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Path Analysis of Factors Influencing Multiple Intelligences of Malaysian Medical Students: A Multi-institutional Study

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ABSTRACT

The Multiple Intelligences (MI) Theory by Howard Gardner emphasises that individuals have a unique blend of "capabilities" ("intelligences"), differing significantly from the traditional concept of intelligence measured by conventional intelligence quotient (IQ) tests. This cross-sectional, multi-institutional study aimed to compare the MI of medical students from three Malaysian medical schools, investigate the effects of demographic factors on the MI of students with diverse cultural and socio-economic backgrounds, and examine the effects of MI on academic performance. The MI Inventory was used to assess the MI of medical students. Path analysis was carried out using the SmartPLS software version 2.0. Inter-institutional differences in MI were observed among the students. University A students (53.51 ± 21.99) scored significantly higher than University B students (46.70 ± 20.34) in the naturalist domain ($p = 0.05$). University A students also scored significantly higher (58.35 ± 21.30) than University B (50.26 ± 19.49; $p = 0.014$) and University C students (46.90 ± 21.58; $p = 0.008$) in the musical/rhythmic domain. In the verbal/linguistic domain, University A students (47.94 ± 21.06) scored significantly higher than University C students (39.05 ± 19.23; $p = 0.05$). Path analysis highlighted a statistically significant effect of family income on the musical intelligence ($\beta = 0.220$, $t = 2.005$, $p < 0.05$), a domain closely related to verbal/linguistic intelligence. Students from all three medical schools consistently achieved the lowest score in the verbal/linguistic domain and the highest score in the intrapersonal intelligence domain. These findings suggest the need for interventions to enhance language proficiency among medical students. Emphasising MI would make medical education more comprehensive, ultimately enhancing learning in their academic pursuit.

Keywords: *Multiple intelligences, Medical students, Path analysis, Multi-institutional study, Malaysia*

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INTRODUCTION

According to the Multiple Intelligences (MI) Theory developed by Howard Gardner, human beings possess several relatively autonomous intelligences. Gardner's focus on human potential relies on the fact that human beings have a unique blend of "capabilities" ("intelligences"), deviating significantly from the traditional concept of intelligence as measured by conventional intelligence quotient (IQ) tests. Using one or more of these intelligences, a person can learn and solve problems related to the societies in which they live (1, 2). However, intelligence differs from a skill, which is a manifestation of cognitive performances due to the use of one or more of the MI (3).

The MI Theory embraces nine aspects of intelligence, which can be further categorised into the analysis domain, introspective domain, and interactive domain. The analysis domain involves thinking processes and is analytical in nature, consisting of logical/mathematical, musical/rhythmic, and naturalist intelligences. The introspective domain consists of the intrapersonal, visual/spatial, and existential intelligences, which can be manipulated and involve imagination. The interactive domain consists of the verbal/linguistic, interpersonal, and kinaesthetic intelligences, which are used in communication (4).

In the past few decades, medical education has witnessed a paradigm shift from the teacher-centred approach to the learner centred (5) and patient-centred (6) approaches. As medical doctors deal with life-and-death matters that require a close human touch, acquiring textbook knowledge and clinical skills alone may not be sufficient. Medical students are also expected to be equipped with soft skills such as good communication, listening, and interpersonal skills, which are the foundation of building a good doctor-patient relationship.

For years, intelligence has been measured using traditional IQ tests. These tests mostly measure a person's linguistic and logical/mathematical intelligences, and other domains are usually not assessed. The precursor of modern-day IQ tests was designed by a French psychologist Alfred Binet in the early 1900s (7). Binet's work was reinforced by Charles Spearman, whose theory of general intelligence or "g" forms the fundamental concept of intelligence (8) and the basis of many IQ tests.

However, focussing on the IQ of medical students alone is not sufficient due to the demanding nature of the medical curriculum. The training of medical students involves the application of a variety of teaching and assessment methods. Therefore, the MI approach holds significant relevance as it embraces diverse capabilities required of a doctor. Additionally, studies have established a connection between MI and academic achievement. For example, Babatunde and Ayoola (9) demonstrated that several domains of MI were positively correlated to the academic performance of higher degree students.

Research has shown that physicians with interventional communication skills training demonstrated improved medical adherence and outcomes in the patients they managed compared to physicians in the control group (10). Consequently, the concept of MI fits well into medical education. It deals with ones' competencies and capabilities from a different

perspective compared to the conventional concept of intelligence, which views intelligence as a global attribute. Furthermore, the MI Theory embraces individual differences, which aligns effectively with the learner-centred approach of medical education.

Various factors such as age, gender, culture, and socioeconomic status have been linked to MI. For example, a high school study in Northern Cyprus reported differences in the visual, logical, intrapersonal, naturalist, and existential domains according to age (11). Besides, the influence of race on MI may be important as one's culture affects how a person's intelligences develop and to what extent they develop. Since the publication of his book *Frames of Mind* (2), Gardner (12) has placed increasing emphasis on one's culture and the inseparability of intellect from one's cultural setting.

Regarding gender differences in MI, Sulaiman et al. (13) reported that females preferred learning activities involving the verbal/linguistic domain, whereas males preferred learning activities involving the kinaesthetic domain among Malaysian students studying various degree programmes. Meneviş and Özad (11) showed gender differences in the verbal, kinaesthetic, existential, musical, interpersonal, intrapersonal, and naturalist domains among high school students. Another study found that females scored significantly higher in the verbal/linguistic and interpersonal domains, whereas males scored significantly higher in the kinaesthetic domain among students sitting for entrance exams for a Lebanese university (14). Socioeconomic differences in MI have been demonstrated in a study by Erkan and Öztürk (15), which reported that socioeconomic status had a significant effect on the musical/rhythmic and interpersonal intelligences of children.

In the published literature, multi-centre studies comparing the MI of medical students are scarce. Many studies have investigated the MI of non-medical/health sciences students (16–20). Comparatively, fewer studies have focussed on the MI of medical and health sciences students (21–25). The lack of inter-institutional studies implies limited insights into how MI can be shaped by learning environments. Other research gaps include inconsistencies and limited understanding of the interplay between demographic factors, especially among students with diverse socioeconomic and cultural backgrounds. Additionally, there is a lack of robust models to examine the interplay between MI and academic achievements in medical education. Conventional statistical methods commonly analyse the variables in isolation, and are unable to study the combined influence of the variables on the academic achievements of medical students.

The present study aimed to fill these gaps by investigating the MI profiles of medical students from three Malaysian medical schools (Universities A, B, and C). The objectives were to: (1) investigate the inter-institutional differences in the MI of medical students; (2) to determine whether demographic factors such as age, gender, race, family income, and first language played a role in the MI of these students; and (3) to determine if MI had an influence on the academic performance of medical students. Notably, this study employed a path analysis approach, which is uncommon in this research area, particularly in the context of medical education. This approach offers a holistic view of the combined influence of various variables, leading to more reliable and interpretable results.

METHODS

Participants

The study was conducted on students enrolled in Year 1 Bachelor of Medicine and Bachelor of Surgery (MBBS) programme from University A (n = 98), University B (n = 115), and University C (n = 42). The students were recruited on a voluntary basis, and the choice of universities was based on the inclusion and exclusion criteria in Table 1. All three institutions have unique features, including the socioeconomic and cultural backgrounds of the students. Their geographical location attracts students from different areas in Malaysia. The multicultural, multiracial, and diverse backgrounds of students in this study allowed the investigation of gender, racial, and socioeconomic differences in MI of medical students in the Malaysian context.

Table 1: Inclusion and exclusion criteria for choosing the participating medical schools

Inclusion criteria	Exclusion criteria
Undergraduate entry medical programme	Graduate entry medical programme
Programme is home grown	Programme is part of a foreign university
Programme is fully completed in Malaysia	Programme is partially conducted in Malaysia (i.e., twinning programme)
Programme is at least 5 years in duration	Programme is less than 5 years (e.g., for graduate entry programmes)

Instrument

The study was conducted in English, which is the medium of instruction for all three participating universities. The MI Inventory (26) was used to assess the MI domains of the participants. The author permits the use of the inventory in its unaltered state. The inventory has been reported to be reliable with a Cronbach's α between 0.8 and 0.9 (27). The inventory consists of nine sections, each describing a domain in MI (i.e., naturalist, musical/rhythmic, logical/mathematical, existential, interpersonal, kinaesthetic, verbal/linguistic, intrapersonal, and visual/spatial strengths). Each section has 10 questions. Participants were to put a "1" next to every question they felt accurately described them. Scores of each section were added up and multiplied by 10. Therefore, the final score of each section ranged between 0 and 100. A sample item for each section is included in Table 2.

Table 2: Sample items in the MI Inventory

Section	MI domain	Sample item
1	Naturalist	I enjoy categorising things by common traits.
2	Musical/rhythmic	I easily pick up on patterns.
3	Logical/mathematical	I am known for being neat and orderly.
4	Existential	It is important to see my role in the "big picture" of things.
5	Interpersonal	I learn best interacting with others.
6	Kinaesthetic	I learn by doing.
7	Verbal/linguistic	Foreign languages interest me.
8	Intrapersonal	My attitude effects how I learn.
9	Visual/spatial	Rearranging a room and redecorating are fun for me.

Data Collection

Data collection was carried out at the three participating universities face-to-face within the same month in a group setting. Before administrating the questionnaire, participants were briefed on the study, and informed consent was obtained. Hard copies of the combined questionnaires, consisting of demographic questions and the MI Inventory, were then administered to the participants.

Data Analysis

Statistical analysis was carried out using the Statistical Package for the Social Sciences (SPSS) version 22.0 (IBM Corp., Armonk, NY, US). The score for each MI domain was expressed as mean ± standard deviation (SD). Comparison of means was carried out using ANOVA. Whenever ANOVA was significant, a post-hoc analysis was performed. A p-value of ≤0.05 was considered statistically significant, and ≤0.001, highly significant. Path analysis was used to investigate the relationships between MI, demographic factors, and academic achievements. Unlike conventional statistical methods that analyse variables in isolation, path analysis offers a holistic view of the combined influence of the various variables. For the path analysis, the SmartPLS software version 2.0 (SmartPLS GmbH, Bönningstedt, Germany) was used. According to Cohen (28), a β value of 0.02 was considered to have a small effect, 0.15, medium effect, and 0.35, large effect. A t-value > 1.96 indicates $p < 0.05$, $t > 2.576$ indicates $p < 0.01$, and $t > 3.29$ indicates $p < 0.001$.

For the variable "race", dummification of data was carried out as suggested by Trinchera et al. (29). Because race is a categorical variable, it was necessary to dummify the data according to standard statistical practices to avoid issues like collinearity, which could lead to inaccurate interpretation of the results. The variable "race" consisted of four categories in this study (i.e., Chinese, Indians, Malays, and others). Hence, dummification was used to transform the "race" variable into a set of binary variables. Dummification involved initial coding of the variable by assigning a unique code to each racial category (e.g., 1 for Chinese, 2 for Indians, 3 for Malays, and 4 for others). This was followed by creating new binary variables based on the initial codes, which were used in the path analysis.

RESULTS

Response Rate and Demographic Data

The overall response rate from all three universities was 89.8%. The demographic data of the participants in this study is summarised in Table 3.

Table 3: Demographic data of the participants

Demographic data	Frequency
Age (years)	
Max	18
Min	25
Mean (±SD)	20.89 (0.89)
Gender	
Male	91 (35.7%)
Female	160 (62.7%)
Unspecified	4 (1.6%)
Race	
Malay	110 (43.1%)
Chinese	96 (37.6%)
Indian	24 (9.4%)
Others	21 (8.2%)
Unspecified	4 (1.6%)
Monthly family income	
<RM5,000	104 (40.8%)
>RM5,000 – <RM10,000	80 (31.4%)
>RM10,000 – <RM15,000	29 (11.4%)
>RM15,000	29 (11.4%)
Unspecified	13 (5.1%)
First language	
English	50 (19.6%)
Non-English	193 (79.6%)
Unspecified	2 (0.8%)
Pre-University CGPA	
Mean (±SD)	3.79 (0.29)

Note: CGPA = cumulative grade point average.

Mean MI Domain Scores of Medical Students

The mean MI domain scores of medical students from Universities A, B, and C are shown in Figure 1. Interestingly, all three cohorts of students had the highest score in the intrapersonal domain and the lowest score in the verbal/linguistic domain. Overall, the mean intrapersonal domain score was 77.32 (±21.13) and verbal/linguistic score was 44.84 (±20.15).

Other domains in decreasing order were the existential (68.27 ± 19.85), kinaesthetic (64.57 ± 22.17), logical/mathematical (59.13 ± 21.58), musical/rhythmic (52.80 ± 20.96), interpersonal (52.52 ± 21.89), and naturalist (49.09 ± 20.77) domains.

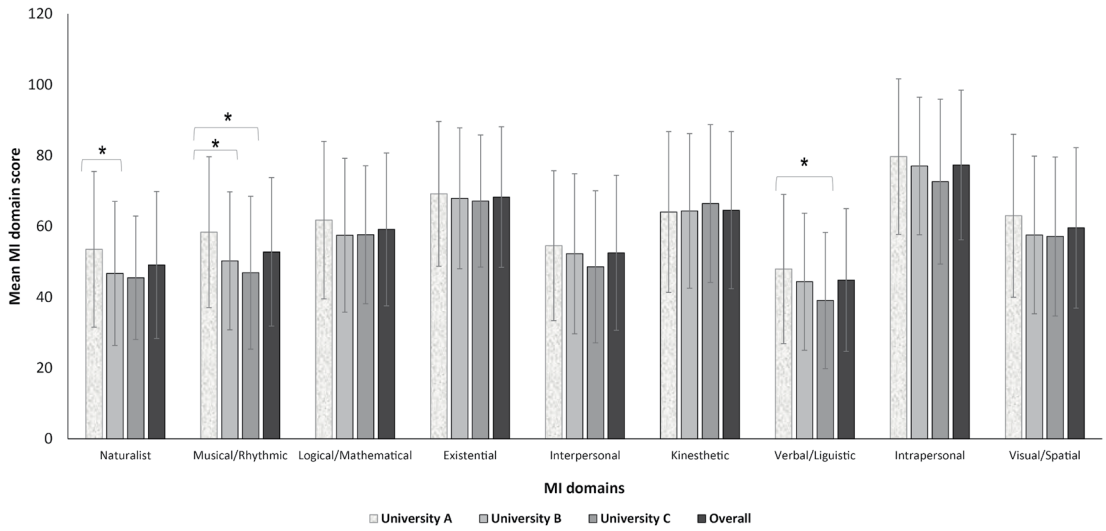

Figure 1: Mean MI domain scores of medical students from Universities A, B, and C.

Note: $^{*}p < 0.05$ is significant.

Inter-institutional Differences in Mean MI Domain Scores

University A Year 1 medical students (53.51 ± 21.99) scored significantly higher than University B Year 1 medical students (46.70 ± 20.34; $p = 0.05$) in the naturalist domain. University A students (58.35 ± 21.30) also scored significantly higher than University B (50.26 ± 19.49; $p = 0.014$) and University C (46.90 ± 21.58; $p = 0.008$) students in the musical/rhythmic domain. As for the verbal/linguistic domain, University A students (47.94 ± 21.06) scored significantly higher than University C students (39.05 ± 19.23; $p = 0.05$). All other pairwise comparisons were not statistically significant ($p > 0.05$). Inter-institutional differences in mean MI domain scores among Universities A, B, and C Year 1 medical students are summarised in Table 4.

Table 4: Inter-institutional differences in mean MI domain scores among Universities A, B, and C Year 1 medical students

MI domain	University	Mean	SD	95% CI	*p*-value
Naturalist	A	53.51	21.99	(40.13, 66.89)	0.050
	B	46.70	20.34	(35.00, 58.40)	
Musical/rhythmic	A	58.35	21.30	(27.36, 89.34)	0.014
	B	50.26	19.49	(18.05, 82.47)	
Musical/rhythmic	A	58.35	21.30	(5.02, 32.22)	0.008
	C	46.90	21.58	(10.37, 83.43)	
Verbal/linguistic	A	47.94	21.06	(15.44, 80.44)	0.050
	C	39.05	19.23	(8.17, 69.93)	

Note: Only statistically significant comparisons are shown.

Path Analysis of the Effects of Various Demographic Factors on the MI of Medical Students and the Effects of MI on Academic Achievements

Path analysis showed that family income had the greatest effect on MI, and the effect was moderate and statistically significant ($\beta = 0.220$, $t = 2.005$, $p < 0.05$). Age, gender, race, first language, and pre-university CGPA did not show any significant effect on MI individually ($t < 1.96$, $p > 0.05$). The combined effect of age, gender, race, first language, family income, and pre-university CGPA was small in the path analysis as the R^2 value was only 0.125 (i.e., only 12.5% of the variances in MI was due to these factors in combination). MI domains had no statistically significant effect on the academic achievement of medical students ($\beta = 0.063$, $t = 0.506$, $p > 0.05$; $R^2 = 0.04$). Figure 2 summarises the path analysis findings.

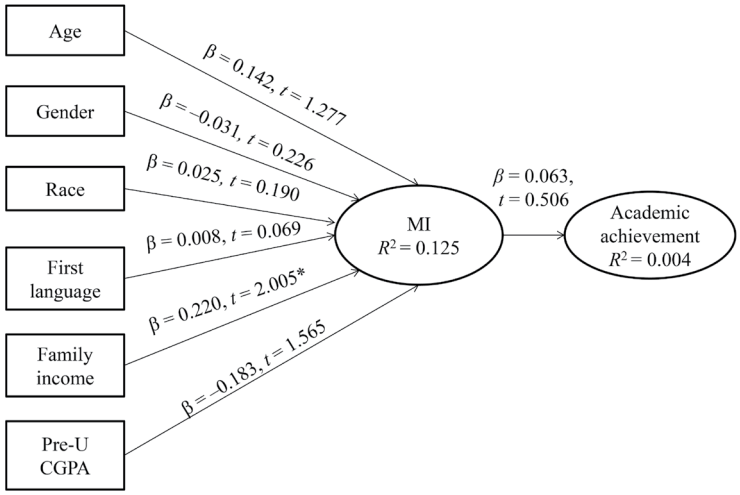

Figure 2: Path analysis of various factors on MI of medical students from Universities A, B, and C.

Note: *$p < 0.05$ is significant.

Role of Family Income on MI

Based on the path analysis findings, further exploration of the effects of family income on the MI of medical students was carried out to compare mean MI domain scores between various income groups. ANOVA was significant for the musical/rhythmic [F (3, 237) = 4.99, $p = 0.002$] and logical/mathematical [F (3, 237) = 3.49, $p = 0.017$] domains, but not significant for the naturalist, existential interpersonal, kinaesthetic, verbal/linguistic, intrapersonal and visual/spatial domains ($p > 0.05$).

However, post-hoc analysis showed only a statistically significant difference in the musical/rhythmic domain, in which the students in the highest monthly family income group (i.e., monthly family income >RM15,000) (55.85 ± 20.65) scored significantly higher than those in the lowest monthly family income group (i.e., monthly family income <RM5,000) (45.27 ± 20.17; $p = 0.002$). Table 5 shows the differences in mean MI domain scores in the musical/rhythmic domain according to family income. All other pairwise comparisons were not statistically significant ($p > 0.05$) (results not shown). Interestingly, the mean MI domain scores for all domains increased with increasing family income, with the exception of the naturalist and interpersonal domains (results not shown).

Table 5: Differences in mean MI domain scores according to family income

MI domain	Family income group	Mean	SD	95% CI	*p*-value
Musical/rhythmic	<RM5,000	45.27	20.17	(34.01, 56.53)	0.002
	>RM15,000	55.85	20.65	(44.51, 67.19)	

Note: Only statistically significant comparisons are shown.

DISCUSSION

This section discusses the findings of the present study from two perspectives: the theoretical/conceptual perspective and managerial perspective. From the theoretical/conceptual perspective, the pattern of MI in medical students, inter-institutional differences in MI, and the impact of demographic factors on MI are explained. From the managerial perspective, the challenges and considerations in verbal/linguistic intelligence, as well as the significance of intrapersonal and musical/rhythmic intelligence in medical education, are discussed. Practical ways of integrating MI in medical education to address the challenges identified are proposed.

Pattern of MI in Medical Students

Medical students in this study demonstrated an interesting pattern in the mean MI domain scores. All cohorts, whether individually or in combination with others, demonstrated the highest score in the intrapersonal domain and the lowest score in the verbal/linguistic domain. This pattern was observed in a previous study, where first-year information technology (IT) students had the highest score in the intrapersonal domain and lowest score in the verbal/linguistic domain (18). Another study also demonstrated a similar pattern among first-year nursing students. Interestingly, this pattern was not observed in second, third, or fourth-year nursing students (24).

Inter-institutional Differences in MI Scores

Inter-institutional differences in the mean MI domain scores were evident in this study. Significant differences were observed in the naturalist, musical/rhythmic, and verbal/linguistic domains. Literature on multi-institutional studies in MI is scarce. However, such differences in mean MI domain scores may be due to differences in the background of medical students from different universities, as Universities A and C are private universities, whereas University B is a public university. All three universities recruit students from different financial, racial, and geographical backgrounds.

Impact of Demographic Factors on MI

In the path analysis, family income was the only factor having a significant effect on the MI of these students. Further exploration revealed that the effect was mainly on the musical/rhythmic domain. It is worth mentioning that University A students generally had a higher percentage of students (n = 28, 29.03%) from the two higher income groups than those from University B (n = 25, 22.12%) and University C (n = 3, 7.89%). Although there is a lack of comparative studies on the effect of socioeconomic status on MI at the tertiary level, one

study on children showed that socioeconomic status had a significant effect on the musical/rhythmic and interpersonal intelligences of children (15), suggesting that the influence of socioeconomic status on MI may have started much earlier in life.

Challenges and Considerations in Verbal/Linguistic Intelligence

Although the MI Inventory is not diagnostic, and a relatively low verbal/linguistic score does not necessarily mean poor verbal/linguistic skills, the low scores reflected on the students' perception on their verbal/linguistic intelligence in this study. Therefore, it may be worthwhile exploring the reasons for this finding in future studies. The verbal/linguistic intelligence refers to the ability in spoken and written language. A person strong in this intelligence is good at reading and using language to express oneself, such as writing and storytelling (30). A previous study has shown that verbal/linguistic intelligence positively correlated with academic performance and was a significant predictor of academic performance (31). Since medical programmes in Malaysia are taught in English, it may also be worthwhile investigating the English proficiency of medical students, as a previous Malaysian study has shown that English language proficiency was related to the academic performance of students (32).

Significance of Intrapersonal Intelligence in Medical Education

The intrapersonal intelligence refers to the ability to understand oneself and one's strength and weaknesses. A person who is good in this domain is adept at understanding their feelings and can set goals for themselves (33). Intrapersonal intelligence encompasses abilities such as adaptability, self-regulation and self-management, which are important in problem solving. In medical education, the ability to understand oneself is crucial, given that self-awareness, self-assessment and self-directed learning are all important components. Students who are self-smart may cope with stress and challenges better (34). Studies have also shown that intrapersonal intelligence was positively correlated with academic performance (9, 35).

Musical/Rhythmic Intelligence in Medical Education

Musical/rhythmic intelligence refers to sensitivity to various components of sounds and music, and the ability to perform, compose, and appreciate music (36). Although initially, the relevance of musical/rhythmic intelligence in medical education seems limited, Gardner and Moran (1) suggest that one's musical/rhythmic intelligence runs in almost structural parallel to one's linguistic intelligence. Music and rhythm have long been regarded as powerful aids in language learning (36, 37), with music and language sharing common ground as two human abilities (38). Furthermore, proponents argue that individuals with high verbal/linguistic intelligence are sensitive to the auditory, grammatical, semantic, and pragmatic aspects of language.

Implications of the Study

Theoretical implications

Inter-institutional differences in MI scores observed in this study open the doors to further investigation, comparing the effects of student backgrounds and different curriculum approaches on MI. The impact of family income on the musical/rhythmic intelligence

highlights the effects of socioeconomic status on MI and the need to develop educational strategies that consider diverse backgrounds and address potential inequalities. While MI showed no significant effect on academic achievement in this study, it may have indirect influences. The importance of MI in medical education goes beyond academic scores, as capabilities like interpersonal and interpersonal intelligences are critical as medical students progress through their careers. This study was limited by a small sample size, which may explain why MI had no significant effect on academic achievement. Furthermore, MI can evolve over time. Given that the medical students in this study were first-year students, follow up studies are recommended to further investigate the relationship between MI and academic achievements.

Practical implications

The consistent low scores in the verbal/linguistic domain imply that further investigations are necessary to understand the underlying reasons. Interventions are necessary as this intelligence is important for effective medical practice. Some interventional strategies include identifying students who need help and providing targeted language support and communication training. Additionally, educators can capitalise on the high intrapersonal intelligence by incorporating self-reflection and personalised learning opportunities into the medical curriculum. This, in turn, can enhance self-awareness, the students' abilities in goal-setting, as well as resilience in handling adversity.

Implications on global medical education

The findings of this study have implications beyond Malaysia. They encourage the recognition of a broader spectrum of intelligences, which differ significantly from conventional IQ tests. The fact that MI encompasses diverse capabilities among medical students and is influenced by demographic factors implies the need for tailored medical curricula, considering environmental factors, regional variations, and cultural differences. The relationship between family income and musical intelligence (closely related to verbal/linguistic intelligence) suggests global initiatives aimed at addressing inequalities in accessing quality medical education.

Limitations of the Study

This study was conducted on three selected medical schools in Malaysia. It was limited to only Year 1 medical students. As MI may change and evolve over time, the study only captured MI of these students at a specific point in time. The MI Inventory is a self-reported questionnaire. Consequently, the findings of the study are not diagnostic but a reflect on the students' perception of their MI.

CONCLUSION

This study yielded several key findings. Firstly, consistent across all cohorts of medical students from three medical schools, there was a notable pattern of high intrapersonal scores and relatively low verbal/linguistic scores. Secondly, inter-institutional statistically significant differences in the mean MI domain scores were observed among these students. Thirdly, in a path analysis, family income was the only demographic factor that had a significant effect on the MI of medical students, and the combined effect of all demographic

factors was small and not significant. Further exploration using ANOVA revealed that the influence of family income was primarily on the musical/rhythmic domain, closely linked to verbal/linguistic intelligence. Lastly, the effect of MI on academic achievements of the students was limited and statistically not significant in the path analysis.

As observed in this study, medical students who exhibit high levels of intrapersonal intelligence may enjoy several advantages in their academic pursuit. Research has shown that individuals with high levels of intrapersonal intelligence are better at coping with stress and burnout (34, 38). Huerta et al. (39) showed that engineering students' intrapersonal skills improved after mindfulness training, while Yamada et al. (40) reported improvement in physicians' intrapersonal empathy after communication skills training. These findings suggest that medical educators could consider incorporating strategies for enhancing intrapersonal intelligence within the medical curriculum.

The consistently low scores in the verbal/linguistic domain among students from the three medical schools highlight the need for medical educators to implement strategies to enhance their language proficiency. This is particularly important in medical education, as a strong command of English is crucial for comprehensive learning and grasping complex concepts. Future studies could expand their scope by involving students from different levels of study. Longitudinal research tracking changes in students' MI from year one to the final year of the programme would provide valuable insights. The involvement of additional medical schools would provide a better representation of the MI of medical students in the country.

ETHICAL APPROVAL

This study has obtained ethical clearance from the Proposal Defence Committee of Asia e University and the approval of the respective deans of the participating universities. At the proposal defence, the committee was in the opinion that the proposed research has complied with the core principles of ethical conduct of the research. The participants signed a consent form and provided full informed consent before attempting the questionnaires. Their participation in the study was voluntary and anonymous.

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