected using the graph of the optimal sequence of pruned subtrees. We used the "1 Standard Error rule" to make this selection, i.e., choosing as the right-sized tree the smallest-sized tree whose cross-validation (CV) costs do not exceed the minimum CV costs plus 1 time the standard error of the CV costs for the minimum CV costs tree [70, 71]. The tree that minimizes the cross-validation error and the complexity parameter was thus selected.

We used this methodology successively for a regression tree with the 4-HCS score (continuous variable) and a classification tree for the level of this score (nominal variable).

Sensitivity analysis — The robustness of the regression models was tested by deleting, one by one, the explanatory variables demonstrated in the literature to have an influence on interpersonal skills

but not found in the sample. We then looked at whether the level of significance of the variables had changed.

For the CARTs, we tested the robustness of the trees obtained by sampling 100 observations randomly in the sample and by calculating a tree again according to the same methodology. We did this sampling five times for the classification tree and five times for the regression tree, then we compared the nodes and leaves obtained.

Statistics were performed using the software RStudio (Version 1.0.143 ©).

Ethical considerations

Students could be included only after signing an individual consent form and image rights. One week before the simulated consultations, they received clear and accurate information from the investigators about the possible use of their data within the framework of research on interpersonal skills, and specifically about the confidentiality requirements. For the validation of the 4-HCS scale and the use of data for educational purposes, ethics committee approval was granted on Sept.18, 2017, by the regional ethics committee: Comité d'Ethique du Centre d'Investigation Clinique de Clermont-Ferrand (IRB 00005891).

The Grenoble Alps University use of academic data was in accordance with the regulations on privacy and personal data. All data were processed anonymously during the study.

Participants

Description of sample — The class of 2016–2017 had 31 student volunteers to participate in the simulation of medical consultations. The next year, we included 169 fourth-year medical students. Our analytic sample consisted of 165 video-recorded medical consultations with standardized patients, after excluding 35 videos due to exclusion criteria (**Figure 1**). 80 students had a low level of interpersonal skills 85 a high level based on the 4-HCS.

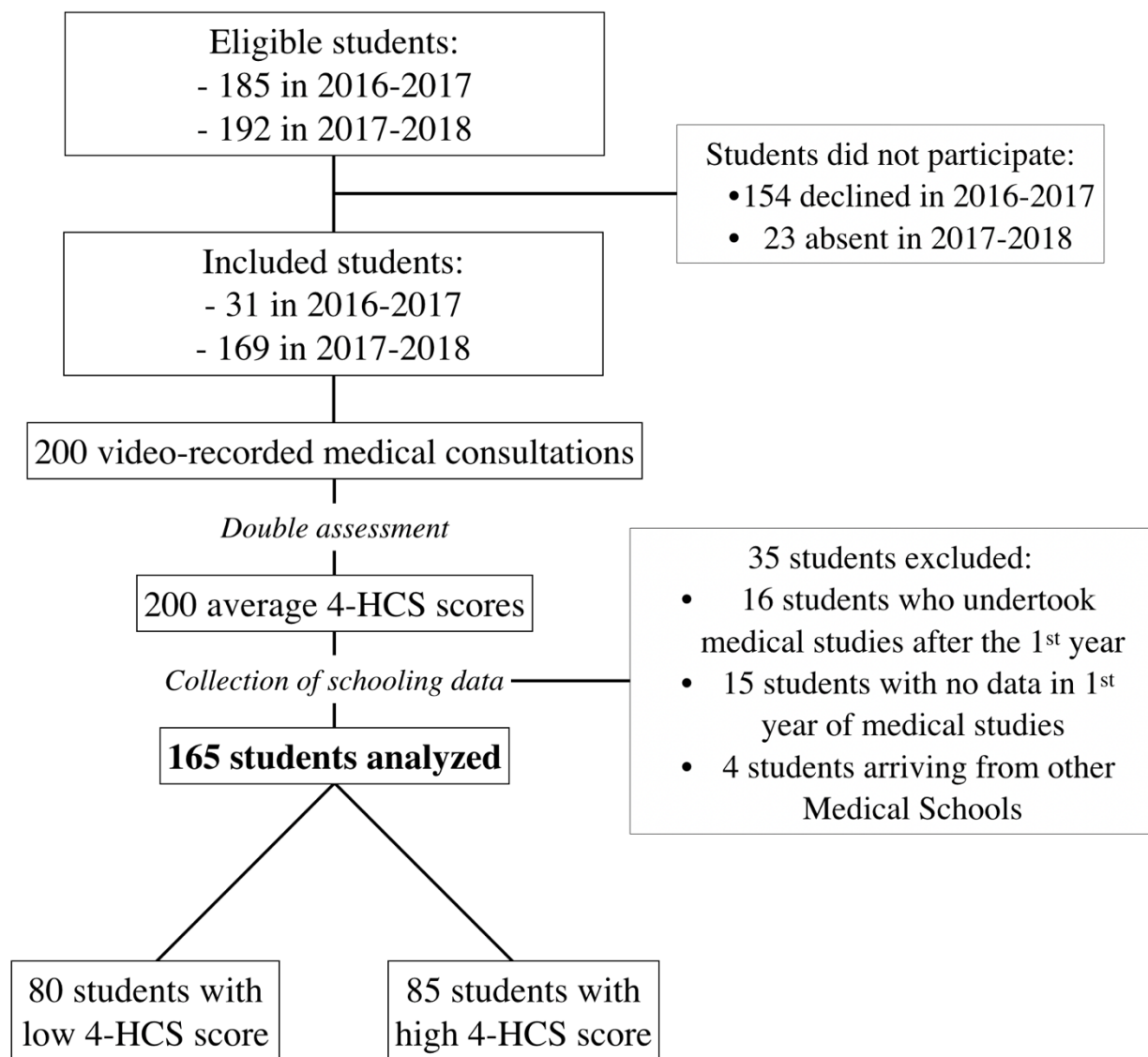


Figure 1. Flow-chart of the study

The overall average grade over the first 3 years of medical studies was 14.27/20 (SD: 0.88) ranging from 14.80 in the 1st year to 13.31 in the 3rd year. In about 1 year, students performed an average

of nearly three hospital placements in medicine (2.96, SD: 0.93) compared to 1.25 (SD: 0.83) in surgery (**Table 1**). Forty-seven students (28.5%) had completed a research internship, 29 had completed an Erasmus internship (17.6%) and 111 were women (67.3%).

a.	1 st year grades	2 nd year grades	3 rd year grades	2 nd and 3 rd year grades	Mean grades
Valid	165	165	165	165	165
Mean	14.80	14.17	13.31	13.74	14.27
S.D.	0.76	1.27	1.49	1.32	0.88
Min.	13.66	10.35	7.60	10.16	12.13
Max.	17.52	17.39	16.85	17.03	17.27

b.	Number of medicine placements n (%)	Number of surgery placements n (%)	Research internship n (%)	ERASMUS Internship n (%)
0	2 (1.2%)	28 (17.0%)	136 (82.4%)	118 (71.5%)
1	8 (4.8%)	80 (48.5%)	29 (17.6%)	47 (28.5%)
2	35 (21.2%)	46 (27.9%)		
3	75 (45.5%)	10 (6.1%)		
4	40 (24.2%)	1 (0.6%)		
5	5 (3.0%)	0 (0.0%)		
Total	165 (100%)	165 (100%)	165 (100%)	165 (100%)

Table 1. a. Description of grade b. Description of placements and internships

Comparison of characteristics according to interpersonal skills— The characteristics of the two groups can be described based on their level of interpersonal skills. Students with a high level of interpersonal skills always had higher grades regardless of the year of study, from only 0.04 points in the 1st year to 0.31 points in the 2nd year of medicine. The mean total score over the first 3 years was 14.19/20 (SD: 0.89) for the low-level group versus 14.35 (SD: 0.86) for the high-level group. However, there was no statistically significant difference between the groups regarding the students' grades (**Table 2**).

n=165	1 st year grade		1 st year ranking		2 nd year grade		3 rd year grade		2 nd and 3 rd year grade		Total grade	
Score	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
Valid	80	85	80	85	80	85	80	85	80	85	80	85
Mean	14.78	14.82	89	85	14.01	14.32	13.20	13.42	13.60	13.87	14.19	14.35
S.D.	0.78	0.74	54	48	1.37	1.164	1.45	1.52	1.37	1.28	0.89	0.86
Min.	13.67	13.66	2	1	10.35	11.77	10.02	7.60	10.45	10.16	12.13	12.34
Max.	16.95	17.52	175	177	16.72	17.39	16.40	16.85	16.51	17.03	16.56	17.27
p	0.732		0.636		0.116		0.334		0.195		0.260	

No missing data (n=0)

Table 2. Comparison of baseline characteristics according to interpersonal skills score

If we look for each discipline studied during the first 3 years, there was no significant difference between the groups. (**Table S2**).

Regarding gender, 62 women (72.9%) were present in the high-level group versus 49 (61.3%) in the low-level group, with no significant difference.

However, concerning the research internship and the ERASMUS internship, the results were significantly different between groups (**Table 3**). For the ERASMUS internship, 36.5% of the students were in the high-level group ($p=0.019$) and 23.5% of the students for the research internship ($p=0.038$).

n=165	Score level		Total	p
	Low (n=80)	High (n=85)		
ERASMUS internship (yes)	16 (20.0%)	31 (36.5%)	47 (28.5%)	0.019*
Research internship (yes)	9 (11.3%)	20 (23.5%)	29 (17.6%)	0.038*
Gender (women)	49 (61.3%)	62 (72.9%)	111 (67.3%)	0.110
PACES done only once (yes)	34 (42.5%)	45 (52.9%)	79 (47.9%)	0.180

Note. PACES = First Year of Medicine

No missing data (n=0)

* $p < .05$

Table 3. Level at the 4-HCS score by nominal variables

Concerning hospital placements, students in the high-level group performed on average 2.75 medicine internships (SD: 0.96) versus 3.18 (SD: 0.87) in the low-level group, with a significant difference ($p=0.004$). Concerning surgical specialties, there were no differences between groups (**Table 4**).

n=165				
Number of traineeships	Medical specialties		Surgical specialties	
Score	Low	High	Low	High
Valid	80	85	80	85
Missing	0	0	0	0
Mean	3.18	2.75	1.25	1.25
S.D.	0.87	0.96	0.89	0.77
Min.	1	0	0	0
Max.	5	4	3	4
p	0.004*		0.982	

Note. No missing data (n=0)

* $p < .05$

Table 4. Level at the 4-HCS score by type of hospital traineeships

For the number of hospital placements in different specialties, the results showed no significant association. The trend was generally the same with a lower average number of placements in the high-level group (**Table S3**).

The gender comparison showed that female students had significantly better academic results than male students ($p=0.022$). They also took part not significantly in more hospital medical placements ($p=0.058$). There was no significant difference regarding ERASMUS internships or research internships (**Table S4**). Considering the different dimensions of the 4-HCS scale, the difference by gender was significant for the Habit1 ($p=0.025$), Habit2 ($p=0.012$) and Habit4 scores ($p=0.038$).

Outcome analysis

Multidimensional analysis — The principal component analysis revealed high correlations between the 4-HCS score and the research internship as well as the ERASMUS internship (**Figure 2**). Correlations with the number of hospital placements or gender were lower. The discipline that best correlated with the 4-HCS score was humanities and social sciences. The other disciplines had very little correlation with the 4-HCS score, regardless of the year of study. However, correlations were strong between the different disciplines of the 2nd and 3rd year, but these grades were poorly correlated with 1st-year grades.

Figure S2 shows the specificities of each dimension of the 4-HCS scale. The different main component analyses focused on the score of each dimension and showed the same trend as observed above. For example, entering into a relationship with the patient and obtaining his point of view were the most highly correlated dimensions related to the ERASMUS internship. The number of students in medical placements was negatively correlated with the scores, especially for the second dimension. The strongest correlation between gender and interpersonal skills concerned empathy, and women seem to have better results than men.

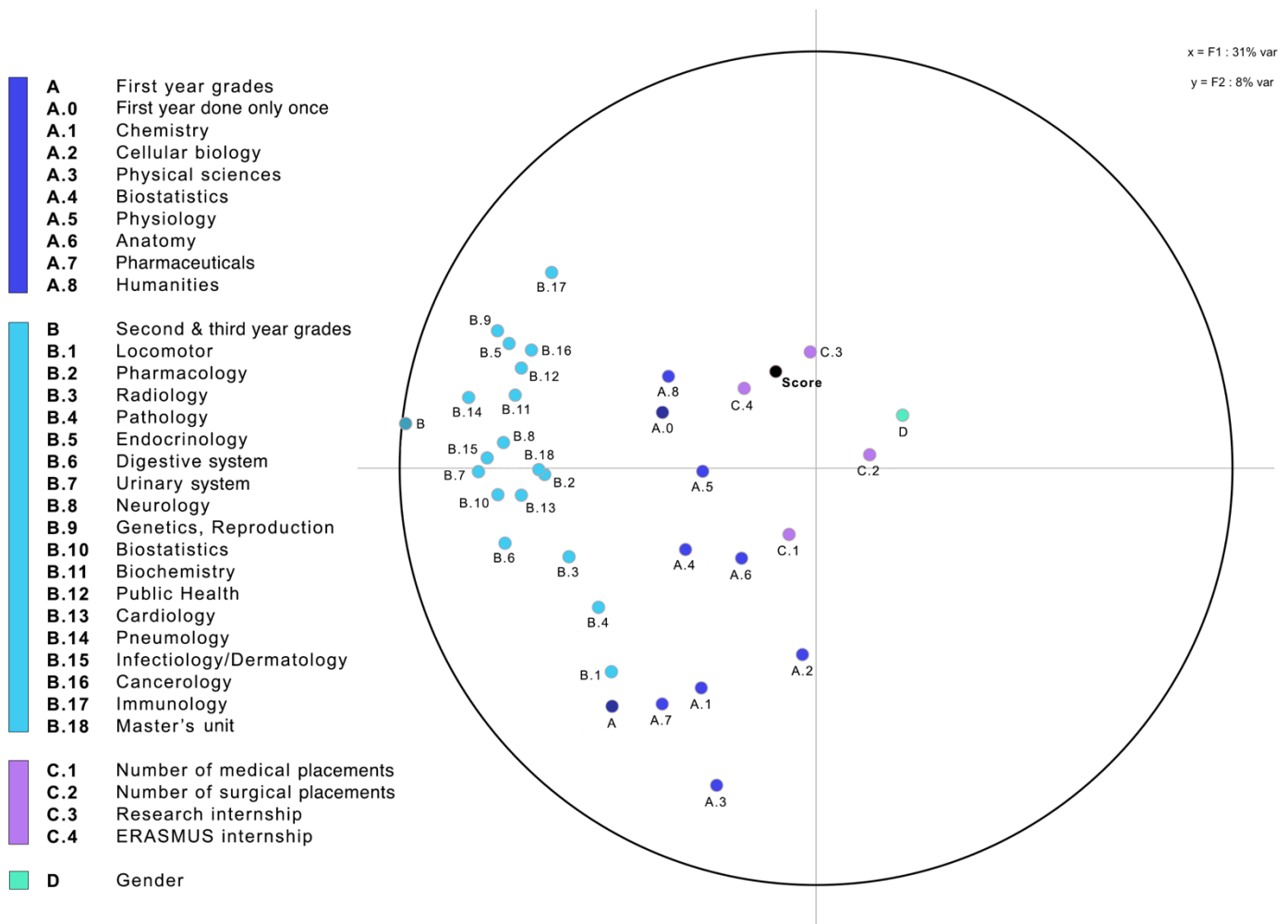


Figure 2. Principal component analysis of the dataset

Regression models — Regarding the linear regression model, the selection procedure of the variables based on the BIC highlighted the influence of gender, the research internship and the ERASMUS internship (**Figure 3**). The confirmatory method based on forward selection using partial F-tests highlighted the same results with the selection of the same three variables (**Table S5**).

Regarding the logistic regression model, the selection procedure of the variables based on the BIC made it possible to highlight the influence mainly of the number of medicine placements. In the second step, the gender variables and the number of surgical placements minimized the BIC (**Figure 3**). The confirmatory method based on forward selection using partial F-tests highlighted the same results with the selection of the same three variables (**Table S5**).

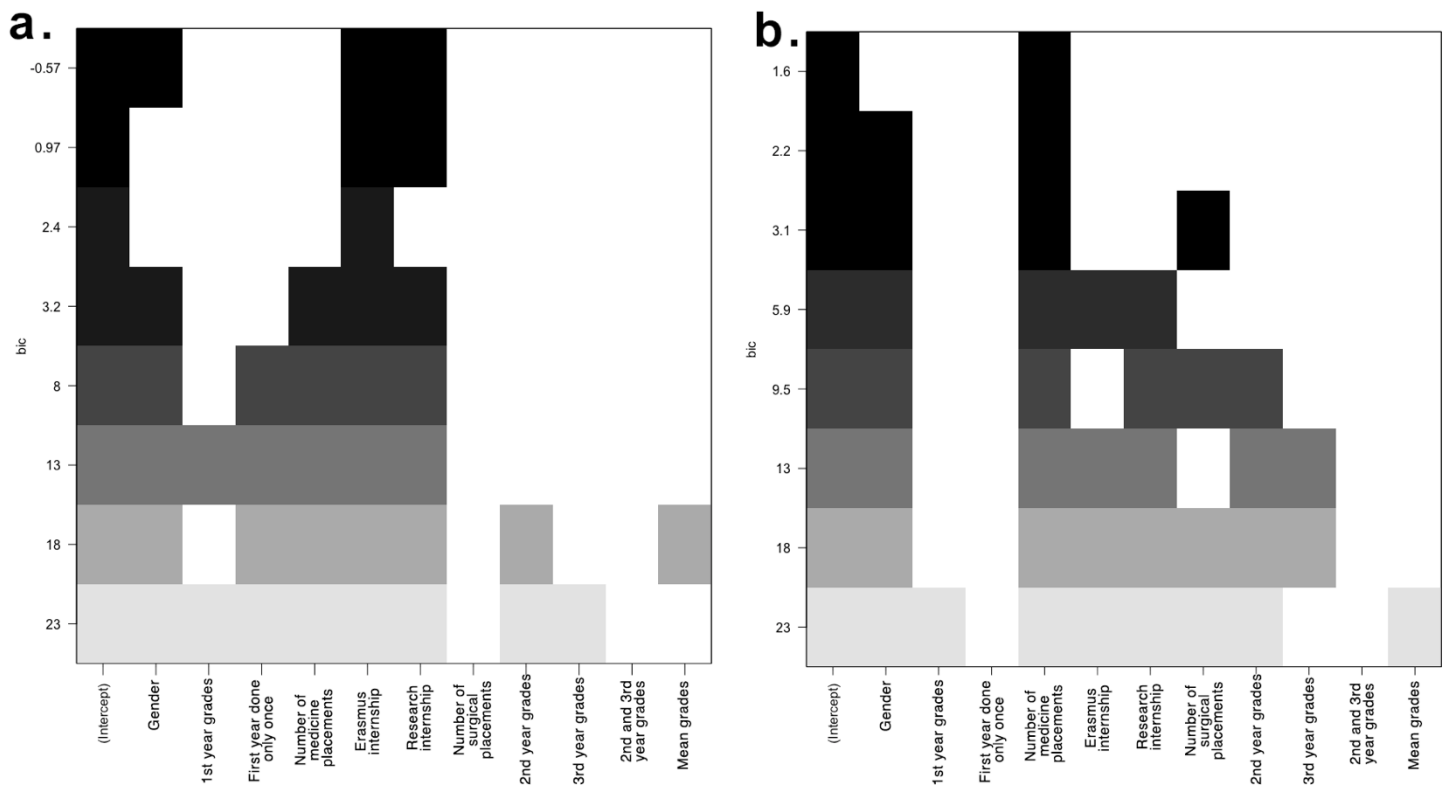


Figure 3. Plots of regression models according to the ordering of the BIC values
(a. Plot for linear regression models, b. plots for logistic regression models)

Academic results were a variable described in the literature as influencing interpersonal skills, so we also chose to include the total average score over the first 3 years in all models.

The results of the two regression models obtained are shown in **Table 5**. The factors significantly associated with interpersonal skills in the linear regression model were the ERASMUS internship ($p=0.0021$), the research internship ($p=0.0056$) and gender ($p=0.0123$).

In contrast, the factors significantly associated with interpersonal skills in the logistic regression model were the number of medicine placements ($p<0.001$) and the number of surgery placements ($p<0.0453$). Gender was not significantly associated ($p=0.0525$). Whatever the model, the academic results were not associated with interpersonal skills.

The graphs in **Figure S3** and **Figure S4** clearly show the meaning of the association between the 4-HCS score and the covariates of the linear regression model, as well as between the 4-HCS score levels and the covariates of the logistic regression model. Better interpersonal skills were visible mainly with the reduction in the number of medicine placements and surgery placements, then for women and for students who had completed a research internship or an ERASMUS internship.

Independent predicts	Multiple linear regression		Multivariable logistic regression	
	β (95%CI)	p	OR (95%CI)	p
Gender (male)	-4.79 (-8.52 ; -1.05)	0.0123*	0.49 (0.23 ; 1.00)	0.0525
ERASMUS internship	6.17 (2.28 ; 10.05)	0.0021*		
Research internship	6.49 (1.93 ; 11.05)	0.0056*		
Number of medicine placements			0.43 (0.26 ; 0.67)	<0.001*
Number of surgery placements			0.61 (0.38 ; 0.98)	0.0453*
Total grade	-0.05 (-2.07 ; 1.98)	0.9641	1.16 (0.81 ; 1.70)	0.4163

Note. No missing data (n=0)

* $p < .05$

Table 5. Results of multivariate analysis for interpersonal skills

CART — The CARTs provided a different visualization of the results in a prediction objective. The regression tree mainly used the variables regarding the number of placements in medicine or surgery to separate the students. Students achieving the highest scores at the 4-HCS scale were those with two or fewer medicine placements (**Figure 4**).

The regression tree proposed six leaves. It was one of the best compromises in terms of the complexity parameter and the risk of relative error (**Figure S5**). However, this relatively simple tree had a very high root node error (0.976) and therefore an 83.0% misclassification rate.

Concerning the classification tree, the tree was more complex with 11 nodes. The variables used to separate the students were the same as in the previous tree, but also with the ERASMUS internship and research internship variables. The students with the highest probability of having a high score on interpersonal skills (more than 95%) were those with fewer than three medicine placements and fewer than two surgery placements (**Figure 5**).

The complexity parameter of this tree was 0.0219. This configuration at 12 leaves was a good compromise with the risk of relative error (**Figure S6**). The root node error was 0.563 with a 27.3% misclassification rate.

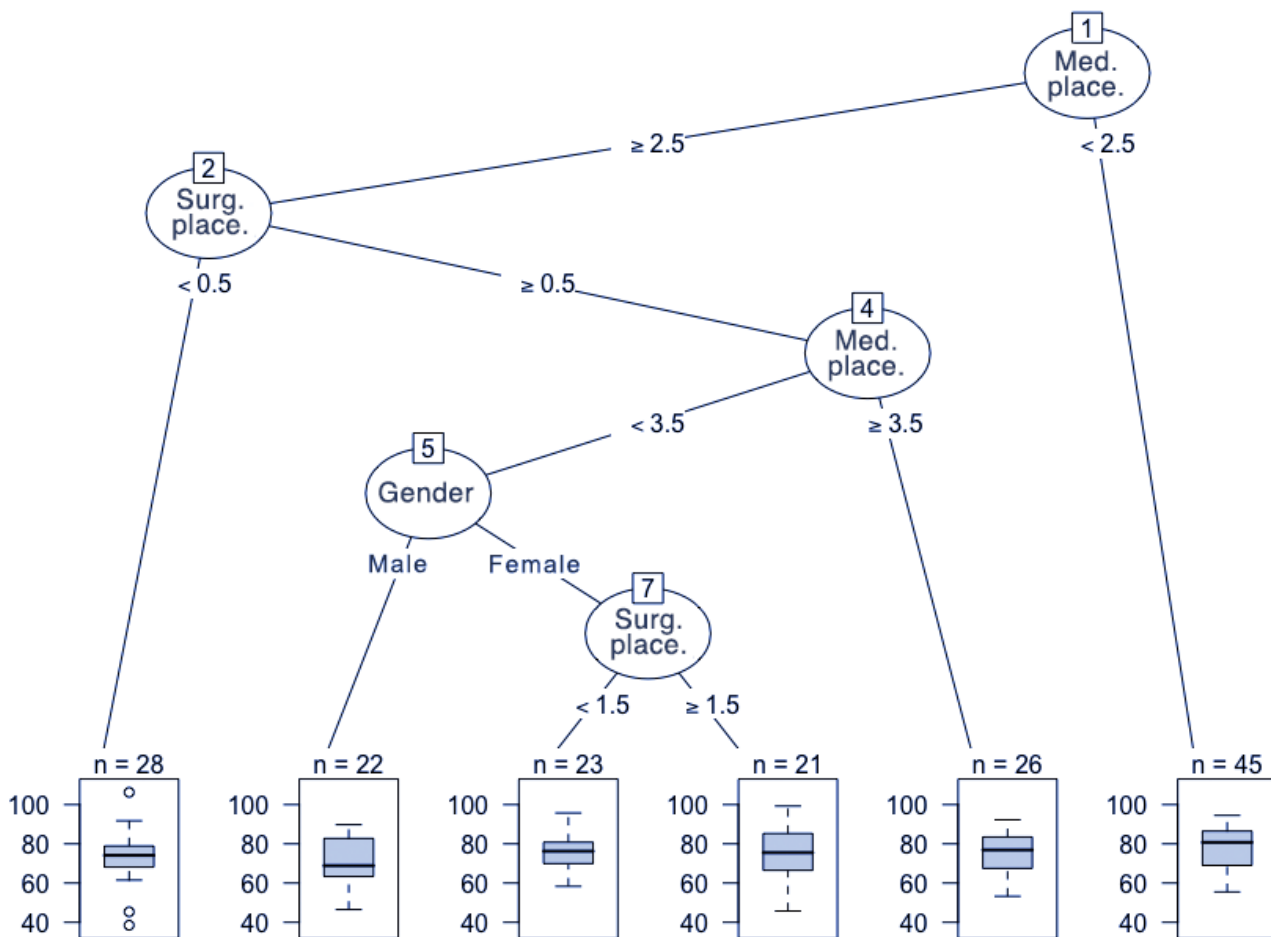


Figure 4. Regression tree for the 4-HCS score

Interactions and sensitivity analyses

We found no significant interaction in the regression models. There was no interaction between gender and the various co-variables, in particular: with the mean grade for the first 3 years of medical studies ($p=0.2418$), the ERASMUS internship ($p=0.0521$), the research internship ($p=0.4360$) and the medicine placement ($p=0.0589$).

Concerning the sensitivity analysis for regression models, we found a collinearity between the ERASMUS internships or research internships and the number of hospital internships. The number of hospital placements is necessarily less important if the student having done an ERASMUS or a research internship in replacement. By adding all these variables in the regression models, we obtained different results, the hospital placements being no longer significantly associated with the interpersonal skills score (**Table S6**). The gender was always associated whatever the model chosen. ERASMUS and research internships were significantly associated with linear regression.

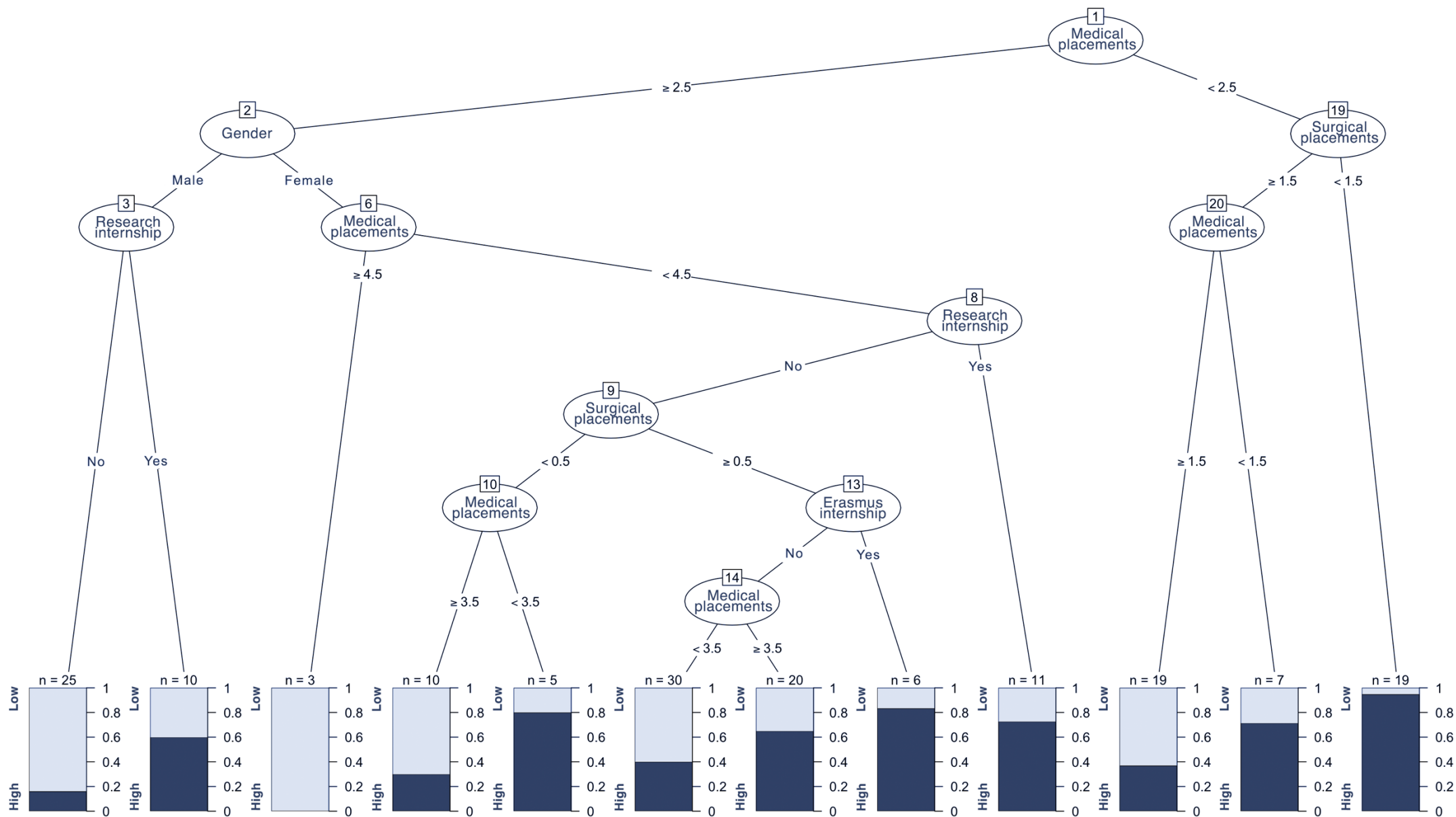


Figure 5. Classification tree for the 4-HCS score

Excluding ERASMUS and research internships from the analysis, the results of the linear regression model were similar. The number of hospital placements was not significantly associated in this subpopulation (**Table S6**).

For the CARTs, sampling 100 students created different trees but with the same variables to separate the data, nonetheless demonstrating a certain robustness.

To summarize the various factors associated with interpersonal skills, we first demonstrated the influence of gender. Gender was significantly associated in regression models, and gender was present in the nodes of both trees. Two other factors strongly associated with interpersonal skills were the ERASMUS internship and the research internship. They were significantly associated in the linear regression model and were present in the classification tree. From the results of the sensitivity analysis, we could not consider hospital placements as significantly associated because of collinearity with the previous variables. Total grades and clinical experience did not affect the interpersonal skills score. **Figure 6** summarizes the various factors associated with the interpersonal skills found during the analyses.

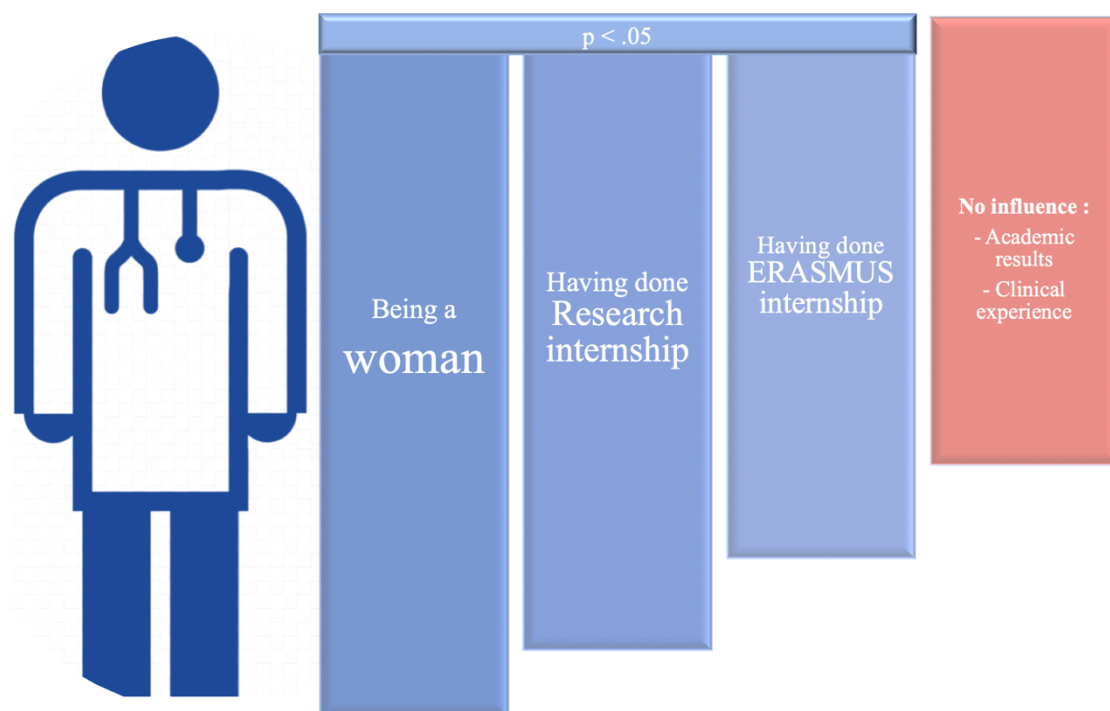


Figure 6. Typical profile of the student with a high level of interpersonal skills

Key results

By screening dozens of variables, we highlighted three factors associated with interpersonal skills. Women had significantly higher scores than men concerning interpersonal skills ($p=0.0123$). Students who completed an ERASMUS internship ($p=0.0021$) or a research internship ($p=0.0056$) also had significantly higher scores. Finally, the number of hospital placements and the academic results were not significantly associated with interpersonal skills.

Interpretation

One of the first factors highlighted in bivariate, multivariate, multidimensional analyses and in CART was gender. This result is consistent with the literature data. Krupat et al. found that female medical students were more patient-centered [54]. This difference was observed very early in the medical curriculum and guided the career choice with a greater interest in primary care. These differences can be explained by women's increased interest in communication and listening in comparison to men [56], particularly in nonverbal communication [26]. Meta-analyses have shown that consultation time is significantly greater for women than for men and that female physicians showed greater engagement in communication [72, 73]. The most significant differences by gender were psychosocial communication, positive talk and active partnership behaviors [72]. Beyond communication, it has been shown that female medical students developed more empathy [74]. However, a decrease was observed in this empathy during the medical curriculum for female students, but not for male students [75].

The choice of different career orientations was found in our results, since female medical students had more medicine hospital placements ($p=0.058$) and fewer surgery placements ($p=0.265$). Their choice was different for hospital placements, but there was no difference for ERASMUS internships or research internships, with these last two factors strongly associated with interpersonal skills. Therefore, the better performance of female students compared to males does not seem to be explained by the internships. Female students also had significantly better academic results in the majority of disciplines and in the average grades for the first 3 years of medicine. However, the academic results were not associated with the interpersonal skills measured by the 4-HCS scale. The difference may therefore come precisely from this capacity for empathy. Indeed,

the third dimension of the 4-HCS scale was the one for which the difference was the greatest between female and male students ($p=0.012$).

Concerning academic results, few data have been reported in the literature. The correlations between the grades obtained during medical school and nontechnical skills are rarely demonstrated [10]. In the present study, we found no statistically significant association between interpersonal skills and academic results in the multivariate models or multivariate analyses. The grades obtained during the first 3 years of medicine did not seem to be good indicators of the student's interpersonal skill level.

From the principal component analysis, it is not surprising that the discipline most associated with the 4-HCS score was the humanities and social sciences. This type of education aims to increase ethics and medical professionalism, in particular with altruism and empathy. However, whether or not skills are improved through these lessons is a matter of debate [76–78].

Finally, in our results some disciplines seemed to be possibly associated but taking into account the inflation of the alpha risk, no discipline could be significantly associated. It is unclear why some disciplines were more associated than others with interpersonal skills. However, they were not found in the multivariate models.

In view of these results, the question of the relevance of these examinations and the selection made in the 1st year of medicine could be raised. This shows the interest of an assessment of the student's skills in addition to the assessment of his knowledge.

Regarding the internships carried out, it is surprising to note that the first to be strongly associated with interpersonal skills were the ERASMUS internship and the research internship. We found no data in the literature linking a research internship to these skills. For the ERASMUS internship, few studies have examined the interest of an internship abroad to improve students' professional practice. Internships abroad seem to increase students' confidence in communicating with people [79] and promote practice sharing [61, 62]. Studies specific to medical students assessing the rationale with communication skills seem missing. However, both the research internship and the internship abroad are experiences that allow students to work on a team and interact with other professionals. These internships may help develop communication skills and open-mindedness as part of interpersonal skills. Otherwise, it is possible that these internships select students most interested in these issues and who are therefore the strongest in terms of relational skills.

The association with other types of internships was less straightforward, but it seems that the number of placements done at the hospital was a factor associated with relational skills.

Surprisingly, there was an inverse relationship with the number of hospital placements. However, the difference was not statistically significant after taking into account the collinearity of the variables with ERASMUS or research internships. Indeed, these variables move in the opposite direction to the number of hospital placements. The interpretation is therefore delicate because we expected an improvement in relational skills scores with hospital clinical experience, but the number of hospital placements performed does not affect the result. The detailed results by type of specialty do not allow more precise prediction of interpersonal skills.

The few results from the literature seemed to suggest an increase in interpersonal skills with an early immersion in an internship [57], but it is true that nothing has been demonstrated on the duration of exposure. One might think that too much exposure to hospital practice can reduce interpersonal skills. This hypothesis could explain the impact of an internship abroad or a research internship and the decline of empathy during the medicine curriculum demonstrated by several studies [18, 74, 80, 81]. The years of clinical study seem to reduce student empathy [82]. The repetition of tasks, the work overload and the high emotional load of certain clinical situations probably make students with more clinical experience tend to pay less attention to these interpersonal skills, focusing instead on technical aspects.

Strengths and limitations

For this study, we used a robust methodology based on the international recommendations on observational studies [63]. We carried out adapted and graduated statistical analyses, with a clear and detailed protocol [69]. The variable selection procedure for the regression models was based on two methodologies: the first is a reference stepwise procedure currently based on the BIC [83–85], while the second is less frequently used today. Indeed, the technique based on the F-test with forward selection is criticized in particular for its alpha risk management. However, the concordance of results on both methods shows the reliability of the models.

For the construction of CARTs, we used the reference methodology published by Breiman [70]. The CART method allows analysis of large data sets. The absence of missing data improves the prediction. Apart from the advantage of interpretability, the CART highlights the variables most associated with the problem considered, especially if they are close to the root. However, this heuristic approach can give biased results. To complete this, we could have defined the importance of a variable by evaluating, in each node, the reduction of heterogeneity generated by the use of the substitution split on this variable and then summing them on all the nodes [70, 86].

We used a linear and logistic regression model for the study of interpersonal skills. The variable selection process has to include different factors between the two models. The advantage of using the 4-HCS score as two modalities rather than a continuous variable is mainly to make the results easy to interpret. From a pedagogical perspective, it is common for the evaluation to set a threshold from which skills will be considered as acquired.

Regarding the simulations, we trained the actors to have standardized consultations. The evaluation was conducted on a scale adapted from English and validated in its French version psychometrically by our team. The evaluation was done by at least two evaluators and the calculated final score was the average of the two scores obtained. In our opinion, this methodology provides a reliable measure of a student's interpersonal skills. However, the medical consultation simulation took place only once for each student and the assessment therefore concerns the student's performance only at that time. To have a better view of his overall level of interpersonal skills, it would be necessary to carry out several consultations with standardized patients.

As for the associated factors, we collected a limited amount of data: students' academic performance. We did not have data on the socioeconomic level, cognitive aspects such as emotional intelligence or the students' psychological profiles. These data could have enriched the study.

In addition, the eligibility criteria resulted in a loss of information. Comparing this subsample with the subjects analyzed was difficult because of a large number of missing data, explaining why we preferred not to analyze these students, even if they had a different profile and therefore potentially different results. If we had chosen to analyze these students, it would have been necessary to impute their missing data. These missing data would probably not have been random, so there would have been statistical bias in the interpretation of the results.

THÈSE SOUTENUE PAR : Alexandre BELLIER

TITRE :

FACTORS ASSOCIATED WITH INTERPERSONAL SKILLS IN MEDICAL STUDENTS TRAINING FOR STANDARDIZED MEDICAL CONSULTATIONS

CONCLUSION :

Through medical consultation simulation exercises and standardized assessment of medical students' interpersonal skills, we showed that the main factors associated with interpersonal skills were gender, participation in an ERASMUS internship or a research internship without influence of academic results or hospital experience.

Based on these results, we showed the importance of these simulation exercises with the assessment of nontechnical skills. Indeed, academic results based on exams do not predict the level of interpersonal skills, and hospital clinical experience seems to degrade them.

It would be interesting to study the decline of empathy, especially among medical students. A major challenge for initial training would be to avoid this decline. It is likely that simulation exercises such as those we have organized will help students realize the importance of these skills and limit the unavoidable decline.

Certainly, scientific and academic excellence should be valued in the medical curriculum, but being a "good" doctor is not limited to these characteristics. Selecting doctors solely on the basis of their academic results does not seem satisfactory because it is weakly correlated with interpersonal skills. The question of the skills that doctors must possess, and the adequacy of their training is raised.

In this context, it would be interesting to study the association between the 4-HCS scores and the rank obtained on the national ranking exam. It is likely that as demonstrated in some studies, the level of these skills influences the choice of a specialty. This exam determines the choice of medical specialty, and in the future it should be based in part on interpersonal skills and not only on theoretical skills. Training students in these skills will be a significant challenge and will help maintain the position of our university nationally and most particularly train the most humane doctors possible.

However, this training lasts throughout a physician's career, emphasizing the importance of continuing education. A randomized controlled trial conducted by our team will begin shortly at

the Grenoble Alps University Hospital to study the interpersonal skills of senior doctor volunteers and the impact of dedicated training. Based on the same rating scale, this study will be an extension of this work. It will seek particular factors associated with interpersonal skills for senior doctors. We can also measure the impact on consulting time, a major determinant in the current economic context. Long neglected, the study of these skills is the subject of renewed interest in the context that we have described. Today, meeting the challenge of quality of care and the relationship with patients is essential.

Long neglected, the study of these skills is the subject of a renewed interest in the context that we have described. Today, the challenge for the quality of care and for the relationship with patients is essential.

VU ET PERMIS D'IMPRIMER

Grenoble, le : 17/09/19

LE DOYEN



Pr. Patrice MORAND

LE PRÉSIDENT DE LA THÈSE



Pr. Patrice MORAND

Pour le Président
et par délégation
—
Le Doyen de Médecine
Pr. Patrice MORAND

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APPENDIX

Table S1. Psychometric properties of the French 4-HCS scale

	Inter-item correlation (n=200)	Item-total correlation (n=200)	Alpha Cronbach (n=200)	Inter-rater reliability ICC (n=600)	Intra-rater reliability ICC (n=600)
Habit1	0.48	0.73	0.80	0.45	0.59
Habit2	0.48	0.80	0.72	0.42	0.45
Habit3	0.52	0.77	0.87	0.53	0.58
Habit4	0.46	0.72	0.88	0.64	0.71
Score total	0.42	0.66	0.94 [0.93-0.95]	0.60 [0.53-0.67]	0.72 [0.67-0.77]

Table S2. Level at the 4-HCS scale by exam grades during the first three years of medical school

First year of medicine (n=165)

Grades Score	Chemistry		Cellular Biol		Physical sci		Biostatistics		Physiology		Anatomy		Pharmaceutical		Humanities	
	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
Valid	80	85	80	85	80	85	80	85	80	85	80	85	80	85	80	85
Mean	12.97	12.84	14.88	14.79	11.88	11.69	14.94	14.76	16.01	16.00	15.31	15.28	13.95	14.04	16.63	16.87
S.D.	1.70	1.49	1.33	1.28	2.02	1.82	2.44	2.41	1.20	1.02	1.29	1.32	1.70	1.62	1.42	1.35
Min.	9.25	9.25	12.50	11.75	6.00	5.60	9.00	9.00	13.00	13.00	12.50	11.00	9.50	10.50	12.50	12.75
Max.	16.50	16.25	18.25	17.50	16.00	16.40	20.00	20.00	18.50	18.00	18.00	18.00	18.50	17.50	19.25	19.25
p	0.599		0.649		0.514		0.648		0.942		0.907		0.742		0.280	

Second year of medicine (n=165)

Grades Score	Locomotor		Pharmacol		Radiology		Pathology		Endoc		Digestive		Urinary		Neurology		GRD		Biostat		Bioch.	
	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
Valid	80	85	80	85	80	85	80	85	80	85	80	85	80	85	80	85	80	85	80	85	80	85
Mean	14.55	14.51	15.66	16.13	15.32	15.74	14.55	14.29	14.69	15.25	12.82	13.32	12.68	12.90	13.38	13.61	14.50	14.86	13.46	13.90	12.86	13.14
S.D.	1.58	1.22	2.30	1.99	1.79	1.65	1.68	1.77	2.17	1.96	2.14	1.88	1.54	1.59	1.90	1.99	1.72	1.64	1.99	1.93	1.67	1.59
Min	10.32	11.81	9.33	9.56	8.54	10.76	11.00	8.18	10.00	10.46	7.74	8.98	9.36	8.82	7.12	5.84	9.00	9.59	9.48	9.06	9.62	9.45
Max	19.18	17.57	19.44	20.00	18.62	18.85	17.60	18.82	18.52	18.41	16.70	17.41	16.56	16.20	16.27	17.65	17.78	18.43	18.03	18.45	17.75	17.86
p	0.831		0.158		0.122		0.333		0.081		0.111		0.371		0.447		0.166		0.145		0.284	

Third year of medicine (n=165)

Grades Score	Public health		Cardiology		Pneumology		Infect/dermatol		Cancerology		Immunology		Master's unit	
	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
Valid	80	85	80	85	80	85	80	85	80	85	80	85	80	85
Mean	13.45	13.86	12.87	13.12	12.70	13.08	13.82	13.92	12.67	12.87	12.95	13.02	13.77	14.14
S.D.	1.55	1.23	2.13	1.72	1.92	1.74	2.09	1.99	1.62	2.08	2.10	2.63	1.68	1.89
Min	9.61	9.37	6.47	9.14	4.33	8.69	8.75	8.52	8.25	0.00	7.56	0.00	10.09	8.28
Max	16.42	16.25	15.87	16.84	16.53	17.35	18.38	18.78	16.85	16.41	17.22	17.92	18.38	18.11
p	0.063		0.418		0.192		0.740		0.498		0.846		0.195	

Note. No missing data (n=0)

biol=biology, sci=sciences, pharmacol.=pharmacology, endoc.=endocrinology, GRD=genetics, reproduction and development, biostat=biostatistics, bioch=biochemistry, infect/dermatol=infectiology and dermatology

Table S3. Number of specialties hospital placements by level at the 4-HCS scale

Number of placements Score	Organ spec		Surgical spec		Psychiatry		Emergency med		Pediatrics/geriatrics		Other spec	
	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
Valid	80	85	80	85	80	85	80	85	80	85	80	85
Mean	1.63	1.67	1.25	1.25	0.24	0.14	0.56	0.37	0.33	0.28	0.40	0.28
S.D.	0.76	0.85	0.89	0.77	0.43	0.34	0.77	0.62	0.50	0.51	0.62	0.45
Min.	0	0	0	0	0	0	0	0	0	0	0	0
Max.	3	4	3	4	1	1	2	2	2	2	2	1
p	0.776		0.982		0.094		0.084		0.529		0.158	

Note. Spec = Specialities

No missing data (n=0)

Table S4. Comparative description between women and men

(Table a. With quantitative variables, Table b. With nominal variables)

Table a.

n=165	Total grade		4-HCS Score		Number of medicine placements		Number of surgery placements	
Gender	Woman	Man	Woman	Man	Woman	Man	Woman	Man
Valid	111	54	111	54	111	54	111	54
Mean	14.38	14.05	76.81	72.42	3.05	2.76	1.20	1.35
S.D.	0.89	0.81	10.57	13.52	0.89	1.01	0.83	0.83
Min.	12.13	12.70	45.75	38.50	1.00	0	0	0
Max.	17.27	16.04	106.30	94.50	5.00	5	4	3
p	0.022*		0.024*		0.058		0.265	

Table b.

Gender	Women (n=111)	Men (n=54)	Total	p
ERASMUS internship (yes)	32 (28.8%)	15 (27.8%)	47 (28.5%)	0.888
Research internship (yes)	17 (15.3%)	12 (22.2%)	29 (17.6%)	0.274

Note. No missing data (n=0)

* $p < .05$

Table S5. Selection of variables in forward using partial F-tests

Models		Linear regression		Logistic regression		
Iterations	Variables	F	p	Variables	F	p
First	Erasmus internship^a	7.87	0.0056*	Number of medicine placements^a	7.91	0.0049*
	Gender	5.18	0.0240*	Erasmus internship	5.36	0.0206*
	Research internship	4.67	0.0321*	Research internship	4.12	0.0422*
	Number of medicine placements	4.35	0.0385*	Public health grade	3.40	0.0650
	Humanities grade	4.31	0.0393*	Endocrinology grade	3.01	0.0827
Second	Research internship^a	6.57	0.0112*	Gender^a	4.35	0.0370*
	Gender	5.26	0.0230*	Number of surgery placements	4.23	0.0398*
	Biostatistics grade	2.70	0.1018	Digestive grade	3.66	0.0555
	Pneumology grade	2.65	0.1050	Endocrinology grade	3.38	0.0660
	Physical sciences grade	1.87	0.1729	Public health grade	3.32	0.0684
Third	Gender^a	6.62	0.0109*	Number of surgery placements^a	4.25	0.0393*
	Biostatistics	2.29	0.1319	Research internship	3.47	0.0652
	Pneumology grade	2.27	0.1335	Public health grade	3.07	0.0795
	Digestive grade	2.20	0.1396	Number of organ specialties	3.18	0.0744
	Anatomy grade	1.54	0.2158	Endocrinology grade	2.77	0.0956
Fourth	Anatomy grade	2.17	0.1486	Number of organ specialties	3.60	0.0576
	Biostatistics grade	1.95	0.1643	Public health grade	2.79	0.0948
	Number of organ specialties	1.69	0.1942	Endocrinology grade	2.37	0.1241
	Pathology grade	1.40	0.2370	Pharmacology grade	2.11	0.1467
	Number of medicine placements	1.69	0.2557	Research internship	2.04	0.1533

Note. No missing data (n=0)

^a Variable selected for the next iteration

* $p < .05$

n=165

Independent predicts	On the total sample (n=165)		After exclusion of ERASMUS/research students (n=94)	
	β (95%CI)	p	β (95%CI)	p
Gender (male)	-5.07 (-8.85 ; -1.29)	0.0089*	-8.22 (-13.82 ; -2.62)	0.0396*
ERASMUS internship	4.97 (0.06 ; 11.01)	0.0457*	-	-
Research internship	5.81 (0.49 ; 11.11)	0.0324*	-	-
Number of medicine placements	-1.34 (-4.72 ; 2.05)	0.4371	-1.78 (-6.06 ; 2.51)	0.4118
Number of surgery placements	-0.23 (-3.95 ; 3.48)	0.9020	0.13 (-4.22 ; 4.48)	0.9536
Total grade	0.08 (-1.97 ; 2.13)	0.9376	1.42 (-1.54 ; 4.37)	0.3428

Note. No missing data (n=0)

* $p < .05$

Table S6. Results of sensitivity analyses for multiple linear regression models

Figure S1. The French simplified version of 4-HCS scale

Système de Codage des 4 Habitudes	
Habitude 1 : S'investir dès le début (/30)	1. Montre de la familiarité avec le patient 2. Accueille les patients chaleureusement 3. Fait du bavardage 4. Utilise principalement des questions ouvertes 5. Encourage l'expression des inquiétudes du patient 6. Suscite toutes les préoccupations
Habitude 2 : Obtenir le point de vue du patient (/15)	7. Intéressé par la compréhension du problème du patient 8. Demande les attentes du patient pour la consultation 9. Montre de l'intérêt à propos de l'impact sur la vie quotidienne
Habitude 3 : Faire preuve d'empathie (/30)	10. Encourage l'expression des émotions 11. Accepte/comprend les sentiments du patient 12. Aide à identifier/nommer les sentiments 13. Fait preuve d'un comportement non verbal efficace
Habitude 4 : S'investir jusqu'à la fin (/50)	14. Enonce les informations/le diagnostic en fonction des préoccupations du patient 15. Marque des pauses permettant l'intégration de l'information 16. Explique clairement sans jargon médical 17. Explique la nécessité des examens et traitements 18. Vérifie efficacement la compréhension 19. Encourage la participation à la prise de décision 20. Vérifie l'acceptance du plan thérapeutique 21. Explore les obstacles à sa mise en oeuvre 22. Encourage des questions supplémentaires 23. Etablit un plan de suivi clair

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Figure S2. Focused principal component analysis for each dimension of 4-HCS scale

(a. For Habit 1, b. For Habit 2, c. For Habit 3, d. For Habit 4)

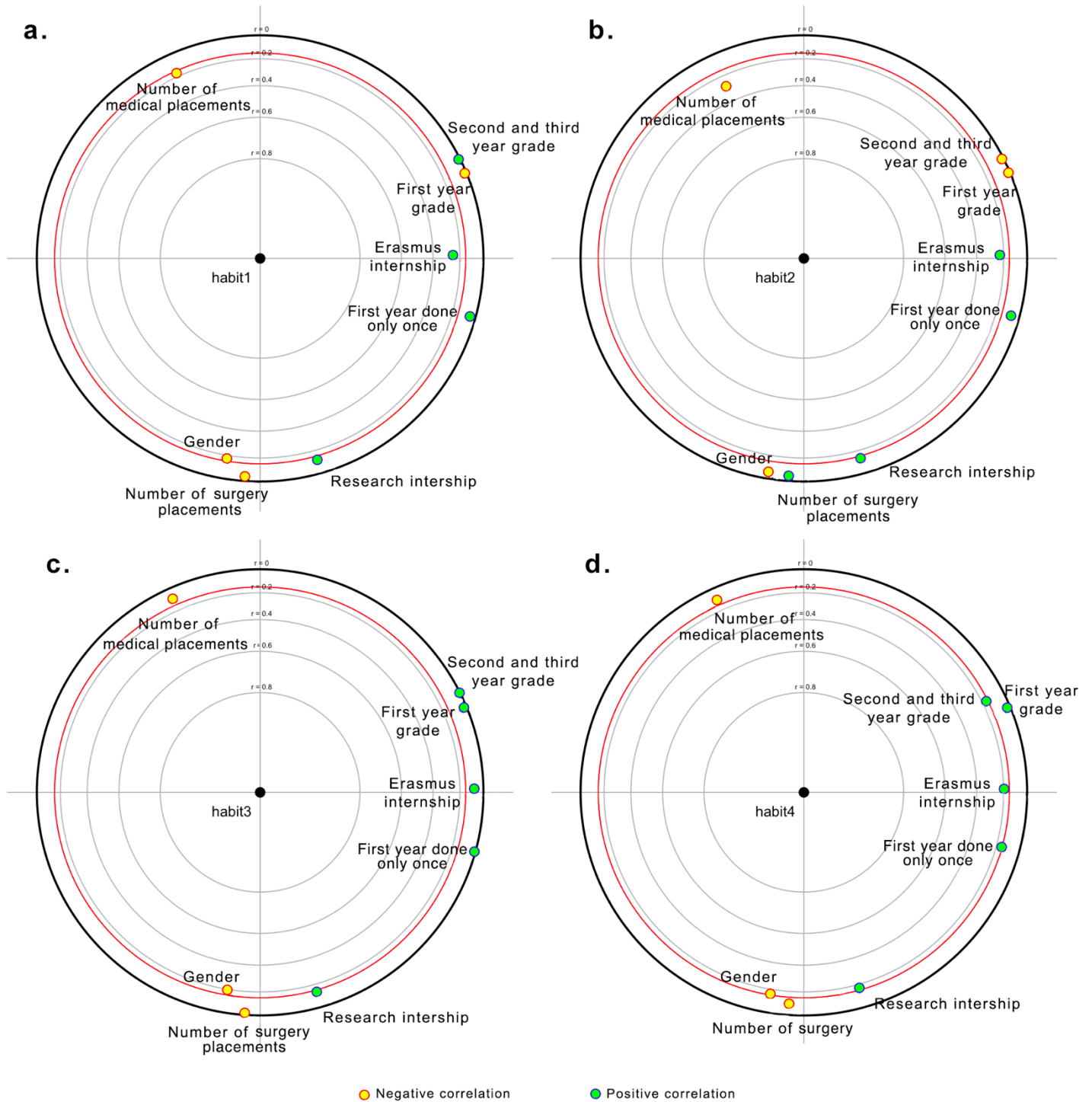


Figure S3. Effect plots of linear regression covariates

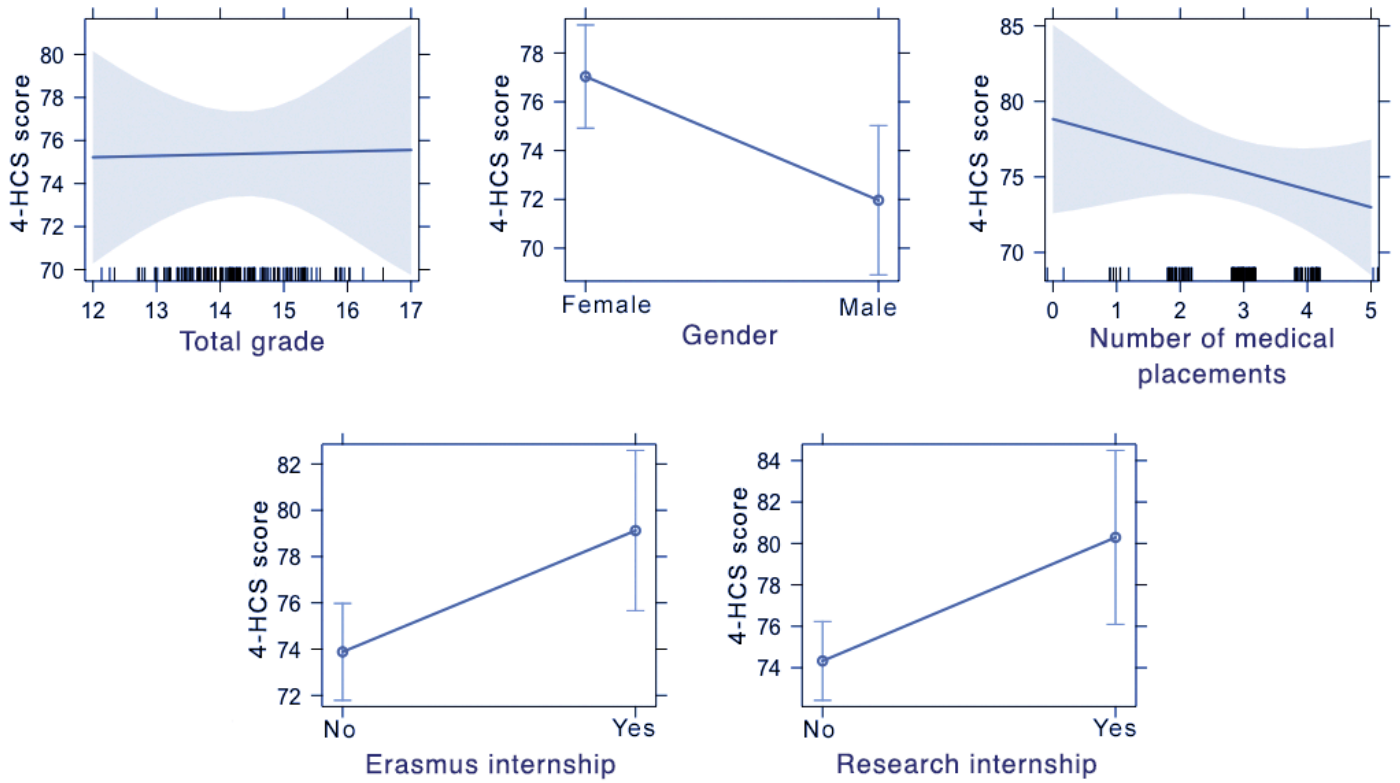


Figure S4. Effect plots of logistic regression covariates

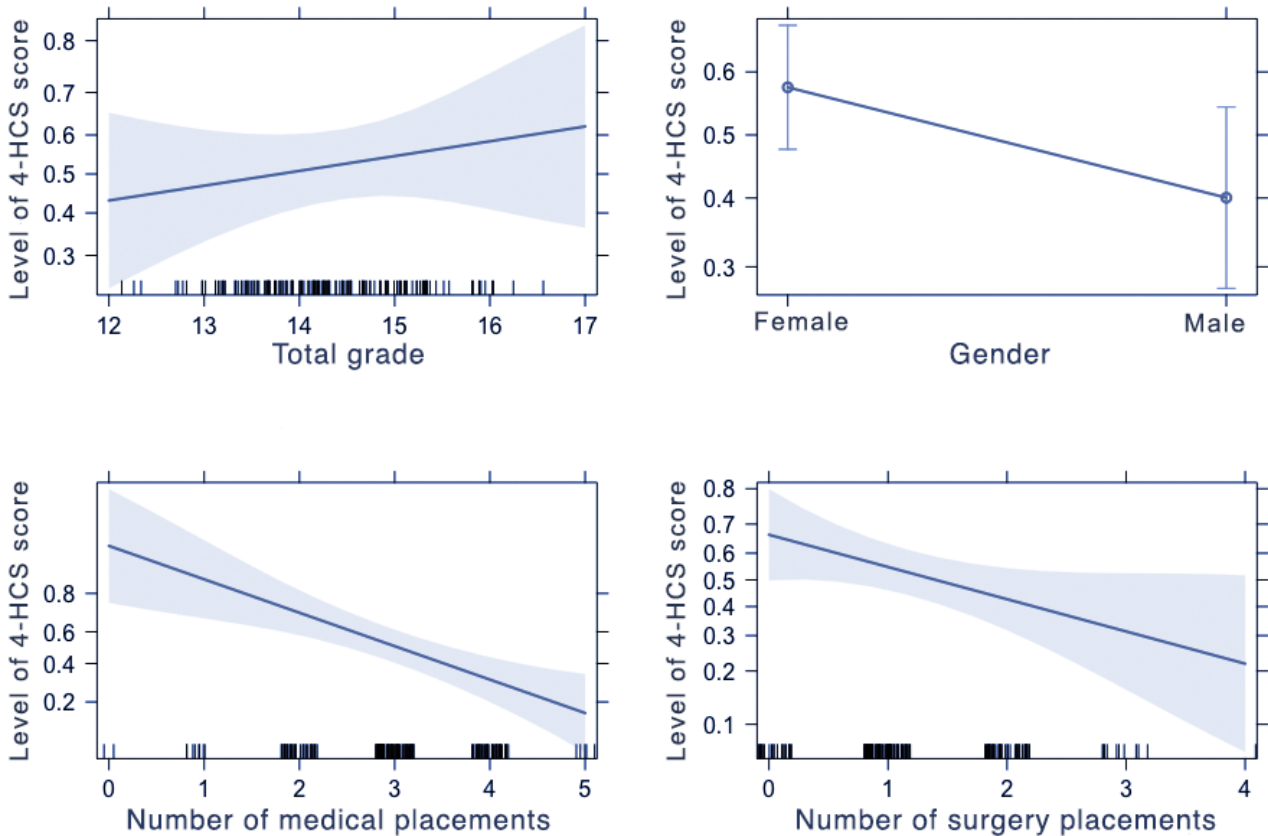
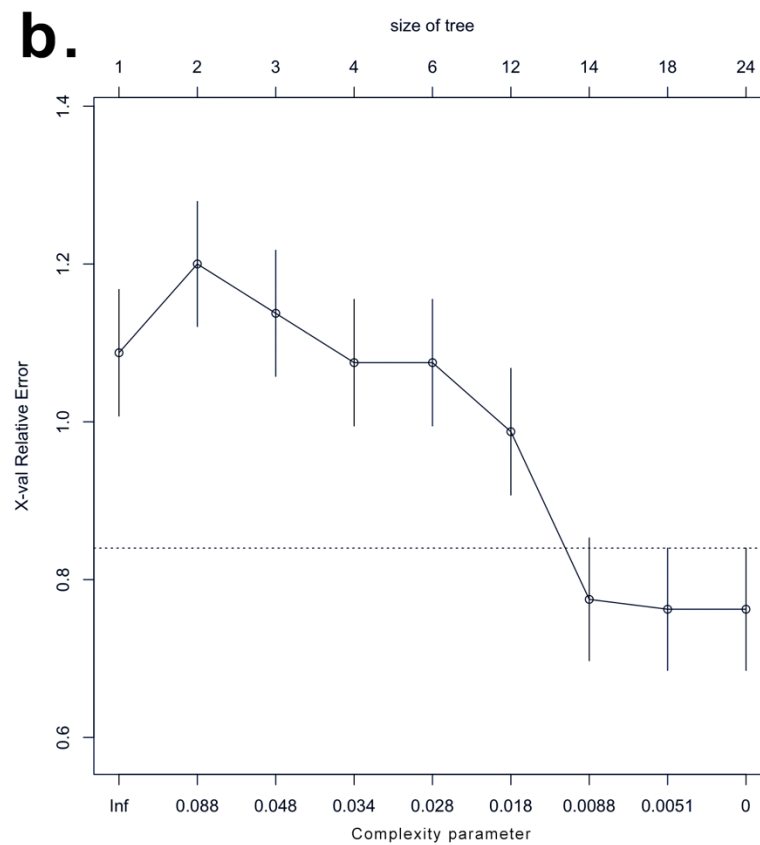
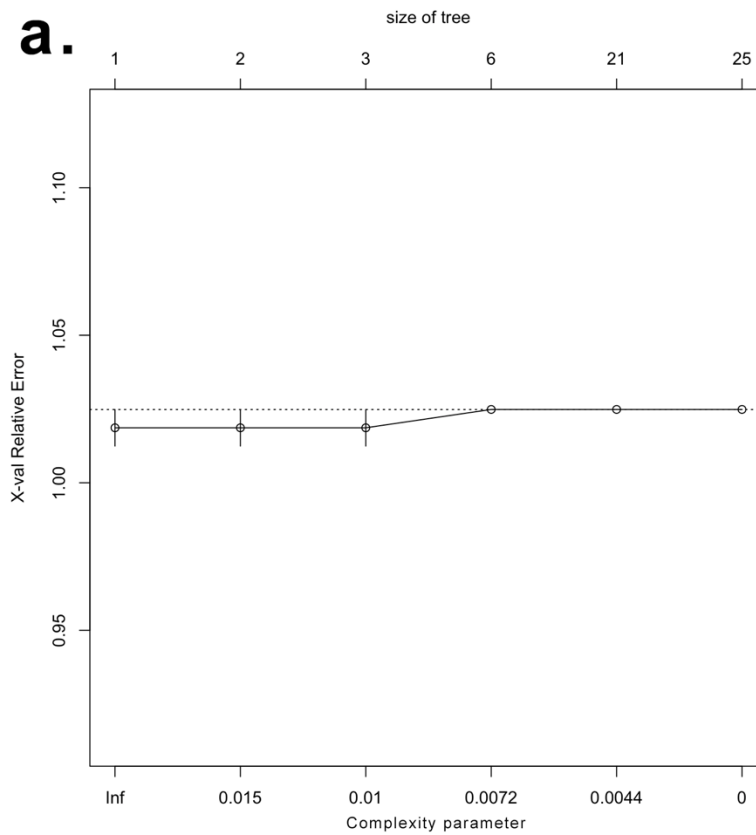
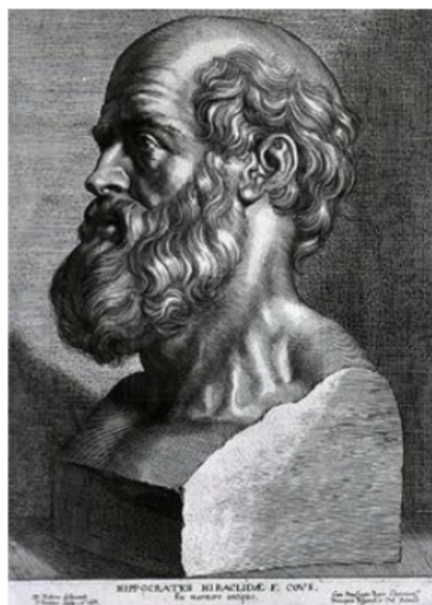


Figure S5. Complexity parameter plots
(a. Regression Tree, b. Classification Tree)





SERMENT D'HIPPOCRATE

En présence des Maîtres de cette Faculté, de mes chers condisciples et devant l'effigie d'HIPPOCRATE,

Je promets et je jure d'être fidèle aux lois de l'honneur et de la probité dans l'exercice de la Médecine.

Je donnerai mes soins gratuitement à l'indigent et n'exigerai jamais un salaire au dessus de mon travail. Je ne participerai à aucun partage clandestin d'honoraires.

Admis dans l'intimité des maisons, mes yeux n'y verront pas ce qui s'y passe ; ma langue taira les secrets qui me seront confiés et mon état ne servira pas à corrompre les mœurs, ni à favoriser le crime.

Je ne permettrai pas que des considérations de religion, de nation, de race, de parti ou de classe sociale viennent s'interposer entre mon devoir et mon patient.

Je garderai le respect absolu de la vie humaine.

Même sous la menace, je n'admettrai pas de faire usage de mes connaissances médicales contre les lois de l'humanité.

Respectueux et reconnaissant envers mes Maîtres, je rendrai à leurs enfants l'instruction que j'ai reçue de leurs pères.

Que les hommes m'accordent leur estime si je suis fidèle à mes promesses.

Que je sois couvert d'opprobre et méprisé de mes confrères si j'y manque.