LEARNING ANATOMY IN THE UNIVERSITY OF OULU: INFLUENTIAL FACTORS TO SUCCESS DURING 2010-2017

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Aaltonen Samuli, Learning anatomy in the University of Oulu: Influential factors to success during 2010-2017

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Abstract

Learning anatomy in the University of Oulu: Influential factors to success during 2010-2017. Our research covers population of 1398 students from eight different medical and dental courses. We collected exam results from 21 anatomic and 14 histologic practical works and combined them with students' background information received from the student register of our medical and dental faculties. The background information included students' name, gender, year of birth, hometown, starting year of medical/dental studies, programme and previous degrees. This research was performed in priority to find possible connections and correlations between the practical work results and the background data. The main purpose was to see if the increasing group sizes have affected on academic performance.

We executed statistical analysis by using nonparametric tests Mann-Whitney U-test and Kruskal-Willis' test for the distributional analysis and for the correlations we used Spearman's correlation coefficient while our result data was not normally distributed (tested with Kolmogorov-Smirnov). The program we used was IBM SPSS Statistics 22.

We found no correlation between the annual student population and the practical work exam results so the increasing group sizes has not affected on academic performance. A good performance in the histologic practical works correlated significantly with similar performance in the anatomic practical works (ρ = 0.409, p <0.001). Female students managed better in the histologic practical works (ρ = 0.103, p < 0.001) but in anatomic practical works there was statistically significant difference between genders. The dentistry students performed inferiorly compared to medical students: histology (ρ = -0.194, p < 0.001) and anatomy (ρ = -0.193, p < 0.001). According to our research the students who are 25-30 years old females studying medicine are going to have the strongest academic performance (histology: ρ = 0.232, p = 0.009; anatomy: ρ = 0.236, p = 0.008) in the anatomy course while the male students of dentistry are receiving the worst results.

Keywords: anatomy, histology, learning, academic performance, student, practical work

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1 INTRODUCTION

The University of Oulu has increased the number of selected students for its medical and dental degree programs during the last years and the selection process is in a changing state. In the spring 2018 the admission examination and selection will be organized as a unified process between different universities and it will have effects on the student population structure. In this research the purpose is to survey the possible effects of increasing number of students and the backgrounds of new students to how they manage through the human anatomy course and its practical works during the first autumn.

The Finnish education system includes a nine-year period of basic education which is compulsory for everyone. After this one can choose to continue voluntary studies in either general or vocational upper secondary education. (Ministry of Education and Culture 2018) The applicant for Finnish medical (and dental) studies are required to have completed the Finnish general upper secondary school syllabus and/or the matriculation examination. Eligibility to apply for the medical education can be fulfilled also with other degrees/diplomas (Table S1). (Studyinfo 2018) Everyone who fulfils these requirements is legitimate to take part in the admission examination which is the only way to be selected for the studies of medicine or dentistry. The admission examination is based on the general upper secondary school syllabus and especially the curriculums of chemistry, biology and physics and also on the material given in the examination. The applicant can decide to take the test in Finnish or in Swedish. (Lääketieteelliset.fi 2018) The test lasts for five hours and it measures applicant's knowledge of natural sciences and the capability to handle stress and time management. The student selection mainly consists of the points received from the admission examination, but the applicants are divided into contingents based on if they are accepted some previous degree place. For example, in 2018 65% of degree places of medicine in the University of Oulu was reserved for the students without previous acceptance. (Studyinfo 2018) As in Turku (Kronqvist et al. 2007) and other medical faculties all the students are chosen to faculties on the basis of an equal admission examination and they will all perform an equal 6-year (5.5-year for dentistry) education for licentiate of medicine, disregarding their educational (or other) background.

Table S1.

- an International Baccalaureate (IB) Diploma - a European Baccalaureate (EB) Diploma - Reifeprüfung (RP) Diploma - a Finnish vocational upper secondary qualification with a scope of 120 credit units or 180 credit points, or a comparable previous Finnish vocational qualification with a minimum scope of 80 credit units - a Finnish post-secondary or higher vocational level diploma - a Finnish vocational upper secondary qualification or a further or specialist vocational qualification as a competence-based qualification, or a comparable previous qualification - foreign qualification that provides eligibility for higher education studies in the awarding country

Medical students and their study motivation have been researched earlier based on their age, gender and educational background. (Kusurkar et al. 2010) Kusurkar et al. compiled a questionnaire which revealed that the age of the student was the largest single predictor of good motivation but also the gender and the earlier degree predicted elevated motivation. Comparable results about previous degree's effect on first-year medical student's motivation have been observed in a study in the University of Turku. (Kronqvist et al. 2007) According to this research the earlier education enhanced the student's ability to combine the theoretical and practical knowledge to their every-day work. Female students' distress increases already during the first year while male students' distress evolves later in preclinical phase and is manifested as predominant emotional symptoms. Among the female students the increased distress levels is seen during both the preclinical and clinical phase. (Niemi et al. 2006)

During the preclinical phase of the medical (and dental) studies the lectures are mostly arranged as large group teaching sessions. According to Luscombe's and Montgomery's (2016) research the large group teaching sessions were experienced as occasion to receive a summary of essentials but the actual learning occurred on their own by means of the teacher's slides provided. Due to this a well-organized slideshow was experienced to provide better value for the effectiveness of the self-study situations. Totally on a self-study-based teaching was experienced too requiring. (Luscombe & Montgomery 2016) In the University of Maiduguri the PowerPoint based teaching was preferred over the conventional "chalk and talk" –method among the female students while the male students preferred the conventional

method. There was a statistically significant difference in the pleasant method between the genders. (Nuhu et al. 2018)

Different kind of 3D-models such as physical 3D skull in learning cranial anatomy (Chen et al. 2017) and graphical computer 3D models (Battulga et al. 2012) were perceived as an effect way to learn human anatomy. Mitrousias et al. (2018) found out that students using 3D models performed better in the examinations than the students using prosection as a learning method. Three-dimensional models were suggested by the students to be included in the teaching of anatomy in the Maastricht University in the Netherlands. (Triepels et al. 2018) In addition in a questionnaire where students from 1st to 4th classes of three Canadian universities were interviewed revealed that during the preclinical phase the amount of radiology should be increased because it was experienced as a useful and widely used utility in an upcoming working environment. (Dmytriw et al. 2015) The ability to interpret and use radiological images has been conceived important also in a research in the University of Dublin. (Davy et al. 2017) Drawing was found to be another effective self-learning method to assimilate human anatomy, especially the musculoskeletal system. (Joewono et al. 2018)

Dissection is used as a teaching method in every medical faculty in Finland. In the human anatomy course in Oulu the dissection course is organized as an optional course for which 40 students are selected by their early study success. Attitudes towards a dissection course and its usefulness have been studied in the Guy's, King's and St. Thomas's School of Medicine in the Great Britain. The studies showed that the medical students were more excited to dissect the deceased compared to dental students. Men reacted more tranquilly to different scents and to touching the body while women were more excited about the course but also felt more negative feelings. (Snelling et al. 2003)

The effect of the group sizes has been studied in the Medical College of Wisconsin. The study concentrated on the effect of the group size in the simulation of resuscitation. The simulations were structured for groups of two, three and four students. Based on the results from these groups there was no difference in the experienced self-confidence in the execution of resuscitation. The simulation was felt as an experience that increased self-confidence, observation ability and management skills. (Rezmer et al. 2011) Larger group has not been detected to have a negative effect on learning results but a smaller group has been experienced more pleasant. (Cho et al. 2016)

The anatomy course (15 ECTS) in the University of Oulu consists of voluntary lectures and also practical works about macro anatomy and histology. The teaching starts in August and ends in December. Practical works are arranged 1-4 times a week and based on the teacher opinions and the student feedback these works have been the most demanding but also the most educational teaching format. Emblematic for practical works is the attendance of students from higher classes who act as teachers with university personnel (Table 1). The practical works are divided into three blocks (Table 1) and the students must pass each block by passing at least 50% of the work examinations in a block. To pass the examination the students are required to receive 50% of points from the questions described in the Figures 2 and 3.

Table 1.Practical works of the macro anatomy and the hours used for each group.

Block	Order	Subject	Duration (h)	The number of teachers
	1	(Introduction)*	1	1
1	2	Head	2	2
	3	Neck	3	3
	4	Upper limb I	4	3
	5	Upper limb II	2	2
	6	Back	2	3
	7	Pelvis	2	2
	8	Lower limb I	4	3
	9	Lower limb II	2	2
2	10	Circulatory system	4	3
	11	Digestive system, upper part	4	3
	12	Digestive system, lower part	(4)[a]	
	13	Abdominal cavity	(4)	
	14	Respiratory system, upper part	3	3
	15	Chest and respiratory system, lower part	(3)	
	16	Urinary system	3	3
	17	Genitals	(3)	
3	18	Central nervous system	2	2
	19	Peripheral nervous system and the autonomic nervous system	3	3
	20	Organs of hearing and equilibrium	2	2
	21	Organ of sight	(2)	

* self-study and work examination without practical work

[a] Works 11-13, 14-15, 16-17, 20-21 are executed together in one session

In the practical works the dental and medical students are divided into four groups of about 50 students. These groups have their own practical work sessions and because of this teaching is arranged approximately four times a week. During the week of certain works the

teachers ordinarily remain the same. In these group works the main focus is in the fundamentals of human anatomy and the teaching is executed by using different checkpoint-type workstations, 3D-models and by examining other students. Figure 1 represents a typical exercise provided in the workstations. Usually there are 1-3 different checkpoint-type workstations in a classroom and students have about 8-15 minutes to use in one workstation before change to next workstation.

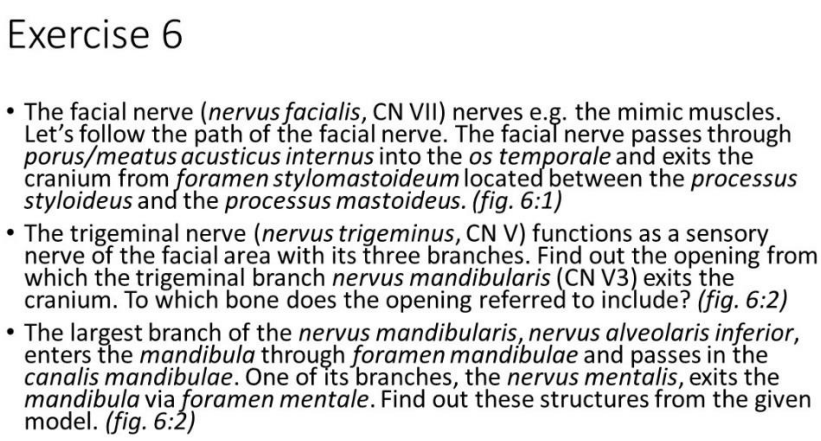

Figure 1.A typical exercise used in a checkpoint-type workstation in macro anatomy works. The workstation includes also anatomical models of human head, atlas of anatomy and two anatomic pictures (not in the figure).

Every group session includes an exam which lasts about 10 minutes and is held before or after the exercises. The exam consists of recognition and statement tasks. A typical exam is presented in Figures 2 and 3.

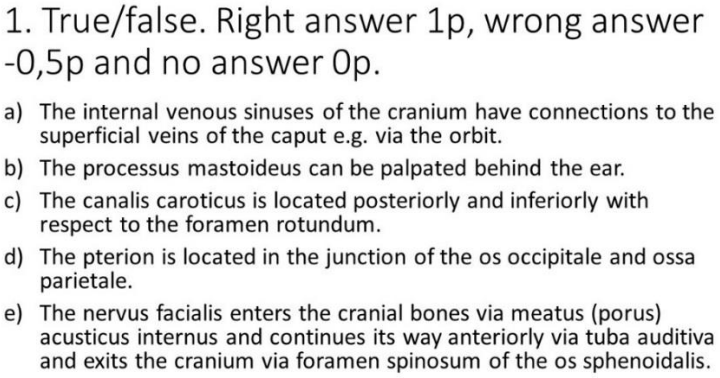

Figure 2. The statement task of the exam.

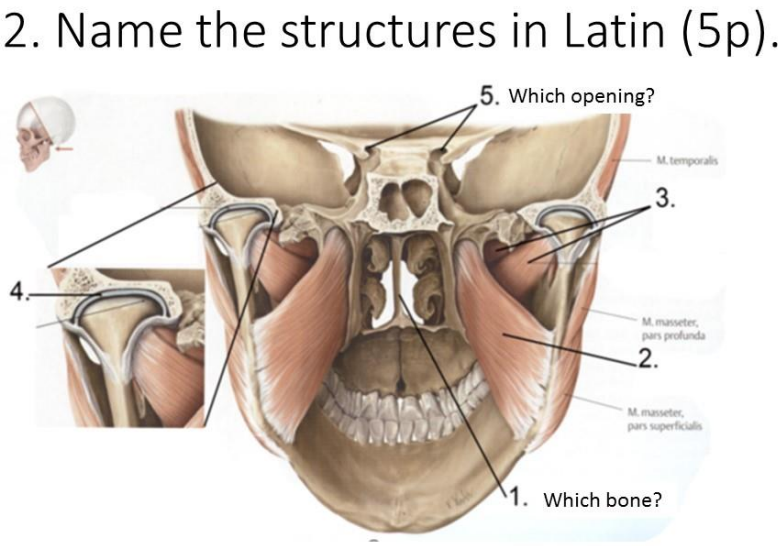

Figure 3. The recognition task of the exam.

In this research we are concentrating on if the increased amount of medicine and dentistry student and in addition larger courses have affected on learning anatomy in the Medical Faculty of the University of Oulu. Besides this we will search for possible differences between genders and different degree programs as well the impact of previous degrees on learning anatomy. The structure of the anatomy course has changed in autumn 2016 which leads us to discuss about the changes probable influence on students' success in the anatomy studies. In addition, we will survey the bachelor and non-graduated contingents' effects on succeeding.

The material for our research is uniquely large and it covers the results and backgrounds of about 1400 students from eight different medical and dental courses. Based on our knowledge this is the first educational research in the Finnish faculties of medicine to be accomplished in this scale.

2 MATERIAL AND METHODS

2.1 Study population

We received information of 1731 medical and dental students of the University of Oulu between the years 2009-2017 from the student register. From this population we selected the ones who had started their studies in 2010 or after because the examination result data from the histologic and anatomic practical works was collected during the years 2010-2017. After this we demarcated the students who did not have recorded results from the histologic or the anatomic works or did not match with the student register. This way we obtained a data that provided us with both the results and the backgrounds of our target sample of students (N = 1398).

2.2 Statistics

All the data was processed anonymously in the secured network of the University of Oulu. This project was a statistical analysis. Collected data was transferred from Excel to SPSS. The SPSS version was IBM SPSS Statistics 22 and it was used for data analysis.

We tested the normality of the result data with Kolmogorov-Smirnov's test of normality. To quantify the correlations between the variables we measured Spearman's correlation coefficients (ρ) and the p-values. We used nonparametric tests for subgroup comparisons. For two subgroups (e.g. programme and gender) we used Mann-Whitney's U-test and for more than two subgroup comparisons (e.g. starting year and graduate/non-graduate) we used Kruskal-Willis' test.

2.3 Visualization

For creating the division maps of Finnish population, we used Statistics Finland's PX-Web databases (Statistics Finland 2018) and the National Land Survey of Finland's (NLS) geodata portal Paikkatietoikkuna (National Land Survey of Finland 2018) as sources of information. After creating a map base of our desire, we customized the map with Corel PaintShop Pro X8 (64-bit).

3 RESULTS

3.1 Participants

In our research 52.2% (730) of the sample were females and 72.1% (1008) studied in the medical course. 1306 students were non-graduated, 24 had a bachelor's degree, 63 with master's degree, 1 licentiate and 4 had doctor's degree. All the students (15) whom had previous dental or medical licentiate's degree had started their previous studies before the year 2009 and were not selected into our study population. The average age of the students was 22.9 years. The diversity of the population is presented in the Table 2 and students' educational backgrounds are presented in the Table 3. The student population in our faculties consisted mostly of 18-25 year-old students. The distribution of students by age is presented in the Table 4. The annual percentual growth of the student population is presented in the Table 5 which also includes the average points of practical works of anatomy and histology for different subgroups. Our study population consisted of students from all the regions of Finland, except for the Province of Åland, most frequently from Northern Ostrobothnia (610), Uusimaa (205), Lapland (178) and Southern Ostrobothnia (101) (Table 7.).

Table 2.The diversity of the population by educational programme, gender and age.

	Programme		Gender		Age
Year	Medicine	Dentistry	Male	Female	Mean
	N (%)	N (%)	N (%)	N (%)	years (std)
2010	110 (69.6)	48 (30.4)	69 (43.7)	89 (56.3)	21.96 (3.26)
2011	107 (69.9)	46 (30.1)	74 (48.4)	79 (51.6)	23.02 (4.50)
2012	118 (68.6)	54 (31.4)	72 (41.9)	100 (58.1)	22.40 (4.07)
2013	118 (72.8)	44 (27.2)	88 (54.3)	74 (45.7)	23.06 (4.95)
2014	130 (72.6)	49 (27.4)	91 (50.8)	88 (49.2)	23.64 (5.11)
2015	144 (75.8)	46 (24.2)	96 (50.5)	94 (49.5)	23.85 (5.28)
2016	132 (72.1)	51 (27.9)	88 (48.1)	95 (51.9)	22.55 (3.66)
2017	149 (74.1)	52 (25.9)	90 (44.8)	111 (55.2)	22.61 (3.99)
Total	1008 (72.1)	390 (27.9)	668 (47.8)	730 (52.2)	22.90 (4.44)

Table 3.Educational backgrounds.

	Educational background				
Year	Non-graduated	Bachelor's degree	Master's degree/Graduate engineer	Licentiate	Doctorate
2010	150	0	7	0	1
2011	143	2	9	0	0
2012	157	4	10	0	1
2013	151	3	8	0	0
2014	163	4	12	0	0
2015	174	5	9	0	2
2016	177	3	3	0	0
2017	192	3	5	1	0
Total	1306	24	63	1	4

Table 4.Age distribution.

Age	Total	Male	Female
years	N (%)	N (%)	N (%)
18-20	436 (31.2)	183 (42.0)	253 (58.0)
20-25	727 (52.0)	358 (49.2)	369 (50.8)
25-30	126 (9.0)	64 (50.8)	62 (49.2)
30-49	109 (7.8)	63 (57.8)	46 (42.2)

3.2 Practical work exam results

The average points of histologic and anatomic practical works for students from different years, programs, genders and for non-graduated/graduated are presented in the Table 5. The points represent the average number of practical works passed for each subgroup. We also calculated the standard deviations for each value. As the Table 6 shows us the total growth of student population in our faculties between years 2010-2017 is 25.37%. The academic performance of the female medical students has been strongest with the averages of 13.63 (histology) and 19.00 (anatomy). Overall, the medical students received better results in the practical work exams than the dental students. The average points of histology and anatomy

practical work exams were greater among the graduated students than the non-graduated students.

The average points for students from different Finnish counties are in the Table 7 including also the number of students from each county. According to counties, we divided Finland in to four sectors. These sectors are also presented in the Table 7 and in the Figure 4. Figure 5 shows the average points of the students from specific geographic area. The ones from the lightest area (most north) have received averagely the highest results in the practical works. In the Table 8 are the average points and standard deviations for each anatomic practical work blocks (see Table 1) for different years.

Table 5.Means and standard deviations of the histology and anatomy exercises presented for different years, genders, programmes and educational backgrounds.

		Average points of histology	Average points of anatomy
Year	N (%-change)	mean (±std)	mean (std)
2010	158	13.08 (±1.18)	18.73 (±2.12)
2011	153 (-3.16)	13.56 (±0.90)	18.77 (±2.23)
2012	172 (+12.42)	13.56 (±0.74)	17.93 (±2.12)
2013	162 (-5.81)	13.27 (±1.21)	18.01 (±2.27)
2014	179 (+10.49)	13.36 (±1.03)	19.42 (±1.69)
2015	190 (+6.15)	13.38 (±1.01)	18.76 (±2.20)
2016	183 (-3.68)	13.50 (±1.05)	18.78 (±2.06)
2017	201 (+8.96)	13.29 (±1.18)	18.73 (±2.17)
Total growth +25.37% [a] / 27.2% [b]			
Programme	N (%)	mean (std)	mean (std)
Medicine	1008 (72.1)	13.51 (±0.90)	18.92 (±2.00)
Male	511 (50.7)	13.40 (±1.00)	18.84 (±2.08)
Female	497 (49.3)	13.63 (±0.75)	19.00 (±1.91)
Dentistry	390 (27.9)	13.02 (±1.33)	17.96 (±2.37)
Male	157 (40.3)	12.71 (±1.49)	17.83 (±2.34)
Female	233 (59.7)	13.22 (±1.16)	18.05 (±2.39)
Gender	N (%)	mean (std)	mean (std)
Male	668 (47.8)	13.24 (±1.17)	18.60 (±2.18)
Female	730 (52.2)	13.50 (±0.92)	18.70 (±2.12)
Education	N (%)	mean (std)	mean (std)
Non-graduated	1306 (93.4)	13.37 (±1.07)	18.63 (±2.15)
Graduated	92 (6.6)	13.51 (±0.92)	18.98 (±2.08)
Total	1398	13.38 (±1.06)	18.65 (±2.15)

[a] Calculated as a sum from the %-change values

[b] Percentual growth: 158/201 = 27.215..%

Table 6. The average points of histology and anatomy for different age groups.

					Number of students	Average points of histology	Average points of anatomy
Age groups	N	Programme	N	Gender	N	mean (std)	mean (std)
18-20	436					13.48 (±0.97)	18.93 (±1.89)
		Medicine	321			13.63 (±0.72)	19.15 (±1.78)
				Male	147	13.63 (±0.78)	19.27 (±1.77)
				Female	174	13.62 (±0.68)	19.04 (±1.78)
		Dentistry	115			13.07 (±1.37)	18.34 (±2.08)
				Male	36	12.50 (±1.54)	18.31 (±1.77)
				Female	79	13.33 (±1.21)	18.35 (±2.21)
20-25	727					13.31 (±1.08)	18.41 (±2.25)
		Medicine	529			13.45 (±0.95)	18.68 (±2.11)
				Male	267	13.30 (±1.08)	18.53 (±2.20)
				Female	262	13.61 (±0.78)	18.84 (±2.00)
		Dentistry	198			12.94 (±1.30)	17.68 (±2.46)
				Male	91	12.84 (±1.37)	17.89 (±2.37)
				Female	107	13.03 (±1.25)	17.50 (±2.53)
25-30	126					13.37 (±1.12)	18.79 (±2.21)
		Medicine	82			13.56 (±0.93)	19.23 (±1.90)
				Male	47	13.32 (±1.14)	18.79 (±2.21)
				Female	35	13.89 (±0.32)	19.83 (±1.18)
		Dentistry	44			13.00 (±1.35)	17.95 (±2.51)
				Male	17	12.35 (±1.80)	16.65 (±2.60)
				Female	27	13.41 (±0.75)	18.78 (±2.10)
30-49	109					13.39 (±1.13)	18.96 (±2.21)
		Medicine	76			13.42 (±1.06)	19.25 (±2.03)
				Male	50	13.36 (±0.96)	19.26 (±1.85)
				Female	26	13.54 (±1.24)	19.23 (±2.39)
		Dentistry	33			13.30 (±1.29)	18.30 (±2.47)
				Male	13	12.85 (±1.72)	17.62 (±2.87)
				Female	20	13.60 (±0.82)	18.75 (±2.12)
Total	1398		1398		1398	13.38 (±1.06)	18.65 (±2.15)

Table 7.The average points of histology and anatomy for student from different counties of Finland.

		Number of students	Average points of histology	Average points of anatomy
Sector	**County**	N	mean (std)	mean (std)
1	Total	327	13.29 (±1.21)	18.42 (±2.30)
	Uusimaa	205	13.31 (±1.20)	18.47 (±2.22)
	Southwest Finland (Proper Finland)	28	13.11 (±1.71)	18.18 (±2.47)
	Satakunta	17	13.59 (±0.62)	18.24 (±2.63)
	Tavastia Proper	10	12.70 (±1.57)	18.10 (±2.08)
	Tampere Region/Pirkanmaa	53	13.47 (±0.85)	18.57 (±2.36)
	Päijänne Tavastia	14	12.86 (±1.56)	17.93 (±2.87)
2	Total	798	13.44 (±0.99)	18.73 (±2.10)
	Central Finland	24	13.46 (±0.83)	19.08 (±2.12)
	Southern Ostrobothnia	101	13.48 (±0.91)	18.72 (±1.81)
	Ostrobothnia	29	13.52 (±0.91)	18.86 (±2.03)
	Central Ostrobothnia	34	13.38 (±1.21)	19.15 (±1.64)
	Northern Ostrobothnia	610	13.43 (±1.00)	18.69 (±2.18)
3	Total	93	13.29 (±1.21)	18.39 (±2.15)
	Kymenlaakso	6	13.00 (±1.67)	18.00 (±2.00)
	Southern Karelia	3	13.00 (±1.00)	18.33 (±1.53)
	Southern Savonia	4	13.25 (±0.50)	18.25 (±1.26)
	Northern Savonia	24	13.21 (±1.06)	17.67 (±2.75)
	Northern Karelia	7	13.43 (±0.79)	19.14 (±1.21)
	Kainuu	49	13.37 (±0.97)	18.69 (±2.00)
4	Lapland	178	13.31 (±1.05)	18.87 (±2.04)
Out	Foreign countries	1	14.00	19.00
	unknown	1	11.00	16.00
	Total	1398	13.38 (±1.06)	18.65 (±2.15)

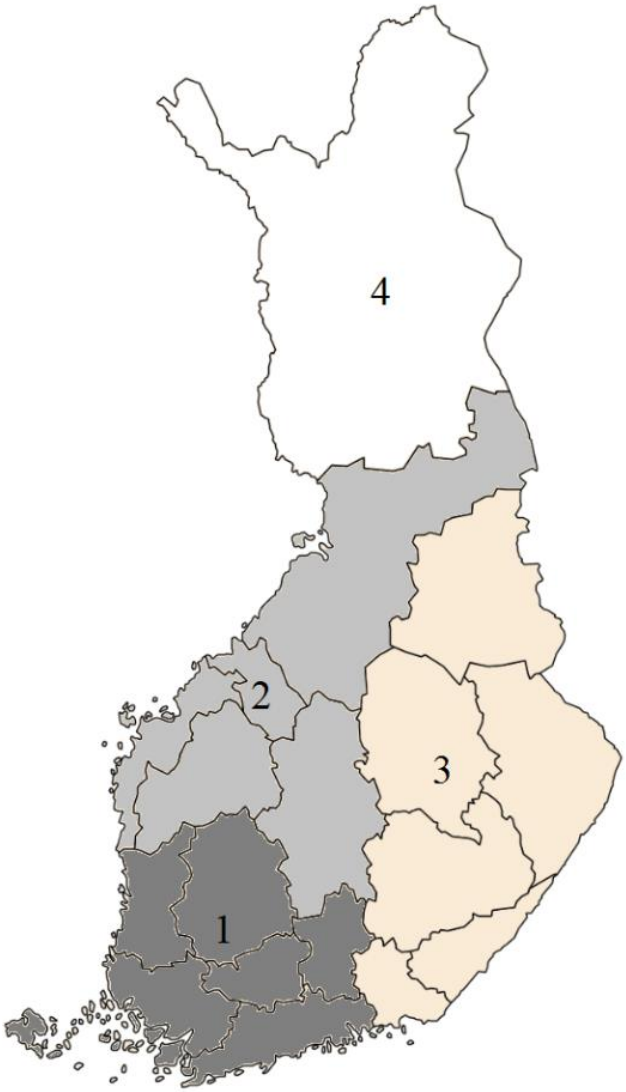

Figure 4. The division of Finland. Legend shows the population sizes and the average points and the standard deviations of the histology and anatomy results for each sector.

Table 8. Areal differences in average points (see Figure 5).

Area	Number of students N	Average points of histology mean (std)	Average points of histology mean (std)
	191	13.28 (±1.22)	18.38 (±2.24)
	73	13.12 (±1.51)	18.47 (±2.35)
	169	13.44 (±0.87)	18.59 (±2.13)
	963	13.40 (±1.01)	18.73 (±2.12)
Unknown	2	12.50 (±2.12)	17.50 (±2.12)

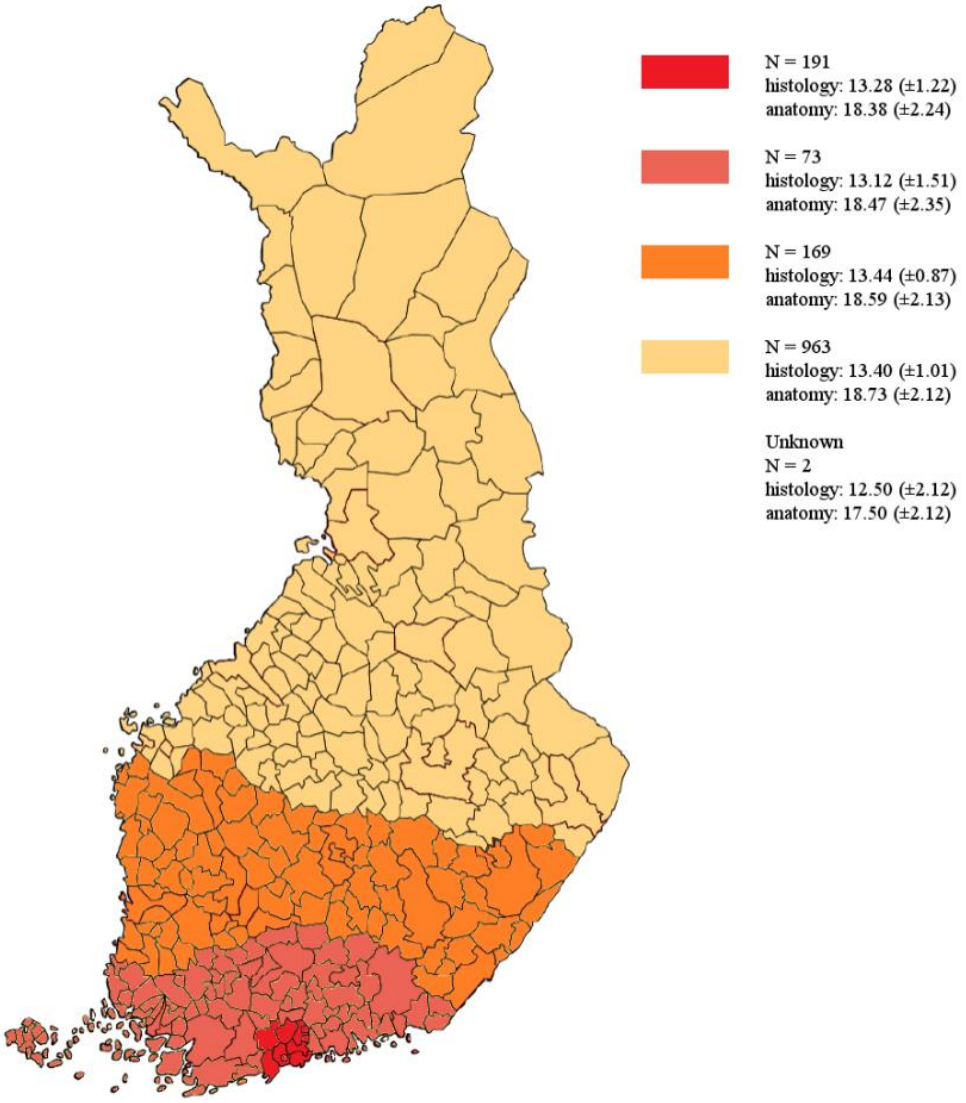

Figure 5. The diversity of Finnish population. All the different colour areas include 25 % of Finnish inhabitants. Visualization is based on data from the National Land Survey of Finland's geodata portal Paikkatietoikkuna (https://www.maanmittauslaitos.fi/en/e-services/geodata-portal-paikkatietoikkuna) and Statistics Finland's PX-Web databases (http://pxnet2.stat.fi/PXWeb/pxweb/en/StatFin/StatFin__vrm__vaerak/statfin_vaerak_pxt_024.px/?rxid=fe94cdf9-b101-4cf4-bd24-5064fca2a491). Legend shows the number of students from each area in our study population and the average points and the standard deviations of the histology and anatomy results for each area.

Table 9.The average points and standard deviations from the three blocks of anatomy practical work exams.

	Block 1	Block 2	Block 3
Starting year	mean (std)	mean (std)	mean (std)
2010	7.31 (±0.93)	6.72 (±1.20)	3.70 (±0.58)
2011	7.39 (±0.87)	6.75 (±1.36)	3.64 (±0.67)
2012	7.20 (±1.08)	6.68 (±1.21)	3.05 (±1.21)
2013	6.96 (±1.10)	6.45 (±1.13)	3.59 (±0.65)
2014	7.47 (±0.68)	7.04 (±1.07)	3.91 (±0.33)
2015	6.91 (±1.20)	7.08 (±0.98)	3.77 (±0.55)
2016	7.29 (±0.94)	6.81 (±1.19)	3.68 (±0.54)
2017	7.09 (±1.10)	7.12 (±0.99)	3.51 (±0.76)
Total	7.20 (±1.02)	6.85 (±1.16)	3.61 (±0.74)

Kolmogorov-Smirnov's test of normality denoted that our data was not normally distributed ($p < 0.001$).

3.3 Distributions

We compared the distributions between groups by using nonparametric tests for two or more groups. The Mann-Whitney U-test revealed us statistically significant ($p < 0.001$) differences in distributions for gender (only in histology) and programmes. We also discovered distributional differences for starting years ($p < 0.001$, Figure 4) and age ($p < 0.001$, only for anatomy) with the Kruskal-Wallis's test. There was no difference in point distributions between graduated and non-graduated students nor between the graduated with different level degrees. In our study, we discovered no distributional differences between the students from different counties. There was no common factor between the students representing the outliers nor the worst quartile of histology and anatomy.

Between different age groups the distributions of anatomy and histology results varied significantly (histology: $p = 0.041$; anatomy: $p = 0.001$), see Figures 6 and 7.

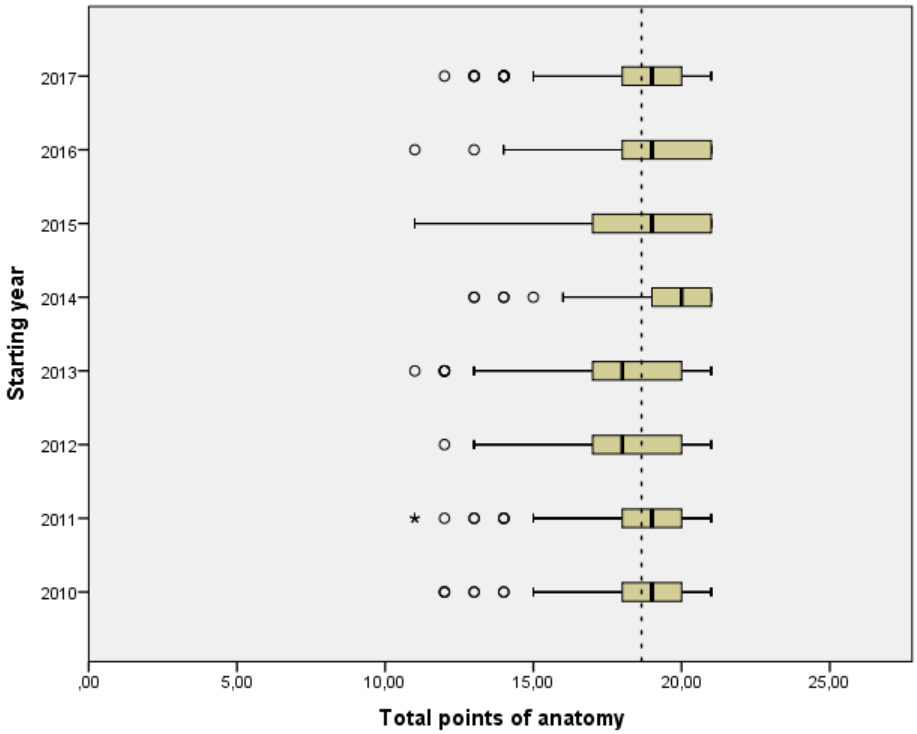

Figure 6. A boxplot of starting year as a function of total points of anatomy. The dashed line presents the mean of the anatomy points and the circles and asterisk show the outliers.

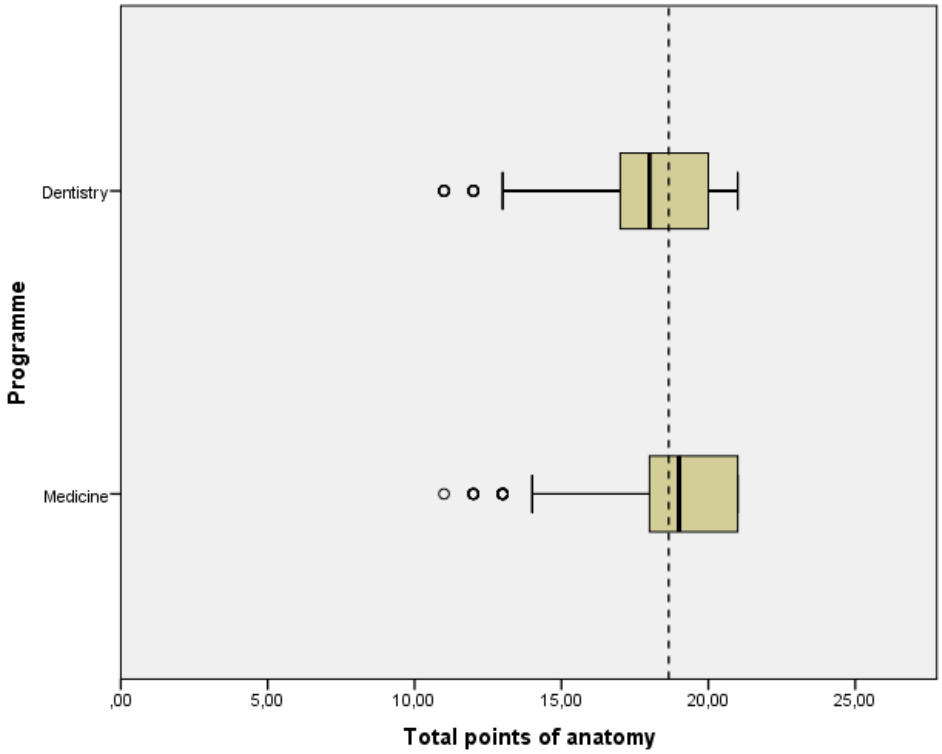

Figure 7. A boxplot of programme as a function of total points of anatomy. The dashed line presents the mean of the anatomy points and the circles show the outliers. The dentistry population consists of 390 and the medicine consists of 1008 students.

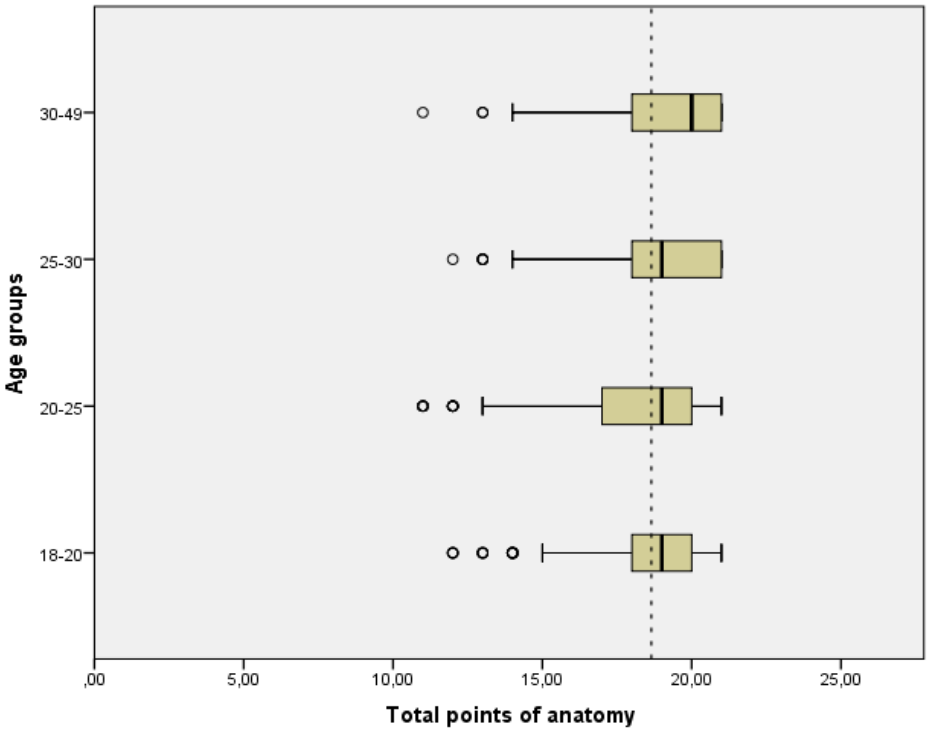

Figure 8. A boxplot of age groups as a function of total points of anatomy. The dashed line presents the mean of the anatomy points and the circles and asterisks show the outliers. Number of students for each age group: N(18-20) = 436, N(20-25) = 727, N(25-30) = 126 and N(30-49) = 109.

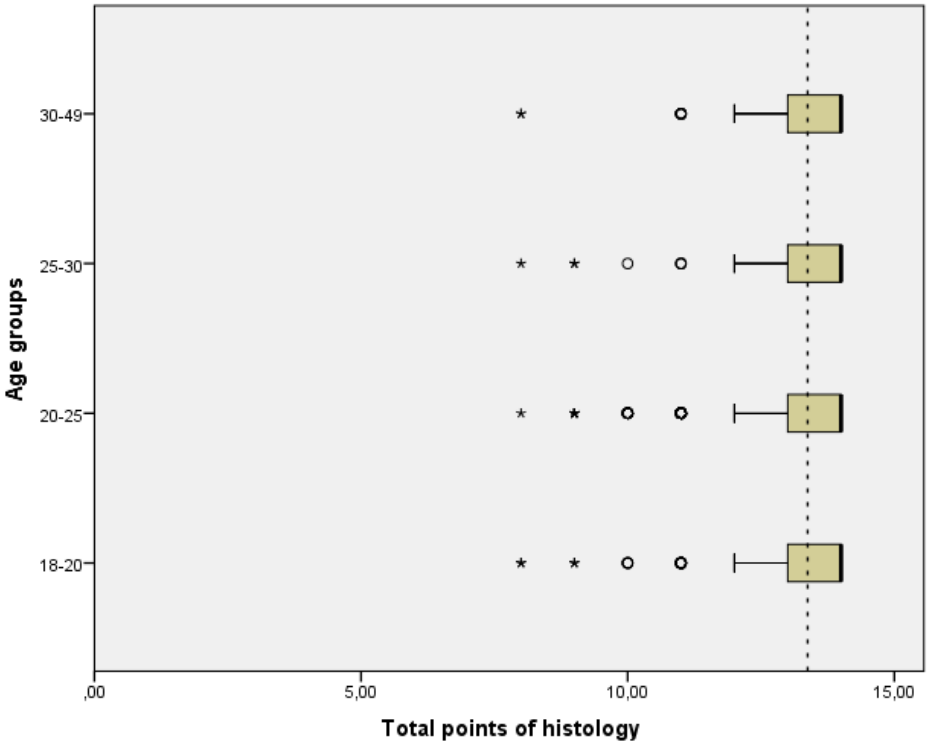

Figure 9. A boxplot of age groups as a function of total points of histology. The dashed line presents the mean of the histology points and the circles and asterisks show the outliers. Number of students for each age group: N(18-20) = 436, N(20-25) = 727, N(25-30) = 126 and N(30-49) = 109.

Figure 10. The compositional change of the best quartile (18.5-21.0 points from the anatomic practical works) of anatomy results. Each column consists of annual percentile in the best quartile of each gender. In the brackets is the size of annual student population.

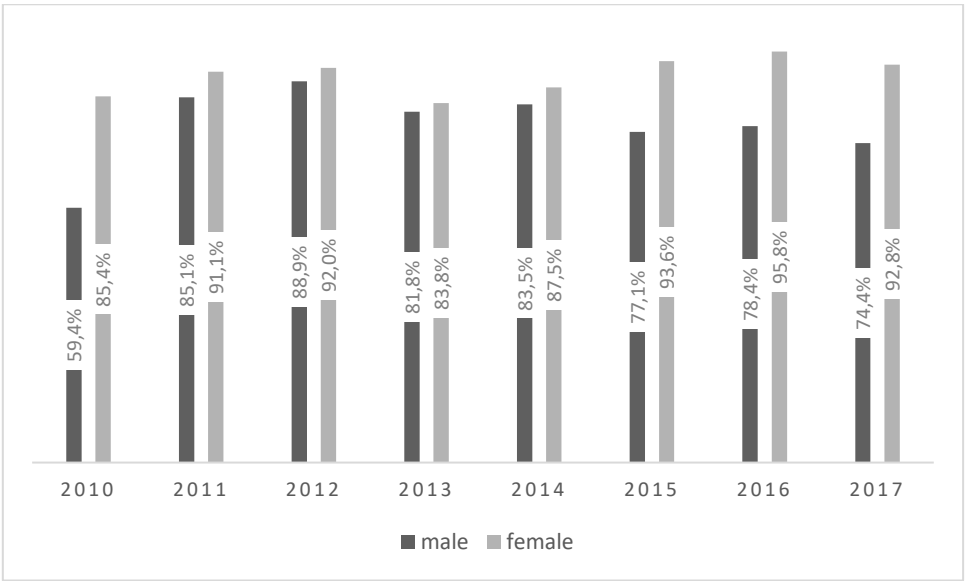

Figure 11. The compositional change of the best quartile (12.25-14 points from the histologic practical works) of histology results. Each column consists of annual percentile in the best quartile of each gender. In the brackets is the size of annual student population.

3.4 Correlations

Based on our research the number of students does not affect student's success in the anatomy and histology practical work exercises. We discovered a slight correlation between the results of anatomy exercises and the starting year ($\rho = 0.058$, $p < 0.029$). The points of practical histology exercises had statistically significant ($p < 0.001$) positive correlation with

the ones of anatomy exercises (ρ = 0.409). Female students achieved better results in histology compared to male students (ρ = 0.103, p < 0.001) but in the anatomy results there was no difference between genders. The students of dentistry were more likely to receive lower points in histology (ρ = -0.194, p < 0.001) and anatomy (ρ = -0.193, p < 0.001) practical work exercises. The Spearman's correlations and p-values are presented in Table 9.

Table 10.The Spearman's correlation coefficients and significance levels (p-values) between the independent and dependent variables.

Independent variable		Histology	Anatomy
Starting year	ρ	0.029	0.058*
	p-value	0.273	0.029
Gender	ρ	0.103**	0.019
	p-value	<0.001	0.475
Programme	ρ	-0.194**	-0.193**
	p-value	<0.001	<0.001
male	ρ	-0.235**	-0.197**
	p-value	<0.001	<0.001
female	ρ	-.179**	-0.195**
	p-value	<0.001	<0.001
Age	ρ	-0.052	-0.032
	p-value	0.054	0.225
Year of birth	ρ	0.056*	0.040
	p-value	0.035	0.137
Age groups	ρ	-0.045	-0.020
	p-value	0.093	0.458
County	ρ	-0.003	0.061*
	p-value	0.915	0.023
Graduated/Non-graduated	ρ	0.036	0.047
	p-value	0.177	0.081

ρ = Spearman's correlation coefficient

p = p-value

* = significance level <0.05

** = significance level <0.001

Gender correlated with better exercise results the strongest in the group of 25-30 years old students (histology: $\rho = 0.232$, $p = 0.009$; anatomy: $\rho = 0.236$, $p = 0.008$). Histology results correlated positively with the gender also in the age groups of 20-25 ($\rho = 0.108$, $p = 0.003$) and 30-49 ($\rho = 0.207$, $p = 0.029$). In the age groups of 18-20, 20-25 and 25-30 the dentistry programme correlated with worse results of practical work exam results. These correlations are presented in Table 10.

Table 11. Spearman's correlation coefficients for gender/programme and exercise results in different age groups.

Age group	N (%)	Independent variable		Histology	Anatomy
18-20	436 (31.1)	gender	ρ	0.016	-0.068
			p-value	0.732	0.156
		programme	ρ	-0.198**	-0.188**
			p-value	<0.001	<0.001
20-25	729 (52.0)	gender	ρ	0.108*	0.017
			p-value	0.003	0.647
		programme	ρ	-0.207**	-0.187**
			p-value	<0.001	<0.001
25-30	126 (9.0)	gender	ρ	0.232*	0.236*
			p-value	0.009	0.008
		programme	ρ	-0.249*	-0.261*
			p-value	0.005	0.003
30-49	111 (7.9)	gender	ρ	0.207*	0.060
			p-value	0.029	0.532
		programme	ρ	0.008	-0.172
			p-value	0.934	0.072

ρ = Spearman's correlation coefficient

* = significance level < 0.01

** = significance level < 0.001

4 DISCUSSION

In Finland the education in the medical faculties is free of charge for the citizens of Finland and one cannot enter the studies only by paying the tuition fee. Because there are limited number of starting places the application for the studies of medicine and dentistry usually takes from three to four times before one receives the place among the new students. Many students prepare for the examination from about six to twelve months. This long-lasting application process eliminates plenty of applicants yet there are over thousand applicants for every medical faculty of Finland every year. Also, the extensive entrance material (general upper secondary school chemistry, biology and physics) forces one to learn how to internalize multiple things but it can also be overwhelming for some. These factors and the stressful examination occasion measures and filters well a high-quality student population for the medical and dental studies. We believe these to be remarkable factors for students to manage well in the anatomical and histological practical works despite the large group sizes. The personnel of our faculty also have answered well to the demands of increasing group sizes and the limited space provided from the faculty by adjusting the teaching methods.

As we discovered the dental students manage inferiorly in practical works compared to medical students. Regarding to entrance examination results (Oulu University student register) the acceptance for dental education does not require significantly lower points than for medical education. After the equal preclinical education, the studies of medicine and dentistry divide into separate groups for clinical educations. During this clinical phase the medical students use wider anatomical knowledge compared to dental students, this difference might lead to lower motivation to internalize anatomical structures. Compared to the University of Michigan (Johnson et al. 2014) the University of Oulu provides more equal education and learning environments. In Michigan the dental students viewed histology to be less relevant for their future career than for the medical students. This motivational aspect can be one important cause for less successful students among the dental students in Finland.

Our research disclosed difference in the practical work exam results between male and female students. Similar results have been discovered earlier. (Sheard 2009) Also, females are having distress symptoms earlier than male students (Niemi et al. 2006). According to these causes and the increasing number of medical and dental students in the Finnish medical and dental faculties the difference between the genders could be partly explained. The larger

group sizes are probably creating more stressful environment for the students and the females are capable to handle it better. How about the best quartile of the anatomy and histology results; is the gender composition going to change over time? There is a fluctuating trend for the female percentage in the top 25% quartile of anatomy (see Figure 10) and since 2013 a clearly increasing trend for the female percentage in the top 25% quartile of histology (see Figure 11). Are the female students doing something differently than the male students? To evaluate the difference between the genders and programmes more specific we probably should have had more information about student's motivation and learning methods. Some results indicate that male students learn better by using visual than verbal learning and female students prefer sequential learning over global learning (Hernández-Torrano et al. 2017). The students using multimodal learning styles are correlated with better academic performance (Nuzhat et al. 2013).

One of our discovery was that the 25-30 years old student showed the strongest academic performance. Age has earlier been discovered to predict a good academic performance (Sheard 2009). Older students have probably more life experience than the younger students so they might have better ability to recognize their own strengths and weaknesses because of this experience. Even though the previous studies or degrees did not have straight correlation between the practical work results the mean of results was greater among the graduated students than the non-graduated students. Older students have more likely been studying something before the medical or dental studies and it might have taught them suitable learning methods.

There were no common factors for the outliers of the practical works. It seems that the ones receiving inferior results are random individuals with no predictable attributes.

Limitations

This research is based on the result data we had collected and, on the data, we received from the student register. We did not have information about student's family status, health or financial status. We had the information in which city the applicants lived during the time they had accepted their first degree place in the University of Oulu which might have differed from the city they had born and grew. The inner motivation of students towards the anatomy course and its practical works was not asked or measured. We collected no information about the possible changes in the motivation, stress levels or health.

Future

To arrange a research where researchers simultaneously collect exam results and information about students' motivation, stress, attitude and backgrounds. It would be interesting to know if the unified application process between the Finnish medical faculties affected on the student population and the learning results in our faculty. We will set a survey for the population of this research to chart more possible factors influencing on academic performance.

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