

Autistic traits in southern Brazilian college students: tracking road autism phenotype in the academia

Traços autísticos em estudantes do colégio do sul do Brasil: rastreamento do fenótipo do autismo amplo na academia

DOI:10.34117/bjdv8n3-256

Recebimento dos originais: 14/02/2022

Aceitação para publicação: 21/03/2022

Jaime Lin

Mestrado

Instituição: Universidade do Extremo Sul Catarinense - UNESC

Endereço: Avenida Universitária, 1105, CEP: 88806-000, Criciúma, SC, Brasil

E-mail: linjaime1407@gmail.com

Bruno de Andrade Marquette

Graduação em Medicina

Instituição: Universidade do Sul de Santa Catarina - UNISUL

Endereço: Avenida José Acácio Moreira, 787, CEP: 88704-900, Tubarão, SC, Brasil

E-mail: bruno.marquette@hotmail.com

Larissa Siqueira

Graduação em Medicina

Instituição: Universidade do Sul de Santa Catarina - UNISUL

Endereço: Avenida José Acácio Moreira, 787, CEP: 88704-900, Tubarão, SC, Brasil

E-mail: larissa.siq@hotmail.com

Thainy Corrêa Beluco

Graduação Medicina

Instituição: Universidade do Sul de Santa Catarina - UNISUL

Endereço: Avenida José Acácio Moreira, 787, CEP: 88704-900, Tubarão, SC, Brasil

E-mail: thainycorrea@hotmail.com

Vitória Bressan Pessoa

Graduação Medicina

Instituição: Universidade do Sul de Santa Catarina - UNISUL

Endereço: Avenida José Acácio Moreira, 787, CEP: 88704-900, Tubarão, SC, Brasil

E-mail: vitoriabressanpessoa@gmail.com

Maiara de Aguiar da Costa

Graduação Biomedicina

Instituição: Universidade do Extremo Sul Catarinense - UNESC,

Endereço: Avenida Universitária, 1105, CEP: 88806-000, Criciúma, SC, Brasil

E-mail: maiaradeaguiardacosta@gmail.com

Franciani Rodrigues da Rocha

Doutorado

Instituição: Universidade para o Desenvolvimento do Alto Vale do Itajaí – UNIDAVI

Endereço: R. Guilherme Gemballa, 13, CEP: 89160-932, Rio do Sul SC, Brasil

E-mail: franciani@unidavi.edu.br

Cinara Ludvig Gonçalves

Doutorado

Instituição: Universidade do Extremo Sul Catarinense - UNESC

Endereço: Avenida Universitária, 1105, CEP: 88806-000, Criciúma, SC, Brasil

E-mail: cinaralg@unescc.net

ABSTRACT

Introduction: Autism is considered a clinical condition distinct from the general population, while autistic traits may be continuously distributed across the population and referred to as "broader autism phenotype (BAP)." Few studies currently address autistic traits in the general population, and little is known about the relationship between the psychiatric condition and the BAP. **Objectives:** This study aimed to evaluate the prevalence of autistic traits in a sample of undergraduate students. **Methods:** An online survey was applied containing sociodemographic questions and the Autism-Spectrum Quotient (AQ), a widely used scale to quantify autistic traits in the general population. The AQ has 50 items, divided into five subscales consisting of 10 items each that assess domains of cognitive strengths and difficulties related to ASD. **Results:** A total of 1.167 students answered the questionnaire, with a female predominance (70%). The most representative higher educational areas were the Health Sciences (54%), followed by Engineering (12.3%). A total of 44 participants (3.8%) reached the AQ cut-off of 32+ points, indicating the presence of autistic traits, 25 (54.3%) female, and 21 (45.6%) male students. The higher academic areas with the highest frequency of autistic traits were linguistics, letters, and arts (12.5%), followed by engineering (6.9%). **Conclusion:** Musicians, scientists, and mathematicians have higher AQ scores than students from different areas. The investigation of autistic traits in the general population might help understand the autism spectrum itself and discuss autism from an educational viewpoint.

Keywords: autism, education, university, skills, talents.

RESUMO

Introdução: O autismo é considerado uma condição clínica distinta da população em geral, enquanto os traços autistas podem ser continuamente distribuídos pela população e referidos como "fenótipo mais amplo do autismo (BAP)". Poucos estudos abordam atualmente traços autistas na população em geral, e pouco se sabe sobre a relação entre a condição psiquiátrica e o BAP. **Objetivos:** Este estudo visava avaliar a prevalência de traços autistas numa amostra de estudantes de graduação. **Métodos:** Foi aplicado um inquérito online contendo questões sociodemográficas e o Quociente de Autismo-Spectrum (AQ), uma escala amplamente utilizada para quantificar os traços autistas na população geral. O AQ tem 50 itens, divididos em cinco subescalas que consistem em 10 itens cada uma que avaliam domínios de forças cognitivas e dificuldades relacionadas com o ASD. **Resultados:** Um total de 1.167 estudantes respondeu ao questionário, com uma predominância feminina (70%). As áreas educacionais superiores mais representativas foram as Ciências da Saúde (54%), seguidas pela Engenharia (12,3%). Um total de 44 participantes (3,8%) atingiu o corte do AQ de 32+ pontos, indicando a presença de traços autistas, 25 (54,3%) estudantes do sexo feminino, e 21 (45,6%)

estudantes do sexo masculino. As áreas acadêmicas mais elevadas com maior frequência de traços autistas foram a linguística, letras e artes (12,5%), seguidas pela engenharia (6,9%). Conclusão: Músicos, cientistas e matemáticos têm notas mais altas de AQ do que estudantes de diferentes áreas. A investigação de traços autistas na população em geral pode ajudar a compreender o próprio espectro do autismo e discutir o autismo do ponto de vista educativo.

Palavras-chave: autismo, educação, universidade, competências, talentos.

1 INTRODUCTION

Autism is a medical term that encompasses a broad spectrum of neurodevelopmental disorders characterized by impaired reciprocal socialization and communication, often accompanied by restricted or repetitive behavior (Hodges et al., 2020). Although a well-publicized and researched lifelong condition, there are still no clear-cut biological markers for the autism diagnosis. Currently defined as a spectrum that can range from mild to very severe, its diagnosis is based mainly upon clinical observation, psychological tests and employment of diagnostic instruments, and standard checklist questionnaires (Lord et al., 2018).

Traditionally, autism was usually considered as a clinical condition distinct from the general population. However, given the evidence that there is a broad range of severity of autistic symptoms, it is reasonably expected that autistic traits may be continuously distributed across the general population (Constantino & Todd, 2003).

This subclinical presentation of one or more behaviors or traits that are qualitatively similar to features of autism is termed Broad Autism Phenotype (BAP) and was initially described in family members of children with autism (Baron-Cohen & Hammer, 1997). In his initial report describing 11 cases of autism, Leo Kanner showed that many of his patients' parents were "highly intelligent" people with extraordinary educational and professional attributes. At the same time, he saw subtle signs of some of his patients' traits in these parents, including an obsession with details, social awkwardness, and rigid behaviors (Kanner, 1943).

Later, it was realized that the BAP could be extended to the general population among individuals with no known familial relationships to autism. In this sense, the meaning of the "S" in the Autism Spectrum Disorder (ASD) calls the attention that the autistic traits are not only heterogeneous but also vary in severity and extend to levels of non-clinical significance in the general population (Sasson et al., 2013). When we

consider ASD children, social inclusion is related to the influence of the family, the school, and a qualified environment to stimulate their brain's perception of the world (de Paula et al., 2020).

It is important to note that people with the BAP are not functionally impaired, as are individuals with ASD. Thus, the BAP is not a diagnosis. However, it is known that the mild weaknesses of the BAP have a negative impact on everyday functioning. Those with the BAP may demonstrate intact abilities in some environments, such as structured or routine interactions or conversations with familiar people who share their interests. Nonetheless, weaknesses may become apparent outside of those situations, leading to poor relationship development, difficulty building social support systems, and loneliness feelings. In addition to the social realm, those with the BAP also demonstrate impairments in occupational achievement, practical skills, emotion regulation, and coping skills (Stevenson & Hart, 2017).

In this sense, undergraduate students constitute a group of particular importance. University life is typically very social – with lectures, group presentations, and living arrangements, often involving a great deal of interaction with other students and staff. In addition to the potential detrimental impact on university success, it has also been found that university students' loneliness is significantly associated with depression. Thus, some aspects of university life might be especially problematic for students under the BAP (Reed et al., 2016). This study aimed to investigate the presence of autistic traits in a large sample of Brazilian college students.

2 METHOD

Population

Undergraduate students from private and public universities belonging to the State of Santa Catarina, southern Brazil, were recruited from electronic social media and were selected for this analysis based on completing an online survey.

Recruitment method

The recruitment method was based on a dedicated published website with a unique domain name internet address where the questionnaire was hosted on a secure server. Participants' responses were encrypted before being transmitted. Participants were also recruited through internet-based social media and were contacted through university-

based academic associations and student groups. Once reached, the students were directed to the online questionnaire.

Instruments and procedures

The questionnaire consisted of an online survey containing questions regarding age, sex, previous history of the neuropsychiatric disorder, and the Autism-Spectrum Questionnaire (AQ).

The AQ is a 50-item self-administered questionnaire designed to assess both cardinal and associated traits of ASD in either clinical or non-clinical populations. Each item consists of a statement that respondent's rate in terms of personal applicability on a 4-point Likert scale ("definitely agree", "slightly agree", "slightly disagree", "definitely disagree"). AQ scores were then analyzed in a binary manner so that the response was rated as one if it is in the direction of autism and zero if in the opposite direction. Item scores are then summed to yield a total score that ranges from 0 to 50. Higher scores indicate more symptoms of ASD. The optimal cut-off was 32 or higher for identifying individuals with clinically significant levels of autistic traits. Total AQ, as well as the five subscale scores (social skill, attention switching, attention to detail, communication, and imagination), were calculated using a key provided by Simon Baron-Cohen with one point awarded for an answer consistent with the key suggesting an autistic trait, and no point for no autistic trait. In 24 statements one point was scored for "strongly agree" or "slightly agree", and in 26 statements for "strongly disagree" or "slightly disagree" (statements 1, 3, 8, 10, 11, 14, 15, 17, 24, 25, 27, 28, 29, 30, 31, 32, 34, 36, 37, 38, 40, 44, 47, 48, 49, 50). The total result was the sum of all points scored by the participant, ranging from 0 to 50. Results in each of the five subscales ranged from 0 to 10 points, with higher values indicating the presence of autistic symptomatology (Baron-Cohen et al., 2001). The translated and validated Brazilian version of the AQ was used in this study (Sato et al., 2009).

The undergraduate students were divided into eight higher education areas: Agrarian sciences; Biological sciences; Engineering; Health Sciences; Humanities sciences; Linguistics, letters, and arts; Social sciences; Exact and earth sciences according to the Brazilian educational system.

Ethical Issues

Online surveys can be constructed so that the respondent must answer a question before advancing to the next question. The first page of the questionnaire contained an informed consent term, and the respondent could only advance to the following questions after completing the agreement procedures.

The research has been conducted in accordance with the Helsinki Declaration. The respondent's confidentiality and anonymity were maintained as no personal details were included in the data form. The study was previously submitted and approved by the ethics committee from Universidade do Sul de Santa Catarina (n^o 3.265.914/CAAE: 04701218.4.0000.5369).

Statistical analysis

Data were analyzed using SPSS version 21.0 software (IBM Corporation, New York, United States). Descriptive analysis of frequencies was performed. Results regarding the characterization of the sample were represented by n (absolute number) and % (percentage). AQ score findings were represented by Mean \pm Standard Deviation (SD). The Kolmogorov-Smirnov test was used to determine whether the data were normally distributed. In addition to the descriptive analysis, for quantitative variables, multiple comparisons between the groups were performed using the H value Kruskal-Wallis test, followed by Dunn's test for the post hoc pairwise analysis. The level of statistical significance was set at $p < 0.05$.

3 RESULTS

A total of 1167 undergraduate students from higher education institutions (private and public universities) from the State of Santa Catarina (southern Brazil) completed the questionnaire. The ages varied between 18 to 30 years (Mean= 20.40, Standard Deviation = 3.53) being 833 (71.4%) women and 334 (28.6%) man students. The antecedent of neuropsychiatric diagnosis, other than ASD, was reported by 310 (26.5%) students. Regarding autistic traits, 44 (3.8%) of the sample presented a cut-off point higher than 32 in de AQ questionnaire indicating the presence of ASD symptoms. The participants were divided into eight subgroups based on their fields of higher educational study: Agrarian sciences; biological sciences; engineering; health sciences; Humanities sciences; Linguistics, letters, and arts; social sciences; Exact and earth sciences. Students from Health Sciences represented most of the sample with 629 (53.9%) participants, and the

least representative subgroup was the literature and arts, represented by only eight students (0.7%), all of them from academic music graduate courses (Table 1).

The presence of autistic traits was evaluated through the AQ questionnaire using cut-off punctuation. Respondents with scores higher than 32 were considered as presenting autism symptomatology. According to each higher educational field, students presenting a higher index of autistic traits came from Linguistics, letters and arts courses (12.5%), followed by Engineering students with 6.9% (Table 2).

Five different questionnaires were applied to the students to evaluate specific skills, such as social skills, attention switching, attention to details, communication and imagination. Regarding the subscale of the social skills AQ questionnaire (Fig. 1), the higher scores on social skills were obtained in Linguistic, letters, and arts students (3.88 ± 2.64), while the lowest scores were found in Applied social sciences students (2.28 ± 2.02). Students from Applied social sciences presented a significantly lower score when compared to students from Humanities sciences (3.24 ± 2.20 , $p=0.037$), followed by Exact and earth sciences students (3.40 ± 2.17 , $p=0.006$), Biological sciences (3.72 ± 2.34 , $p=0.007$) and Agrarian sciences (3.43 ± 2.41 , $p=0.007$).

There was no statistical difference between the higher educational fields concerning attention switching abilities (Fig. 2). All fields analyzed Health sciences, Engineering, Social sciences, Humanities sciences, Exact and earth sciences, Biological sciences, Agrarian sciences, Linguistics and arts presented similar averages.

On the attention to details subscale, the average score of Health sciences students was 4.96 ± 2.28 , with an average statistically lower ($p=0.001$) when compared to Engineering students with an average of 5.93 ± 2.11 . Engineering students also reported significantly higher scores when compared to Humanities science students (4.99 ± 2.27 , $p=0.049$) (Fig. 3).

On communication skills, the lowest average scores were reported by Social science students (3.02 ± 1.71), with significantly lower values when compared to Health sciences students (3.16 ± 1.89 , $p=0.015$) and Agrarian sciences students (4.39 ± 1.95 , $p=0.016$) (Fig. 4).

Finally, regarding the subscale that dwells with the ability of imagination (abstract thinking), students on Humanities sciences obtained the lowest average scores (2.58 ± 1.55), values significantly lower than those from Health sciences students (2.89 ± 1.75 , $p=0.045$) and Engineering students (3.45 ± 1.87 , $p=0.009$) (Fig. 5).

4 DISCUSSION

Student samples are often used in psychological and cross-cultural studies because of the facility of recruitment, lower administration cost, assumed lower response bias, and lower heterogeneity in the sample due to differences in education levels (Arnett, 2008). It could be supposed that a sample composed of students from private and public schools may not be suitable due to possible socioeconomic bias. In Brazil, however, on a national research conducted on the household sample (*Pesquisa Nacional por Amostra de Domicílios – PNAD*) in 2017, it was found that either in public schools or in private graduate schools, the student's average economic levels did not present a significant difference (Malbouisson et al., 2017).

However, specific challenges exist for obtaining high response rates in college students' surveys, meaning that access for research purposes can be challenging. Barriers to engagement and recruitment commonly include lack of time, lack of interest in the research question and, the tension of participating in a study that may contain sensitive questions (Dommeyer et al., 2004).

In this sense, online surveys result in several advantages: it allowed a global reach since, according to Vicknair and coauthors (2010), more than 90% of college students currently and daily use social networking; it could be administered in a time-efficient manner with a low cost; it was convenient for the respondents since each one of them could answer at a convenient time, which revealed a crucial issue since college students present a hectic and irregular schedule; and, above all, it was secure, granting the anonymity of the respondents even for the researchers (Vicknair et al., 2010).

In a total of 1167 undergraduate students, female subjects, with more than 70% of the respondents, composed most of the sample, including students ranging from 18 to 21 years. In Brazil, higher education schools have more female students than males. Due to higher schooling rates (women represent 52% of the enrollments in Brazilian high schools), they present lower school failure rates or evasion and higher rates of high school graduation. Consequently, female students represent 53.8% of the enrollments in public college schools and 58.6% in private ones; 66% of the postgraduate master students, and 50.8% of doctorate degrees students (Barros & Mourão, 2018).

Regarding neuropsychiatric antecedent history, about 27% of the students reported a previous diagnosis of any psychiatric disorder other than autism. In 2008, Stallman and Schochet evaluated the prevalence of mental health complaints in a predominant female undergraduate student sample with 1168 subjects. The findings

suggested that almost 24.4% of the participants had a previous psychological disorder, and around 45.1% had mild mental health complaints, most of them underdiagnosed (Stallman, 2008).

Concerning ASD, the application of an autism symptom assessment scale showed that 3.8% of the sample exhibit clinical signs compatible with ASD according to the proposed cut-off score. Studies evaluating ASD symptoms in undergraduate students vary widely. In 2011, White *et al.* evaluated a group of 667 undergraduate students (228 men and 439 women) using the AQ questionnaire and verified that 1.9% of the sample presented clinical signs of ASD (White *et al.*, 2011).

Pisula and coauthors (2013) performed a study which evaluated 2819 undergraduate students (1328 men and 1491 women) from 9 different higher education institutions located in Poland, reaching a prevalence of 1.56% of the sample with compatible signs with ASD. Moreover, another study evaluating 100 individuals aged between 18 and 25 years (40 men and 20 women) found that 7.34% of students had clinical signs compatible with ASD according to the questionnaire (AQ) applied (Woodbury-Smith *et al.*, 2005).

However, the evaluation and correlation of the different subscales of symptoms according to the higher educational areas of undergraduate students seems to engender more exciting results. Interestingly, although students of Linguistics, literature and arts are presented by only eight students - all of them from academic music courses - one of them showed signs compatible with ASD (12.5%). In general, the scores obtained in the subscales of the Autism Spectrum Quotient (social skills, the shift in attention, communication, and imagination) were greater than all other areas of knowledge.

In 2019, Wenhart *et al.* evaluated the presence of autistic traits in professional musicians (64 classical music professionals with an average age of 25), of which 31 presented Absolute Pitch (AP) and 33 had Relative Pitch (RP). Among the musicians with AP, 20.48% had symptoms compatible with ASD, while 16.88% of musicians with RA presented results above the cut-off point. Besides, the age that the musicians started an instrument was an average of 5.97 years (AP) and 7.12 years (RA). Finally, the daily time devoted to studying the instrument was 11.96 hours/day (AP) and 13.73 hours/day (RA) on average.

It is possible that central characteristics of autism favor success in a professional area as tricky as classical music. Absolute pitch (AP), for example, can be defined as the rare ability to correctly identify or produce a musical tone without the aid of supporting

instruments. AP can often be considered a reflection of musical talent but also can be associated with sensory hyper-reactivity found in autism (Bonnel et al., 2003).

A study performed by Dohn and coauthors (2012), compared 16 musicians with AP, 18 without AP, and 16 without musical skills, verifying that the musicians with AP presented higher scores on AQ and also obtained higher scores on the subscales of social skills, change in attention, attention to details, communication and imagination corroborating with the findings on the present study.

Possibly, the musicians with autistic traits, possessing sensory skills for music, directed them to become interested in a musical instrument from an early age. Moreover, ASD symptoms as resistance to routine changes could favor the affinity for music and sheet music with all its strict rules. Finally, the difficulties of social interaction and the restricted interest inherent to autism would also allow the incessant hours of study necessary in a professional classical musician's practice.

Regarding this, 6.9% of engineering students also present symptoms compatible with ASD. This knowledge area had significantly higher scores on social skills, attention to detail, and imagination. These data corroborate with Baron-Cohen *et al.* (2001) findings, which evaluated 840 undergraduate students, comparing the presence of ASD symptoms according to the AQ questionnaire among science students (engineering, computer science, mathematics, and physics) with the other students. They found that scientists had higher scores, both in the total score and in the subscales, showing that there may be a link between the presence of autism traits and professional choice.

Again, it is possible that characteristics such as resistance to changing rules and routines, great attention to detail, less intensity of variation in levels of attention, and greater affinity for concrete thinking, favor careers that depend on high affinity for numbers and calculations.

Mathematical competence is an ability that the individual has to develop and apply mathematical thinking (logical and spatial thinking) and its representations (models, graphs, and tables) in order to solve several problems, which requires an in-depth knowledge of rules, algorithms, and numerical processing methods. Therefore, cognitive aspects favorable to mathematics would be declarative memory, working memory, and spatial processing speed, which could be found at a higher level among individuals with ASD (Peklari, 2019).

In fact, one of the theories that try to explain autism is the Empathizing–Systemizing (E-S) theory. According to this theory, the human brain has a systematization

mechanism. Systematization is how the brain can predict changes, which can be highly regular, obeying rules and patterns (for example, sunrise and sunset, seasons, musical note sequences and numerical rules, and mathematics). Thus, the autistic brain would be highly systematized, making it less able to deal with distinctive aspects of daily life, such as social interaction (Baron-Cohen, 2006). Therefore, autism as a symptom can be found in the general population, without being directly related to any functional impairment, sometimes favoring the choice, or even conferring the necessary skills to perform a job and should be appropriately directed and stimulated.

This study has limitations. Despite the advantages initially described in the text, samples from undergraduate students cannot be considered fully representative of the general population. It may represent a specific section of society with little variation in socioeconomic and educational levels. Also, it was not a balanced sample with an excess of female participants (ASD is a predominantly male condition; it would be possible to find different numbers if the sample had greater male representation). Finally, the knowledge areas were also not represented equally. The courses in the health areas had a much higher response rate (perhaps due to the interest related to the topic) while other areas had a much lower response rate (perhaps due to the number of students in each course, which varies or perhaps due to the lower interest in responding extensive questionnaires).

5 CONCLUSIONS

BAP is a subclinical presentation of one or more behaviors or traits that are qualitatively like features of autism. Although people with this phenotype are not functionally impaired, as are individuals with ASD, they also know that they have a negative impact on their everyday functioning. Our study showed a relationship between the higher frequency of autistic traits and the area of study. We evaluated the prevalence of autistic traits in undergraduate students from different knowledge areas. We concluded that the higher scores were obtained from linguistics, literature, and art students than professionals from other areas. ASD seems to be more common in people with mathematical, visuospatial, and musical abilities, which may reflect the unusually narrow interests and direct the choice for a specific higher educational area. The study of autistic traits in the general population might contribute to our understanding of the autism spectrum itself and discuss autism from an educational viewpoint.

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TABLES

Table 1. Sample characterization.

Variables	n (%)
Sex	
Female	831 (71.2)
Male	334 (28.6)
Non-respondent	2 (0.2)
Age (years)	
18 a 21	577 (49.4)
22 a 24	309 (26.5)
25 a 27	124 (10.6)
28 a 30	54 (4.6)
30 plus years	103 (8.8)
Previous Diagnosis	
No	857 (73.1)
Yes	310 (26.5)
AQ* score	
Below 32 cut-off point	1123 (96.2)
Above 32 cut-off point	44 (3.8)
Higher education field	
Health sciences	629 (53.9)
Engineering	143 (12.3)
Applied social sciences	103 (8.8)
Humanities sciences	97 (8.3)
Exact and earth sciences	88 (7.5)
Biological sciences	46 (3.9)
Agrarian sciences	28 (2.4)
Other	25 (2.1)
Linguistics, letters and arts	8 (0.7)

*AQ - Autism-Spectrum Questionnaire

Table 2. Autistic symptomatology by higher educational field.

Educational Field	Below cut-off point n (%)	Above cut-off point n(%)
Health sciences	604 (96.1)	25 (3.9)
Engineering	133 (93.1)	10 (6.9)
Humanities sciences	94 (97)	3 (3)
Applied social sciences	100 (97.1)	3 (2.9)
Linguistics, letters and arts	7 (87.5)	1 (12.5)
Agrarian sciences	28 (100)	0 (0)
Exact and earth sciences	86 (97.7)	2 (2.3)
Biological sciences	46 (100)	0 (0)
Others	25 (100)	0 (0)

FIGURE LEGENDS

Fig 1. AQ Social skills scores comparison between area of study. Values were expressed in mean \pm standard deviation; H value Kruskal-Wallis test, followed by Dunn's test for the post hoc, pairwise analysis were used. The level of statistical significance was set at $p < 0.05$.

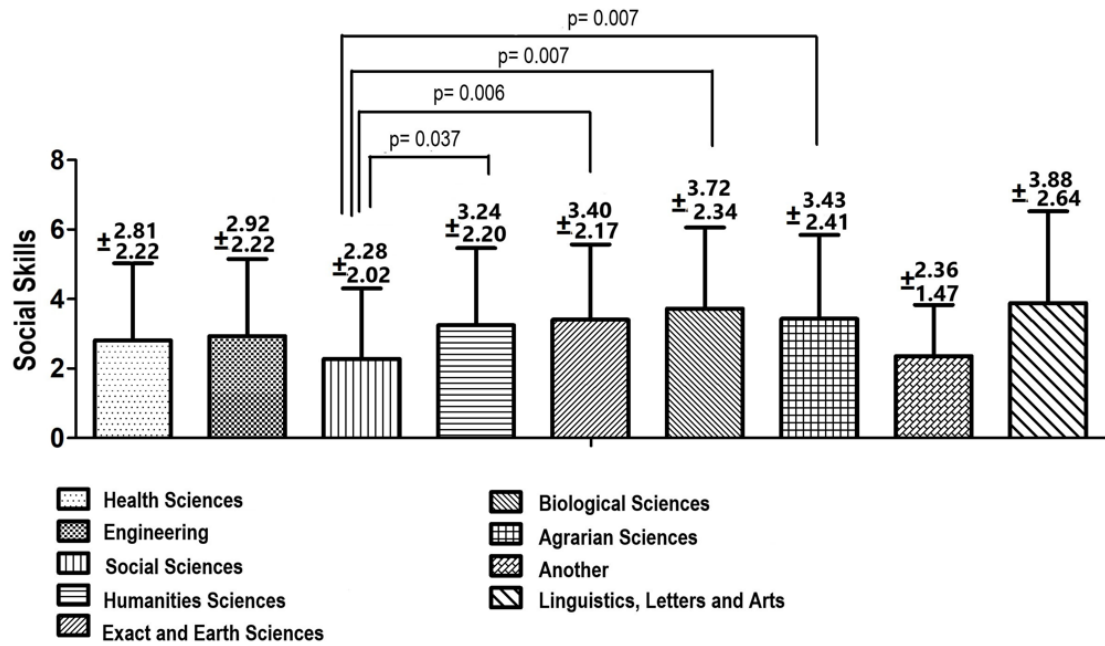


Fig 2. AQ Attention Switching scores comparison between area of study. Values were expressed in mean \pm standard deviation; H value Kruskal-Wallis test, followed by Dunn's test for the post hoc, pairwise analysis were used. The level of statistical significance was set at $p < 0.05$.

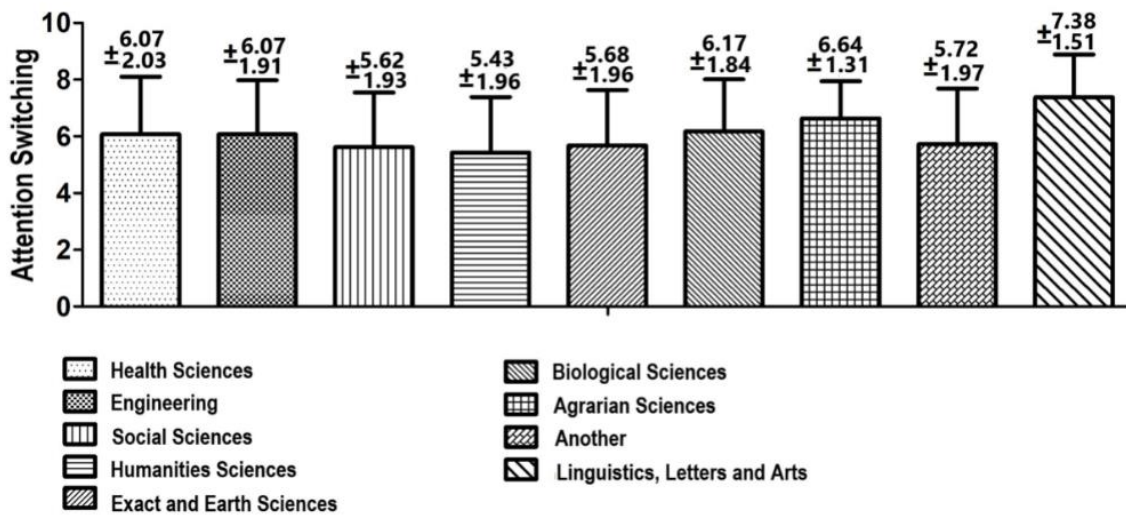


Fig 3. AQ Attention to Detail scores comparison between area of study. Values were expressed in mean \pm standard deviation; H value Kruskal-Wallis test, followed by Dunn's test for the post hoc, pairwise analysis were used. The level of statistical significance was set at $p < 0.05$.

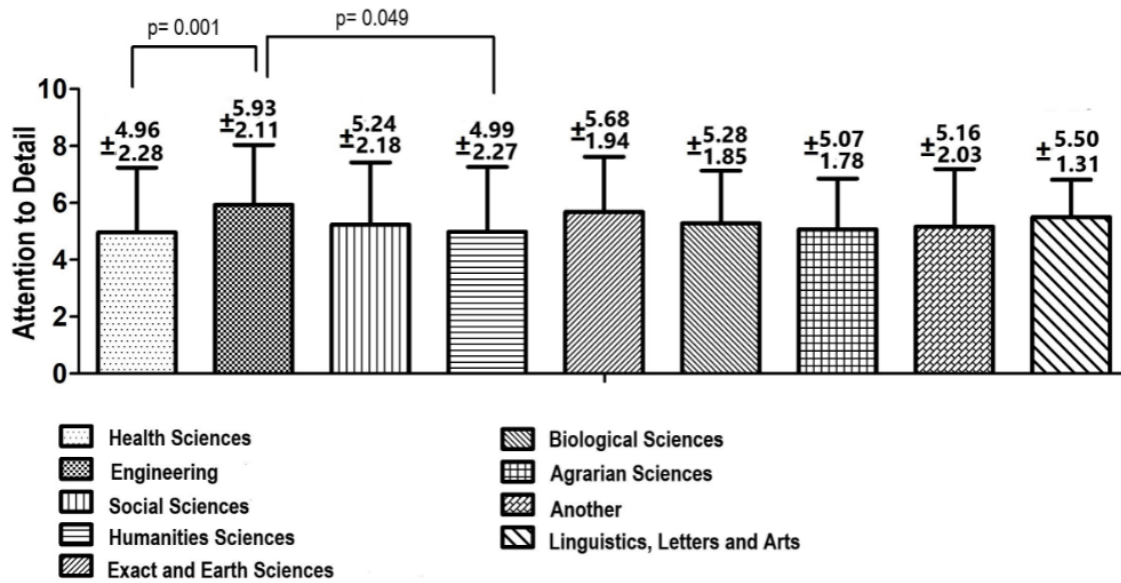


Fig 4. AQ Communication scores comparison between area of study. Values were expressed in mean \pm standard deviation; H value Kruskal-Wallis test, followed by Dunn's test for the post hoc, pairwise analysis were used. The level of statistical significance was set at $p < 0.05$.

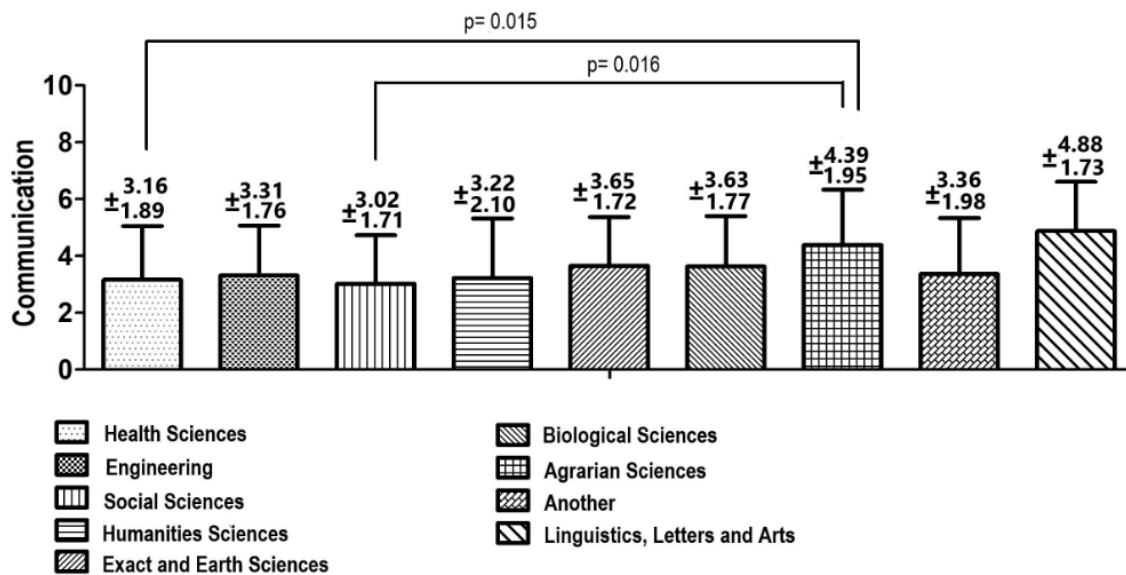


Fig 5. AQ Imagination scores comparison between area of study. Values were expressed in mean \pm standard deviation; H value Kruskal-Wallis test, followed by Dunn's test for the post hoc, pairwise analysis were used. The level of statistical significance was set at $p < 0.05$.

