ORIGINAL ARTICLE

The Association Between Smartphone Usage and Academic Performance Among Health Sciences Students: An Institutional Study

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ABSTRACT

Introduction: Smartphones play a crucial role in student's life but their misuse can negatively impact their academic performances. This study investigates the association between smartphone usage and academic performance among undergraduate health science students at a public university in Kuala Lumpur. **Materials and methods:** 410 students from the Faculties of Dentistry, Pharmacy, and Health Sciences participated in this cross-sectional study. Through the Google form, they were asked to complete the Smartphone Use Survey (SUS) and provide their demographic information and Grade Point Average (GPA). Data were analysed using Statistical Package for the Social Sciences (SPSS) software. Kruskal-Wallis and Spearman's correlation test were used to determine the effects of smartphone usage on the student's academic performance, with $p \leq 0.05$ regarded as significant. **Results:** Most students used smartphones frequently, both for academic and non-academic purposes. 64.4% and 68.7% of students always used smartphones to discuss assignments during and outside class, respectively, while 70.6% always used smartphones for non-academic internet searches. Over 70% of students rarely saw their peers using smartphones to cheat during exams. The use of smartphones for emailing, whether academic or non-academic, was statistically linked to high academic performance ($p<0.05$). Specifically, emailing for academic purposes showed a weak positive correlation with higher GPA ($p=0.042$), while emailing for non-academic purposes showed a stronger positive correlation ($p=0.001$). **Conclusion:** Smartphone use does not adversely affect the academic performance of health sciences students. However, ongoing efforts are needed to monitor its usage among the students to ensure academic success.

Malaysian Journal of Medicine and Health Sciences (2025) 21(SUPP9):1-11. doi:10.47836/mjmhs.21.s9.1

Keywords: Academic performance, health science courses, smartphone usage, Smartphone Use Survey, undergraduate students

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INTRODUCTION

Smartphones have successfully replaced desktop computers for non-complex office work due to their functionality and small size that everyone can easily keep inside their pocket. Through the revolution and advancement in mobile technologies, emailing, web browsing and reading, for example, can be accomplished seamlessly through smartphones (1). Ever since, smartphones have become an integral part of today's generation in every aspect of life, especially for students and adolescents who are the major users of smartphones (2). Its versatility enables users to utilise it as a medium for communication, personal diary, and planner, as well as for taking photos, seeking information, listening to music and watching videos, and even for calculation (3). In addition, smartphones also play an important role for university students, in both formal and informal learning (4). Most lecturers in the university use mobile devices such as smartphones and tablets in teaching and learning activities since both devices are affordable, popular and have practical functions (5).

The benefit of learning through smartphones is the convenience and flexibility offered by online mobile learning, especially through applications. It minimises the barriers inherent in traditional methods or activities that used to be carried out in schools and universities (6). For instance, students use smartphones to share

notes and videos with classmates, record lectures, and take pictures of important slides and assignments for future references which they may have missed during the class (7). Smartphones nowadays are equipped with short message service (SMS) features and internet connections which result in easy access to information, social networks and up-to-date news which will increase students' ways of finding knowledge (8,9).

Not only that, a study by Sun et al. (10) has found that university students also used smartphones for socializing and entertainment purposes. Students agreed that they use mobile phones to communicate with friends and family. The parents saw this opportunity as a way for them to keep in touch with their children. In addition, students can access many entertaining applications using the internet such as Facebook, YouTube and TikTok, hence helping them relieve their stress following day-long learning (10). Roberts and David reported an increased usage of smartphones among undergraduate students and the higher the usage, the students perceived better social connections and associated with better psychological well-being. Interestingly, in the same study, they also reported that due to a lack of social interaction, some students were found to be at a higher level of stress and depression (11).

However, if students misuse and abuse smartphones, it can lead to smartphone addiction and bring harm to them especially when they overuse them for personal and entertainment purposes per se rather than for academic purposes (12). Spending more time browsing Facebook and sending a non-academic related text message for example can have negative effects on their academic performance. Evidence from the literature has suggested that university students often see smartphones as a source of entertainment rather than as a working tool (12, 13).

Further, indulging in texting during lectures greatly reduces students' ability to self-regulate and give constant attention to classroom tasks. The notifications received on smartphones may distract students during class or study time with visual and sound alerts. Students often want to know what is happening online and try to interact continuously with the world, thus it can lead to a great lack of focus while studying (14) and perhaps can cause a deterioration of their academic performance greatly (15). Furthermore, smartphones can provide a fast and tempting escape from the lack of academic motivation and a sense of boredom when studying. All these factors can greatly reduce productivity and eventually lower the overall academic performance of university students (16,17).

Many questionnaires have been established for research purposes to measure the daily smartphone usage of a student. One of the questionnaires is the Smartphone Use Survey (SUS) devised by Almahfud (18). SUS was developed in English and used a five-point Likert scale and measured the time that the students spent using their smartphones for academic and non-academic related activities each day. Another questionnaire that is used to assess smartphone use is the Smartphone Addiction Scale (SAS). As the name suggests, this 33-item self-reported questionnaire measures the level of addiction of the students when using their smartphones. Using both questionnaires, mixed outcomes have been reported in the literature. There is a large body of literature reported on the negative impact of smartphone usage in class and associates it with poor academic performance of the students (19-21).

However, many studies that have been conducted measure the impact of smartphone usage on students' academic performance involving those from social sciences and engineering courses in tertiary institutions. Interestingly, except for medical students, no study of a similar nature has been particularly carried out among health sciences students. It is interesting to see whether the use of smartphones has detrimental effects on their academic performance. Thus, this study aims to evaluate the impact of smartphone usage on academic performance among health science-based university students by using the SUS and comparing it with their Grade Point Average (GPA).

MATERIALS AND METHODS

Study Type and Design

This observational, cross-sectional study was conducted at a public university in Kuala Lumpur involving undergraduate students. This study was approved by the institution's Research Ethics Committee (JEP-2022-216). The students were recruited from three different faculties namely the Faculty of Dentistry, Pharmacy and Health Sciences. The minimal sample size needed in the study for each faculty was based on a calculation by the Raosoft sample size calculator, incorporating a 5% margin of error, 95% confidence level and 50% response distribution, yielding 120, 130 and 160 students from the Faculty of Dentistry, Pharmacy and Health Sciences respectively.

The sampling method used in the present study was simple randomised sampling. The inclusion criteria were any undergraduate students of the institution from the 3 faculties involved and they must own a smartphone; while the exclusion criteria were the undergraduate students from the 3 faculties who have not sat for any examination yet and hence have no GPA. Following the inclusion and exclusion criteria, the list of students identified through their matric numbers was obtained from the Dean's Office of respective faculties. The list was entered into Microsoft Excel. Using Microsoft Excel, a random list of students for each faculty was generated based on the calculated sample size. The selected

students were approached through email and were given the participant's information sheet (PIS) and a consent form, asking for their participation in the study. The PIS includes all information about the study: inclusion and exclusion criteria, eligibility to participate, risks and benefits of the study and the contact person if they have any queries regarding the study. Students were able to decide either to decline or participate in the study by signing the consent form using their digital signature. Upon acceptance, they were given a set of online questionnaires distributed through Google Forms.

The questionnaire used consists of two sections. The first section of the questionnaire looked into the demographic information of the students such as age, gender, faculty, current year of academics, types of smartphones and their latest Grade Point Average (GPA). Students who did not disclose their GPA results through the questionnaire were excluded from the study and were not replaced. The second part of the questionnaire is the Smartphone Use Survey (SUS), developed and validated previously by Almahfud (18). Using the original questionnaires, this self-rated questionnaire consists of 41 questions in English and uses the five-point Likert scale to assess how often respondents use smartphones during class and outside of the class on a weekly basis (18).

The scores for each question range from 1 to 5 in which 1 indicates the lowest usage of a smartphone for that particular activity, while 5 indicates the highest smartphone usage in a day. A higher score indicates a higher amount of time spent when using a smartphone and vice versa. The academic performance of each student was assessed through their GPA from the questionnaire, which was stratified into high (3.5 or higher), good (3 – 3.49), normal (2 – 2.99), and low (less than 2). The GPA scores were self-declared academic performances as the scores were collected only from the questionnaires instead of the involved faculties.

Statistical Analysis

Statistical Package for the Social Sciences (SPSS) software, version 25.0 for Windows (IBM; SPSS Inc., Chicago, IL., USA) was used to enter and analyse the data. The demographic data were calculated and reported in terms of frequency and percentages. The mean GPA of students from the three faculties was calculated. The normality of the data was assessed using Kolmogorov-Smirnov test, which was not normally distributed. The SUS scores were compared with the GPA of the student from each faculty using the Kruskal-Wallis test. Further, the association between the SUS component and the student's GPA was determined using Spearman's correlation coefficient test. A p-value of ≤0.05 was regarded as significant for both statistical tests.

RESULTS

Demographic data

The demographic characteristics of the students involved in the study are presented in Table I. A total of 374 students participated in the study with 300 (80.2%) of them female and 74 (19.8%) of them male. In terms of faculty, 137 (36.6%) were students from the Faculty of Health Sciences, while 114 (30.5%) and 123 (32.9%) students were from the Faculty of Dentistry and Faculty of Pharmacy respectively. Of the 374 students who participated, Year 3 students had the highest number of participants with a total of 94 (25.1%) students, followed by Year 4: 91 students (24.3%), Year 2: 89 students (23.8%), Year 1: 71 students (19.0%) and Year 5: 29 students (7.8%). The mean GPA from last semester for students from the Faculty of Health Sciences, Dentistry and Pharmacy were 3.90, 2.91 and 3.51 respectively.

Table I: Demographic data of the students

PART A	Frequency (n)	Percentage (%)
Gender		
Male	74	19.8
Female	300	80.2
Faculty		
Allied Health Sciences	137	36.6
Dentistry	114	30.5
Pharmacy	123	32.9
Current Year of Study		
Year 1	71	19
Year 2	89	23.8
Year 3	94	25.1
Year 4	91	24.3
Year 5	29	7.8
PART B		
Mean GPA Last Semester		
Allied Health Sciences		3.9
Dentistry		2.91
Pharmacy		3.51

Mean GPA regarded as Excellent (≥3.5), Good (3-3.49), Average (2-2.99), Poor (<2.0).

Smartphone Use Survey (SUS) analysis of the students

For the analysis of the Smartphone Use Survey (SUS), the responses from the students across the three faculties were merged and analysed together, making the total number 374. Based on Table II, 56.9% of the students 'Often' and 'Always' use smartphones in class, with the median response of 'Often'. Only 1 (0.3%) person reported never use a smartphone in class while others do use a smartphone in class either rarely (10.4%) or sometimes (32.4%).

Table II: How often do the students use a smartphone in class

Questions	Never	Rarely	Some-times	Often	Always	Mode	Med	IQR
	n(%)	n(%)	n(%)	n(%)	n(%)			
How often do you use a smartphone in class?	1 (0.3)	39) (10.4)	121 (32.4)	125 (33.4)	88 (23.5)	3	3	4

Med= median, IQR= Interquartile range. For Mode and Median: 0=never, 1= rarely, 2= sometimes, 3=often, 4=always

Table III summarises the frequency of smartphone usage by the students in the last semester. With regards to the usage of smartphones during their class, 241 (64.4%) students always use a smartphone to communicate with others about class assignments via texting while 189 (50.5%), 164 (43.9%), 151 (40.4%), 136 (36.4%), 127 (34.0%), 95 (25.4%), 92 (24.6%), 83 (22.2%), 74 (19.8%), 63 (16.8%), and 56 (15.0%) of them always used smartphones to find meanings for words or terms used in class, access course information such as the syllabus and assignments, view course pictures such as diagrams and maps, and find references material for class activities and assignments, read course materials such as notes, communicate with others about class assignments through emails, view course PowerPoints, view course videos, listen to a class lecture, take notes in class and record a class lecture respectively. The overall median response regarding how frequently the student uses a smartphone in class for study purposes is 'Often'. A statistically significant difference was observed between the usage of smartphones for communication about class assignments in the class through emails and the student's GPA ($p<0.05$).

Table III: The frequency of smartphone usage among the students during the last semester.

Questions	Never	Rarely	Some-times	Often	Always	Mode	Med	IQR	*p-value
	n(%)	n(%)	n(%)	n(%)	n(%)				
A. During the past semester, how often did you use your smartphone during class to:									
Access course information (syllabus, assignments)	2 (0.5)	10 (2.7)	56 (15)	142 (38.0)	164 (43.9)	4	3	4	0.85
Read course materials (notes)	8 (2.1)	30 (8)	81 (21.7)	128 (34.2)	127 (34)	3	3	4	0.54
Take notes in class	38 (10.2)	83 (22.2)	111 (29.7)	79 (21.1)	63 (16.8)	2	2	4	0.7
Find the meaning words or terms used in class	0 (0)	5 (5)	52 (13.9)	128 (34.2)	189 (50.5)	4	4	3	0.78
Find references material for class activities and assignments	4 (1.1)	29 (7.8)	78 (20.9)	127 (34)	136 (36.4)	4	3	4	0.21
View course pictures (diagrams, maps, etc)	6 (1.6)	19 (5.1)	75 (20.1)	123 (32.9)	151 (40.4)	4	3	4	0.06
View course Power Points	17 (4.5)	60 (16)	88 (23.5)	117 (31.3)	92 (24.6)	3	3	4	0.9
Record a class lecture	100 (26.7)	91 (24.3)	74 (19.8)	53 (14.2)	56 (15)	0	1	4	0.91
Listen to a class lecture	54 (14.4)	75 (20.1)	84 (22.5)	87 (23.3)	74 (19.8)	3	2	4	0.67
View course videos	21 (5.6)	60 (16)	114 (30.5)	96 (25.7)	83 (22.2)	2	2	4	0.66
Communicate with others about class assignments by texting	4 (1.1)	12 (3.2)	35 (9.4)	82 (21.9)	241 (64.4)	4	4	4	0.21
Communicate with others about class assignments through emails	93 (24.9)	90 (24.1)	48 (12.8)	48 (12.8)	95 (25.4)	4	2	4	*0.03
B. For academic purposes, during the past semester, how often did you use your smartphone outside of class to:									
Access course information (syllabus, assignments)	3 (0.8)	16 (4.3)	76 (20.3)	128 (34.2)	151 (40.4)	4	3	4	0.94
Read course materials (notes)	10 (2.7)	37 (9.9)	81 (21.7)	119 (31.8)	127 (34)	4	3	4	0.65
Find the meaning words or terms used in class	1 (0.3)	10 (2.7)	50 (13.4)	131 (35)	182 (48.7)	4	3	4	0.91
Find references material for class activities and assignments	3 (0.8)	33 (8.8)	73 (19.5)	130 (34.8)	135 (36.1)	4	3	4	0.91
View course pictures (diagrams, maps, etc)	5 (1.3)	32 (8.6)	84 (22.5)	128 (34.2)	125 (33.4)	3	3	4	0.37
View course Power Points	25 (6.7)	64 (17.1)	97 (25.9)	94 (25.1)	94 (25.1)	2	3	4	0.39
Listen to a class lecture	57 -15.2	57 -15.2	94 -25.1	86 -23	80 -21.4	2	2	4	0.29
View course videos	22 (5.9)	66 (17.6)	91 (24.3)	109 (29.1)	86 (23)	3	3	4	0.65
Communicate with others about class assignments by texting	1 (0.3)	4 (1.1)	24 (6.4)	88 (23.5)	257 (68.7)	4	4	4	0.27

CONTINUE

CONTINUE

Table III: The frequency of smartphone usage among the students during the last semester (CONT.)

Questions	Never	Rarely	Some-times	Often	Always	Mode	Med	IQR	*p-value
	n(%)	n(%)	n(%)	n(%)	n(%)				
Communicate with others about class assignments through emails	87 (23.3)	68 (18.2)	54 (14.4)	56 (15)	109 (29.1)	4	2	4	0.22
Others by texting, email or through wikis	52 (13.9)	48 (12.8)	52 (13.9)	88 (23.5)	134 (35.8)	4	3	4	*0.04
C. How often do you use your smartphone in daily routine non-academic purposes for:									
Reading email	0 (0)	28 (7.5)	93 (24.9)	111 (29.7)	142 (38)	4	3	3	0.09
Writing email	14 (3.7)	106 (28.3)	136 (36.4)	68 (18.2)	50 (13.4)	2	2	4	*0.01
Reading news	4 (1.1)	49 (13.1)	120 (32.1)	107 (28.6)	94 (25.1)	2	3	4	0.87
Accessing media (music, video, etc)	0 (0)	3 (0.8)	18 (4.8)	85 (22.7)	268 (71.7)	4	4	3	0.22
Gaming	52 (13.9)	116 (31)	82 (21.9)	58 (15.5)	66 (17.6)	1	2	4	0.93
Browsing the internet for information	0 (0)	1 (0.3)	19 (5.1)	90 (24.1)	264 (70.6)	4	4	3	0.16
Tasks (banking, ordering, etc)	0 (0)	2 (0.5)	27 (7.2)	97 (25.9)	248 (66.3)	4	4	3	0.5

Med= median, IQR= Interquartile range. For Mode and Median: 0=never, 1= rarely, 2= sometimes, 3=often, 4=always. *A p-value of ≤ 0.05 is regarded as significant, assessed using the Kruskal-Wallis test.

In addition, smartphones were heavily used by 257 (68.7%) students outside of the class to communicate with others about class assignments via texting. 182 (48.7%) of the students also always use a smartphone to find the meaning of words or terms used in class, while 151 (40.4%), 135 (36.1%), 127 (34.0%), 125 (33.4%), 109 (29.1%), 94 (25.1%), 86 (23.0%), and 80 (21.4%) of the students used their smartphones to access course information, find references material for class activities and assignments, read course materials, view course pictures, communicate with others about class assignments through emails, view course PowerPoints, view course videos and listen to a class lecture respectively. The overall median response regarding how frequently the student uses a smartphone outside the class for study purposes is 'Often'. Kruskal-Wallis test showed a statistically significant difference between the student's GPA and the usage of smartphones for emailing and/or texting apart for assignment work ($p<0.05$).

In terms of the usage of smartphones in daily routine for non-academic purposes, 268 (71.7%) of the students always use smartphones to access media, 264 (70.6%) browse the internet for information, and 248 (66.3%) students always use smartphones to do tasks such as online banking and ordering food. In addition, 254 (68%) of the students responded 'Sometimes' or more when asked about their usage of smartphones to write emails. However, 14 (3.7%), 4 (1.1%) and 52 (13.9%) have never used a smartphone to write an email, read news and play games respectively. As for overall usage of smartphones for daily routine for non-academic purposes, the median response of the students is 'Often'. There was a statistically significant difference noted between the student's GPA and using the smartphones for writing emails outside the classroom for non-academic related activity ($p<0.05$).

Based on the students' observation, 160 (42.8%) students reported never seeing others cheat on tests, quizzes and assignments as shown in Table IV. Further, 192 (51.3%) of the students have never observed other students send answers to other students during quizzes or exams, 207 (55.3%) never received answers from other students during quizzes or exams, 160 (42.8%) never accessed lecture notes or other course materials during quizzes or exam, 257 (68.7%) never shared answers with someone who has not taken the exam or quiz yet and 188 (50.3%) never checked facts while writing a paper during quiz or exam. Overall, the median response from students regarding observing other students using a smartphone to cheat during the exam is 'Rarely'.

Table IV: The response of students on observing other students used smartphones for cheating during tests in the last semester.

Questions	Never	Rarely	Some-times	Often	Always	Mode	Med	IQR
	n(%)	n(%)	n(%)	n(%)	n(%)			
During the past semester, I have observed others using their smartphones in class to:								
Cheat on tests, quizzes and other assignments	160 (42.8)	89 (23.8)	86 (23)	27 (7.2)	12 (3.2)	0	1	4
Send (text/ email) answers to other students during quiz or exam	192 (51.3)	88 (23.5)	62 (16.6)	21 (5.6)	11 (2.9)	0	0	4
Receive (text/ email) answers from other students during quiz or exam	207 (55.3)	65 (17.4)	72 (19.3)	16 (4.3)	14 (3.7)	0	0	4
Access lecture notes or other course materials during quiz or exam	160 (42.8)	85 (22.7)	72 (19.3)	39 (10.4)	18 (4.8)	0	1	4
Share (text/ email) answers with someone who has not taken the exam or quiz yet	257 (68.7)	53 (14.2)	36 (9.6)	17 (4.5)	11 (2.9)	0	0	4
Check facts while writing a paper during quiz or exam	188 (50.3)	78 (20.9)	62 (16.6)	29 (7.8)	17 (4.5)	0	0	4

Med= median, IQR= Interquartile range. For Mode and Median: 0=never, 1= rarely, 2= sometimes, 3=often, 4=always.

A Spearman's rank order correlation was performed to assess the relationship between the academic performances of the students and the reason for smartphone usage during and outside the classroom for academic purposes and their non-academic daily routine purposes (Table V). There is a weak positive correlation between the student's academic performance and usage of the smartphone for texting and emailing for academic purposes both inside and outside the class with a correlation coefficient of 0.05 and 0.04 ($p \leq 0.05$) respectively. For non-academic daily routine usage of smartphones, a positive correlation between emailing and academic performance with a correlation coefficient of 0.001 was found. Whereas, others have no statistically significant correlation between smartphone usage inside and outside the class with academic performance.

Table V: The correlation between smartphone usage among the students and their last semester's GPA.

A. In class, for academic purposes			
	Input	**Output**	
Spearman's rho	GPA	Correlation coefficient	1
		Sig. (2-tailed)	
		N	374
	Access course information (syllabus, assignments)	Correlation coefficient	0.025
		Sig. (2-tailed)	0.633
		N	374
	Read course materials (notes)	Correlation coefficient	0.044
		Sig. (2-tailed)	0.397
		N	374
	Take notes in class	Correlation coefficient	0.021
		Sig. (2-tailed)	0.689
		N	374
	Find the meaning words or terms used in class	Correlation coefficient	0.021
		Sig. (2-tailed)	0.693
		N	374
	Find references material for class activities and assignments	Correlation coefficient	0.001
		Sig. (2-tailed)	0.983
		N	374
	View course pictures (diagrams, maps, etc)	Correlation coefficient	0.096
		Sig. (2-tailed)	0.065
		N	374
	View course Power Points	Correlation coefficient	0.058
		Sig. (2-tailed)	0.266
		N	374
	Record a class lecture	Correlation coefficient	0.045
		Sig. (2-tailed)	0.39
		N	374
	Listen to a class lecture	Correlation coefficient	0.061
		Sig. (2-tailed)	0.238
		N	374

CONTINUE

Table V: The correlation between smartphone usage among the students and their last semester's GPA. (CONT.)

A. In class, for academic purposes			
Input		**Output**	
View course videos		Correlation coefficient	0.001
		Sig. (2-tailed)	0.978
		N	374
Communicate with others about class assignments by texting		Correlation coefficient	0.096
		Sig. (2-tailed)	0.064
		N	374
Communicate with others about class assignments through emails		Correlation coefficient	0.101
		Sig. (2-tailed)	.050*
		N	374
B. Outside class, for academic purposes			
Access course information (syllabus, assignments)		Correlation coefficient	0
		Sig. (2-tailed)	0.992
		N	374
Read course materials (notes)		Correlation coefficient	0.036
		Sig. (2-tailed)	0.483
		N	374
Find the meaning words or terms used in class		Correlation coefficient	0.011
		Sig. (2-tailed)	0.832
		N	374
Find references material for class activities and assignments		Correlation coefficient	0.037
		Sig. (2-tailed)	0.471
		N	374
View course pictures (diagrams, maps, etc)		Correlation coefficient	0.096
		Sig. (2-tailed)	0.064
		N	374
View course Power Points		Correlation coefficient	0.078
		Sig. (2-tailed)	0.132
		N	374
Listen to a class lecture		Correlation coefficient	0.048
		Sig. (2-tailed)	0.352
		N	374
View course videos		Correlation coefficient	0.011
		Sig. (2-tailed)	0.825
		N	374
Communicate with others about class assignments by texting		Correlation coefficient	0.033
		Sig. (2-tailed)	0.519
		N	374
Communicate with others about class assignments through emails		Correlation coefficient	0.082
		Sig. (2-tailed)	0.115
		N	374
Others by texting, email or through wikis		Correlation coefficient	0.105
		Sig. (2-tailed)	.042*
		N	374

CONTINUE

Table V: The correlation between smartphone usage among the students and their last semester's GPA. (CONT.)

C. Outside class, for non-academic purposes		
Input	**Output**	
Reading email	Correlation coefficient	0.009
	Sig. (2-tailed)	0.867
	N	374
Writing email	Correlation coefficient	0.174
	Sig. (2-tailed)	.001*
	N	374
Reading news	Correlation coefficient	0.037
	Sig. (2-tailed)	0.478
	N	374
Accessing media (music, video, etc)	Correlation coefficient	0.037
	Sig. (2-tailed)	0.475
	N	374
Gaming	Correlation coefficient	0.015
	Sig. (2-tailed)	0.769
	N	374
Browsing the internet for information	Correlation coefficient	0.06
	Sig. (2-tailed)	0.246
	N	374
Tasks (banking, ordering, etc)	Correlation coefficient	0.029
	Sig. (2-tailed)	0.58
	N	374

*Correlation is significant at the 0.05 level (2-tailed)

DISCUSSION

Smartphones are the most popular devices in this modern and ever-changing society that are used for information transfer and consumption. The usage of smartphones as a tool in teaching and learning has increased dramatically over the past couple of years following the widespread of the Covid-19 viral infection (22). However, excessive smartphone usage in academics is found to be associated with neurological and osteo-muscular problems, anxiety, depression, decreased productivity, and poor academic performance (23).

Academic performance reflects the ability of the students to comprehend and consolidate the knowledge gained during the teaching and learning sessions (24). With regard to health sciences courses, students are expected to achieve a certain level of competencies and acquire the necessary skills before entering the working field. This will ensure that their quality of work meets the standard as outlined by the appropriate professional bodies since they are dealing mainly with patients who seek healthcare services and advice. Therefore, it is worth exploring and identifying any factor that may influence their academic performance negatively.

The initial sample size calculated was 410 students across three faculties. However, the final number of students who were eligible for data analysis was 374 students, with a response rate of 91%. The disparity between the figures was due to incomplete data entry in which the students refused to disclose their GPA scores. Most respondents from the study were females, which comprises more than 4/5th of the total respondents. This phenomenon is a common finding in universities worldwide as the distribution of students, mainly in health-sciences-related courses, was dominated by the female gender (25, 26). A study by Huyer reported almost two-thirds of the graduates from health-related courses in Brunei Darussalam, Malaysia, Myanmar and the Philippines were women (27).

In the present study, students from the Faculty of Health Sciences made up the majority of the respondents as it is a large faculty comprising 13 different programs such as Optometry, Environmental Health, Occupational Therapy, Speech Therapy, Diagnostic Imaging and Radiotherapy and Physiotherapy. Meanwhile, the Faculty of Dentistry and Faculty of Pharmacy only have 1 program running in each faculty. Among Year 1 to Year 5 students, Year 3 reported the highest number of respondents. The lowest proportion of Year 5 students recruited in this study was due to only the Faculty of Dentistry having a 5-year course as compared to a 4-year course in other faculties, with around 50 students per batch.

Excellent mean GPAs were obtained by the students from both the Faculty of Health Sciences and Pharmacy, with a score of 3.90 and 3.51 respectively. Meanwhile, the Faculty of Dentistry students achieved an average mean GPA score of 2.91. This was largely contributed by the results of the preclinical students. Several factors have been discussed in the literature associating poor learning style, poor coping strategies and culture shock with poor academic performance among pre-clinical students (28, 29). As the students progress into the clinical years, better coping strategies and learning techniques have helped them to integrate their pre-clinical knowledge into their clinical practice and subsequently improve their GPA.

SUS was used in the present study as the questionnaire was designed to evaluate and measure the usage of smartphones among the students in and outside the class. Although it was designed in 2014, the content of the questionnaire is still relevant. The questions are very specific and involve the related activities that require the usage of smartphones during the teaching and learning session. Furthermore, the usage of smartphones for daily routine and non-academic purposes was also included, giving comprehensive coverage and a wide range of questions that may influence the students' academic performance. Ng and colleagues have used similar tools to measure the impact of smartphone usage on the academic performance of university students from

the social sciences course. They reported a negative association between the frequency of smartphone usage and the mean CGPA of the students (13).

The majority of the students involved in this study have a high duration of smartphone usage as reflected by the SUS median scores. The median for smartphone usage during and outside class for both academic and non-academic purposes was reported as "Often". This showed that similar to other students from social science and engineering courses (13, 19), the health science students also regularly used smartphones for their daily activities regardless of academic or non-academic purposes. The highest percentage of smartphone usage during class was finding the meaning of words or terms used in class, whereas, outside the class, smartphones were used mostly for communicating with others about class assignments by texting. Additionally, with regard to the non-academic daily routine, the students reported a high frequency of smartphone usage to access media for music and videos, browsing the internet for information and completing online banking and ordering.

Finding the meaning of words or terms during class can be beneficial to students in learning and understanding new terms. Students in engineering courses managed to enrich their technical vocabulary just by checking the meanings of difficult technical terms immediately during class, which later helped them learn faster and remember more terms (30). Similarly, students in pharmacy, dentistry and health science courses encounter numerous medical and scientific terminologies during their study. With the help of smartphones, the meanings of such terminologies can be found in a matter of seconds during their class and lead to better engagement during the lecture.

Self-directed learning and group work assignments are among the common approaches used by the lecturer mainly in health science courses to enhance the knowledge of the students regarding a specific topic. The availability of smartphone applications such as WhatsApp and Telegram which allow the user to create a group chat via texting makes communication easier, with all group members able to participate in the chat and give their feedback. These features provide a suitable platform for the students to discuss their group assignments hence it is not surprising that the majority of the students often use their smartphones outside the class for this purpose (31, 32).

In addition, the majority of the students in the present study often use their smartphones outside the class for entertainment purposes by browsing the internet and other media platforms searching for music and videos. This can be viewed as a form of relaxation for the student, providing some sort of escapism for them from the demanding course which requires full commitment during the class. Listening to music and watching online videos, when chosen and used properly provide emotional satisfaction to the students, which later can lead to positive cognitive development and psychological well-being (33). However, students must be able to strike a balance when using smartphones for leisure since overindulging in those activities can lead to smartphone addiction and potentially poor academic performance (15, 34).

The questionnaire also addressed the issue of smartphone misuse among students for cheating during examinations. The median response was reported as "Rarely", which indicates a low prevalence of cheating using smartphones during examinations and quizzes. This proves that the awareness of academic integrity is high among the students, reflecting their professionalism and truthfulness during the examination. A similar outcome was also reported in a study by Rusdi and colleagues (35). The authors reported a low incidence of cheating during examination among the students from 7 faculties at their institution. In addition, the setting of the examination at our institution itself may contribute to this outcome, since students need to hand over their smartphones and other devices to the examination invigilator before the examination starts. In terms of online examination, the positioning of the students has been standardised to allow the invigilator to monitor them closely for any misconduct during the examination. The use of video analysis and computer-assisted monitoring have also been described in the literature as an effort to minimise the incidence of cheating during online examinations (36).

The Kruskal-Wallis test showed a significant difference between the student's academic performance and the use of smartphones for texting and emailing done for both academic and non-academic purposes either inside or outside the classroom. Similarly, Spearman's coefficient correlation reflected that texting and emailing others through smartphones has a weak positive correlation with academic performances among the students while writing email routinely for non-academic purposes has a positive effect on their academic performance. This association shows that the students managed to use their smartphones effectively for learning purposes and sharing their learning material and group assignments via email and text message. Documents sharing via smartphone applications such as WhatsApp and Telegram for small file sizes and through emails for bigger file sizes enable them to use the technology to their advantage. These actions indirectly help the students to increase their motivation and understanding of the subject through group study.

In addition, students also used emails to discuss and share documents among themselves for non-academic purposes, especially when planning for programs or events with regard to their extra-curricular activities. At the current university, students are encouraged to

participate in extra-curricular activities which include their participation in various clubs, student organisations and sports activities. Students are required to prepare paperwork for each activity prior to approval from the higher authority. In order to make things easier, students will communicate and share all the documents among themselves through emails and virtual storage media such as Google Drive or iCloud. There have been various pieces of evidence in the literature that showed the positive impact of extracurricular activities on students' academic performance (37-39), thus supporting the positive correlation found in the present study.

The finding of the present study was in line with the study done by Sumathi et al. (40). In their study among university students, the majority of respondents claimed that correct usage of smartphones can enhance academic results. They later concluded that managing and effectively utilising mobile phone use will undoubtedly boost students' academic performance. Similar views were shared by Weber et al. (41), where through their study, information-seeking activity among internet users has a positive impact on the academic performance of the respondent. These findings proved that proper usage of smartphones can improve academic performance.

In contrast to our findings, low academic performance has been reported in the literature following the usage of smartphones among university students (42-44). Distraction during class and addiction to smartphones has been identified as the main contributing factors (45). The outcome of these studies, although contradicting the present study, should be appreciated and not be overlooked. Self-discipline, motivation and consistency of the students are dynamic and may fluctuate over time. Thus, it is of paramount importance to continuously monitor the usage of smartphones, especially during class. Improving students' awareness of the negative impact of smartphone abuse and offering counselling services to those who are in need may help the students in improving their academic performance.

The present study has some limitations which can be improved in the future. Firstly, this was a cross-sectional study done among the three health-science-related faculties. Thus, the cause-and-effect relationship between variables could not be established. Multivariate analysis or logistic regression of the data may add more value in determining the effects of each variable in order to establish a more meaningful outcome. In addition, a qualitative analysis using a focus group discussion can be done in the future to capture any undefined themes or problems that may not be able to be captured through the questionnaire. Further, this study demonstrates a long duration of smartphone usage among undergraduate students during and outside of class, however, the level of addiction towards smartphone usage was not assessed. Assessment of the smartphone addiction level can give a better insight into the impact of smartphone usage among them.

Apart from that, factors such as sleep deprivation and socioeconomic factors that may impact the student's academic performance were also not assessed in the present study. Evaluation of these factors may give a more holistic representation of the student's academic performance. The use of self-reported questionnaires and GPA also may not be accurate in case the students did not answer the questionnaire truthfully. This may lead to misinterpretation of the actual problem faced by the students. However, we believe that the students are mature enough to give an honest answer which later will help them to have a better learning environment and experience. We did not anticipate any language issues or misinterpretation of the question since the entry requirement into the health science courses requires the student to achieve a good level of English proficiency.

CONCLUSION

This is the first study that has been conducted exploring the association between smartphone usage and student's academic performance in health-science-related courses. Within the limitations of this study, the students often use their smartphones during and outside of class regardless of whether for academic or non-academic purposes. There was a weak positive correlation between the academic performance of the students and the frequency of smartphone usage for emailing and texting for academic purposes outside the class. A positive correlation was found for similar activity done for non-academic daily routine purposes. Further research is needed with the inclusion of smartphone addiction level, sleep quality and socioeconomic status to investigate the factors that might affect the student's academic excellence.

ACKNOWLEDGEMENT

We would like to thank the Dean of each faculty involved in this study for their continuous support throughout this study.

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