

E-ISSN 2228-8082

Volume 73, Number 1, January 2021



SMIJ

Siriraj Medical Journal

MONTHLY

ORIGINAL ARTICLE

REVIEW ARTICLE

By Walailak Chaiyasoot, et al.



Indexed by

Scopus®



Thai Association for Gastrointestinal Endoscopy



International Association of Surgeons
Gastroenterologists & Oncologists
Thailand Chapter



<https://he02.tci-thaijo.org/index.php/sirirajmedj/index>

E-mail: sijournal@mahidol.ac.th



First Editor: Ouay Ketusingh **Emeritus Editors:** Somchai Bovornkitti, Adulya Viriyavejakul, Sommai Toongsuwan, Nanta Maranetra, Nippon Pongvarin, Prasit Watanapa, Vithya Vathanophas, Pipop Jirapinyo, Sanya Sukpanichnant, Somboon Kunathikom

Executive Editor: Prasit Watanapa

Editorial Director: Manee Rattanachaiyanont

Managing Editor: Gulapar Srisawasdi, Chenchit Chayachinda

Editor-in-Chief: Thawatchai Akaraviputh

Associate Editor: Varut Lohsiriwat, Prapat Wanitpongpan

Online Editor: Puttinun Patpituck

International Editorial Board

Philip Board (Australian National University, Australia)
Richard J. Deckelbaum (Columbia University, USA)
Yozo Miyake (Aichi Medical University, Japan)
Yik Ying Teo (National University of Singapore, Singapore)
Harland Winter (Massachusetts General Hospital, USA)
Philip A. Brunell (State University of New York At Buffalo, USA)
Noritaka Isogai (Kinki University, Japan)
Yuji Murata (Aizenbashi Hospital, Japan)
Keiichi Akita (Tokyo Medical and Dental University Hospital, Japan)
Shuji Shimizu (Kyushu University Hospital, Japan)
David S. Sheps (University of Florida, USA)
Robin CN Williamson (Royal Postgraduate Medical School, UK)
Tai-Soon Yong (Yonsei University, Korea)
Anusak Yiengpruksawan (The Valley Robotic Institute, USA)
Stanley James Rogers (University of California, San Francisco, USA)
Kyoichi Takaori (Kyoto University Hospital, Japan)
Tomohisa Uchida (Oita University, Japan)
Yoshiki Hirooka (Nagoya University Hospital, Japan)
Hidemi Goto (Nagoya University Graduate School of Medicine, Japan)
Kazuo Hara (Aichi Cancer Center Hospital, Japan)
Shomei Ryozaawa (Saitama Medical University, Japan)
Christopher Khor (Singapore General Hospital, Singapore)
Yasushi Sano (Director of Gastrointestinal Center, Japan)
Mitsuhiro Kida (Kitasato University & Hospital, Japan)
Seigo Kitano (Oita University, Japan)
Ichizo Nishino (National Institute of Neuroscience NCNP, Japan)

Masakazu Yamamoto (Tokyo Women's Medical University, Japan)
Dong-Wan Seo (University of Ulsan College of Medicine, Korea)
George S. Baillie (University of Glasgow, UK)
G. Allen Finley (Dalhousie University, Canada)
Sara Schwanke Khilji (Oregon Health & Science University, USA)
Matthew S. Dunne (Institute of Food, Nutrition, and Health, Switzerland)
Marianne Hokland (University of Aarhus, Denmark)
Marcela Hermoso Ramello (University of Chile, Chile)
Ciro Isidoro (University of Novara, Italy)
Moses Rodriguez (Mayo Clinic, USA)
Robert W. Mann (University of Hawaii, USA)
Wikrom Karnsakul (Johns Hopkins Children's Center, USA)
Frans Laurens Moll (University Medical Center Utrecht, Netherlands)
James P. Dolan (Oregon Health & Science University, USA)
John Hunter (Oregon Health & Science University, USA)
Nima Rezaei (Tehran University of Medical Sciences, Iran)
Dennis J. Janisse (Subsidiary of DJO Global, USA)
Folker Meyer (Argonne National Laboratory, USA)
David Wayne Ussery (University of Arkansas for Medical Sciences, USA)
Intawat Nookaew (University of Arkansas for Medical Sciences, USA)
Victor Manuel Charoenrook de la Fuente
(Centro de Oftalmologia Barraquer, Spain)
Karl Thomas Moritz
(Swedish University of Agricultural Sciences, Sweden)
Nam H. CHO (University School of Medicine and Hospital, Korea)

Editorial Board

Watchara Kasinrer (Chiang Mai University, Thailand)
Rungroj Kittayaphong (Siriraj Hospital, Mahidol University, Thailand)
Wiroon Laupattarakasem (Khon Kaen University, Thailand)
Anuwat Pongkunkorn (Lampang Hospital, Thailand)
Nopporn Sittisombut (Chiang Mai University, Thailand)
Vasant Sumethkul (Ramathibodi Hospital, Mahidol University, Thailand)
Yuen Tanniradorn (Chulalongkorn University, Thailand)
Saranatra Waikakul (Siriraj Hospital, Mahidol University, Thailand)
Pa-thai Yenchitsomanus (Siriraj Hospital, Mahidol University, Thailand)
Surapol Issaragrisil (Siriraj Hospital, Mahidol University, Thailand)
Jaturat Kanpittaya (Khon Kaen University, Thailand)
Suneerat Kongsayreepong (Siriraj Hospital, Mahidol University, Thailand)

Pornchai O-Charoenrat (Siriraj Hospital, Mahidol University, Thailand)
Nopphol Pausawasdi (Siriraj Hospital, Mahidol University, Thailand)
Supakorn Rojananin (Siriraj Hospital, Mahidol University, Thailand)
Jarupim Soongswang (Siriraj Hospital, Mahidol University, Thailand)
Suttipong Wacharasindhu (Chulalongkorn University, Thailand)
Prapon Wilairat (Mahidol University, Thailand)
Pornprom Muangman (Siriraj Hospital, Mahidol University, Thailand)
Ampaiwan Chuansumrit
(Ramathibodi Hospital, Mahidol University, Thailand)
Sayomporn Sirinavin
(Ramathibodi Hospital, Mahidol University, Thailand)
Vitoon Chinswangwatanakul
(Siriraj Hospital, Mahidol University, Thailand)

Statistician: Saowalak Hunnangkul (Mahidol University, Thailand)

Medical Illustrator: Chananya Hokierti (Nopparat Rajathanee Hospital, Thailand)

Online Assistant: Surang Promsorn, Wilailuck Amornmontien, Hatairat Ruangsuan **Editorial Office Secretary:** Amornrat Sangkaew

SIRIRAJ MEDICAL JOURNAL is published bimonthly, 6 issues a year (Jan-Feb, Mar-Apr, May-Jun, Jul-Aug, Sep-Oct and Nov-Dec) and distributed by the end of the last month of that issue.

SIRIRAJ MEDICAL JOURNAL is listed as a journal following the Uniform Requirements for Manuscripts Submitted to Biomedical Journals (URM) by the International Committee of Medical Journal Editors (ICMJE) since 9 July 2010 [<http://www.icmje.org/journals.html>].

Knowledge, Risk Perception, Precautionary Behavior and Level of Worry towards the 2019 Coronavirus Disease (COVID-19) among Psychiatric Outpatients

Pakpoom Maneepongpermpoon, M.D., Jarurin Pitanupong, M.D.

Department of Psychiatry, Faculty of Medicine, Prince of Songkla University, Hat Yai, Songkhla 90110, Thailand.

ABSTRACT

Objective: To identify level of worry towards COVID-19, and related factors among psychiatric outpatients.

Methods: A cross-sectional study surveyed psychiatric outpatients at Songklanagarind Hospital; from May to June, 2020. The questionnaires composed of; 1) Demographic inquiry 2) COVID-19 knowledge 3) COVID-19 risk perception 4) COVID-19 precautionary behaviors 5) Level of worry towards COVID-19. All data were analyzed using descriptive statistics, and associated factors as to the level of worry towards COVID-19 were analyzed by chi-square and logistic regression.

Results: There were 400 participants; neurosis (60.0%), and non-neurosis (40.0%). The majority of participants were female (62.0%), with a mean age of; 44.5 ± 14.6 years. Almost all participants reported a good score of COVID-19 knowledge (91.8%), and having good precautionary behavior towards COVID-19 (97.5%). Majority of participants had a low risk perception (54.2%) and a low level of worry towards COVID-19 (67.0%). Generalized anxiety disorder and major depressive disorder participants were the 1st and 2nd group who had a high to moderate level of worry towards COVID-19. Aside from, from the multivariate analysis, this study indicated income, psychiatric disorders and risk perception towards COVID-19 were statistically significant associated factors related to levels of worry.

Conclusion: Most psychiatric outpatients had good knowledge, good precautionary behaviors and a low level of worry towards COVID-19; with associated factors to level of worry being income, risk perception and being diagnosed with generalized anxiety disorder. However, major depressive disorder patients should also be concerned.

Keywords: COVID-19; knowledge; perception; psychiatric patient; worry (Siriraj Med J 2021; 73: 1-9)

INTRODUCTION

The 2019 coronavirus disease (COVID-19) epidemic in China became a global health horror, and the rapid spread of the disease raised grave concerns about the future trajectory of the outbreak.¹ In January 2020, the World Health Organization (WHO) declared the COVID-19 epidemic as a public health emergency of international

concern.² In Thailand, on the 13th of January 2020, the first COVID-19 case from Wuhan, Hubei Province, China was imported.³

During the initial phase of the COVID-19 epidemic in China, feelings of extreme vulnerability, uncertainty and threat to life were perceived.⁴ In addition, it caused a profoundly wide range of psychosocial impacts on people

Corresponding author: Jarurin Pitanupong

E-mail: pjarurin@medicine.psu.ac.th

Received 18 August 2020 Revised 24 September 2020 Accepted 25 September 2020

ORCID ID: <http://orcid.org/0000-0001-9312-9775>

<http://dx.doi.org/10.33192/Smj.2021.01>

individually, within the community and on international levels. According to the individual impact level, the study reported that the Chinese people suffered from a moderate to severe psychological impact;^{5,6} such as, fear of falling sick or dying, feelings of helplessness, worrying or anxiety about their family members contracting COVID-19 and stigma. Female gender, student status, specific physical symptoms and poor self-rated health status were significantly associated with a greater psychological impact of the outbreak; causing higher levels of stress, anxiety, depression,⁶ fear and stigma, which might be certainly a consequence of mass quarantine.^{6,7} Some quarantined people expressed psychological concerns including fears about infecting others, being infected themselves or having avoidance behaviors of people and places after quarantine.⁸ Additionally, during the “repair” phase: when the infection was being brought under control, depression and avoidance were evident.⁴

However, during the outbreak of this severely infectious disease, the changing of individual mental health and psychosocial responses to crisis were the major topics that needed essential and adequate handling.⁹ The next emerging outbreak of disease, like COVID-19, may cause the same psychological impact; informed, ignorance, panic,¹⁰⁻¹² fear^{13,14} and misperceived as possible sources for infection,^{9,14} or it may cause different responses. In addition to this, the stigmatization of patients who are perceived as possible sources for infection,⁹ is remarkable.

Psychiatric patients are people with vulnerable mental health, when having significant stress, some patients have maladaptive coping, or use an immature defense mechanism.¹⁵ In the past, the study about psychiatric inpatient’s reaction to the SARS epidemic reported the patients attempted to reduce the effect of stress by living in an “autistic bubble” or by denying it was happening. On the other hand, some patients also psychotically interpreted these stressors.¹⁶ Thereby, psychiatric patients should be protected by adequate caution and sufficient supplies of protective gear.¹¹ However, COVID-19 is a new, emerging, and rapidly evolving situation. This outbreak may impact not only healthy people¹¹⁻¹³, but also those with vulnerable mental health.¹⁷ Studies concerning knowledge, risk perception or concern, precautionary behavior, levels of worry towards COVID-19 and related factors among patients with mental health problems will provide basic, useful information for employment of realistic risk perception, effective precautions, communication through various information sources and psychosocial support frameworks before, during and after a challenging incident.¹⁸⁻²⁰

MATERIALS AND METHODS

Study design

This cross-sectional study explored all psychiatric outpatients, who were diagnosed with generalized anxiety disorder (GAD), panic disorder, major depressive disorder (MDD), schizophrenia and bipolar disorder (BD), at Songklanagarind Hospital, Faculty of Medicine, Prince of Songkla University. The inclusion criteria were psychiatric outpatients, who able to complete all of the questionnaires. Exclusion criteria were patients who had more than one psychiatric diagnosis or comorbidity and were unable or lacked the mental capacity to complete all of the questionnaire, or when it was inconvenient for them to participate or those that wanted to stop doing the questionnaire.

Patients interested in participating in the study, were provided with the rationale and overview of the research, and the researcher called them for an interview, by telephone, later. If, at that time was not convenient for the participants the researcher would request an interview later or stop the interview. Adhering to the policy of strict confidentiality, the signatures of the participants were not required, and all of the participants retained the right to withdraw from the research at any time. After the interview, the participants received the result promptly, and advice, or further management would be provided; if the participants had a high level of worry.

This study was endorsed by The Ethics Committee of the Faculty of Medicine, Prince of Songkla University. (REC:63-166-3-4)

Participants

Using n. for. Survey from R program, the sample size was given as at least 384 subjects. Then the participants were included from all psychiatric outpatients, who had an appointment and were followed up at the psychiatric outpatient clinic; from May to June, 2020. The co-researcher grouped the patients by counting 80 participants per diagnosis. The neurosis group contained patients diagnosed with panic disorder, GAD and MDD. Whereas the non-neurosis group contained patients diagnosed with schizophrenia and BD. Each diagnosis was retrieved from the medical register, which was based on ICD-10 criteria.

Measurement tools

Questionnaire modification was performed by 5 psychiatrists, then content validity was conducted. The questionnaires composed of 5 parts:

1) Personal and demographic inquiry consisting

of gender, age, education level, religion, hometown, marriage status, income and underlying disease.

2) Knowledge towards COVID-19 contained 5 items; etiology; route of infection; nature of disease. Each item was rated into 2-points ranging from "1" (disagree) to "2" (agree).^{5,21} A total score of more than 3 was having good knowledge, and a score of less than 3 was poor knowledge.

3) Risk perception towards COVID-19 contained 6 items; personal and comparative risk of contracting COVID-19 at the same gender, age and living area; personal and comparative beliefs in the ability to prevent COVID-19 and general infectious diseases. Each item was rated into 3-points ranging from "1" (low risk) to "3" (high risk). The total scores ranged from 6 to 18; a score of 6 (low risk perception), 7-12 (moderate risk perception), 13-18 (high risk perception).²²

4) The precautionary behaviors towards COVID-19 were measured by 10 items. The items were: avoiding travel in affected areas, or travel on public transport, eating at food courts or restaurants, going to work or school, shaking hands; wearing mask protection; washing your hands by having taken extra care of cleanliness; health promotion by eating a balance diet, regular exercise and sleeping enough. The total scores ranged from 10 to 30; a score of 10 (poor precaution), 11-20 (moderate precaution), 21-30 (good precaution).²²

5) The level of worry towards COVID-19 contained 5 items; worry about one's own risk of COVID-19; prevention and avoidance behavior; disturbance of daily activity. Each item was rated into 3-points ranging from "1" (no worry) to "3" (high worry).^{22,23} The total scores ranged from 5 to 15; a score of 5-6 (low level of worry), 7-11 (moderate level of worry), 12-15 (high level of worry).²³

Statistical analysis

All data were analyzed, in order to describe the knowledge, risk perception, precautionary behavior and level of worry towards COVID-19, using the descriptive statistic method. The results were presented as average, percentage, frequency, and standard deviation. Associated factors to level of worry towards COVID-19 were analyzed by chi-square and logistic regression.

RESULTS

Demographic characteristics

There were 400 psychiatric outpatients who completed the questionnaires by telephone, 248 were female (62.0%) and 204 were unmarried (51.0%). Overall, the mean age was 44.5 ± 14.6 years. Of the participants, 245 were

employed (61.3%) and the median income (IQR) was 20,000 (20,000-30,000) Baht, per month. In addition, more than a half of the participants (64.5%) had no medical illness. (Table 1)

Knowledge towards COVID-19

Almost all participants had a good score of knowledge towards COVID-19 (91.8%). The mean score of knowledge towards COVID-19, among all participants, was 4.7 ± 0.9 ; whereas, the mean score of knowledge towards COVID-19 among both neurosis and non-neurosis groups was 4.8 ± 0.9 , 4.6 ± 0.9 , respectively. However, when a comparison of the mean scores of knowledge towards COVID-19 between the two groups was made it revealed a statistically significant difference. Schizophrenic disorder participants were the group which had the lowest number of a good score of knowledge towards COVID-19 (77.5%). (Table 2)

In addition, the majority of participants gained their COVID-19 information and knowledge from television, family members and social media (98.8%, 67.0%, 59.5%, respectively). Besides this, the participants felt satisfied with the amount of health information available in media (95.2%).

The risk perception towards COVID-19

According to this survey, more than a half of the participants had low risk perception towards COVID-19 (54.2%). The mean score of risk perception towards COVID-19, among all participants, was 7.8 ± 2.2 ; whereas, the mean score of risk perception towards COVID-19 among the neurosis and non-neurosis group were 8.2 ± 2.4 , 7.2 ± 1.8 , respectively. In addition, there was statistically significant difference of the mean score of risk perception towards COVID-19 between the two groups. (Table 2)

The precautionary behavior towards COVID-19

Almost all participants had good precautionary behavior towards COVID-19 (97.5%). The mean score of precautionary behavior towards COVID-19 among all participants was 24.8 ± 2.3 ; whereas, the mean score of precautionary behavior towards COVID-19 among both the neurosis and non-neurosis group were 25.5 ± 2.2 , 23.9 ± 2.1 , respectively. Among the precautionary behavior towards COVID-19, there was no statistically significant difference between the two groups. (Table 2)

The level of worry towards COVID-19

More than a half of the participants had a low level of worry towards COVID-19 (67.0%). The mean level of worry towards COVID-19, among all participants, was 6.4 ± 1.9 ; whereas, the mean level of worry towards

TABLE 1. Demographic characteristics (n=400).

Demographic characteristics	Number (%)								Chi2 P-value
	All group (n=400)	GAD (N=80)	Neurosis Panic (N=80)	MDD (N=80)	Total (N=240)	BD (N=80)	Schizophrenia (N=80)	Total (N=160)	
Gender									<0.001
Male	152 (38.0)	17 (21.2)	16 (20.0)	28 (35.0)	61 (25.4)	47 (58.8)	44 (55.0)	91 (56.9)	
Female	248 (62.0)	63 (78.8)	64 (80.0)	52 (65.0)	179 (74.6)	33 (41.2)	36 (45.0)	69 (43.1)	
Marital status									<0.001
Single/ Divorce	211 (52.8)	23 (28.7)	36 (45.0)	48 (60.0)	107 (44.6)	38 (47.5)	66 (82.5)	104 (65.0)	
Married	189 (47.2)	57 (71.2)	44 (55.0)	32 (40.0)	133 (55.4)	42 (52.5)	14 (17.5)	56 (35.0)	
Religion									0.84
Buddhism	337 (84.2)	70 (87.5)	66 (82.5)	65 (81.2)	201 (83.8)	70 (87.5)	66 (82.5)	136 (85.0)	
Islam, other	63 (15.8)	10 (12.5)	14 (17.5)	15 (18.8)	39 (16.2)	10 (12.5)	14 (17.5)	24 (15.0)	
Highest level of education									0.01
Primary school and below	119 (29.8)	37 (46.2)	28 (35)	13 (16.2)	78 (32.5)	17 (21.2)	24 (30)	41 (25.6)	
Secondary school	124 (31.0)	13 (16.2)	14 (17.5)	34 (42.5)	61 (25.4)	32 (40.0)	31 (38.8)	63 (39.4)	
Bachelor degrees and above	157 (39.2)	30 (37.5)	38 (47.5)	33 (41.2)	101 (42.1)	31 (38.8)	25 (31.2)	56 (35.0)	
Home province									0.68
Songkhla	261 (65.2)	48 (60)	57 (71.2)	54 (67.5)	159 (66.2)	51 (63.7)	51 (63.7)	102 (63.7)	
Other	139 (34.8)	32 (40)	23 (28.7)	26 (32.5)	81 (33.8)	29 (36.2)	29 (36.2)	58 (36.2)	
Income (Baht/month)									0.19
No salary	135 (33.8)	35 (43.8)	18 (22.5)	37 (46.2)	90 (37.5)	16 (20.0)	29 (36.2)	45 (28.1)	
≤15,000	58 (14.5)	11 (13.8)	14 (17.5)	10 (12.5)	35 (14.6)	10 (12.5)	13 (16.2)	23 (14.4)	
15,001-25,000	134 (33.5)	24 (30.0)	34 (42.5)	19 (23.8)	77 (32.1)	34 (42.5)	23 (28.7)	57 (35.6)	
>25,000	73 (18.2)	10 (12.5)	14 (17.5)	14 (17.5)	38 (15.8)	20 (25.0)	15 (18.8)	35 (21.9)	
Medical illness									1
No	258 (64.5)	38 (47.5)	60 (75.0)	57 (71.2)	155 (64.6)	45 (56.2)	58 (72.5)	103 (64.4)	
Yes	142 (35.5)	42 (52.5)	20 (25.0)	23 (28.7)	85 (35.4)	35 (43.8)	22 (27.5)	57 (35.6)	

Chi2 p-value is comparison between neurosis and psychosis

TABLE 2. Knowledge, risk perception, precautionary behavior and level of worry towards COVID-19 (n=400).

	Number (%)								Chi2 P-value
	All group (n=400)	GAD (N=80)	Neurosis Panic (N=80)	MDD (N=80)	Total (N=240)	Non-neurosis BD (N=80)	Schizophrenia (N=80)	Total (N=160)	
Knowledge									< 0.001
Poor	21 (5.2)	5 (6.2)	2 (2.5)	4 (5.0)	11 (4.6)	2 (2.5)	8 (10.0)	10 (6.2)	
Fair	12 (3.0)	1 (1.2)	0 (0.0)	0 (0.0)	1 (0.4)	1 (1.2)	10 (12.5)	11 (6.9)	
Good	367 (91.8)	74 (92.5)	78 (97.5)	76 (95.0)	228 (95.0)	77 (96.2)	62 (77.5)	139 (86.9)	
Risk perception									<0.001
Low risk	217 (54.2)	35 (43.8)	42 (52.5)	34 (42.5)	111 (46.2)	54 (67.5)	52 (65.0)	106 (66.2)	
Moderate	169 (42.2)	39 (48.8)	35 (43.8)	42 (52.5)	116 (48.3)	25 (31.2)	28 (35.0)	53 (33.1)	
High	14 (3.5)	6 (7.5)	3 (3.8)	4 (5.0)	13 (5.4)	1 (1.2)	0 (0.0)	1 (0.6)	
Precautionary behavior									0.53 ^a
Poor	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	
Moderate	10 (2.5)	2 (2.5)	2 (2.5)	1 (1.2)	5 (2.1)	1 (1.2)	4 (5.0)	5 (3.1)	
Good	390 (97.5)	78 (97.5)	78 (97.5)	79 (98.8)	235 (97.9)	79 (98.8)	76 (95.0)	155 (96.9)	
Level of worry									<0.001
Low	268 (67.0)	39 (48.8)	59 (73.8)	44 (55.0)	142 (59.2)	61 (76.2)	65 (81.2)	126 (78.8)	
Moderate	120 (30.0)	36 (45.0)	19 (23.8)	32 (40.0)	87 (36.2)	18 (22.5)	15 (18.8)	33 (20.6)	
High	12 (3.0)	5 (6.2)	2 (2.5)	4 (5.0)	11 (4.6)	1 (1.2)	0 (0.0)	1 (0.6)	

^aFisher's exact test

Chi2 p-value is comparison between neurosis and psychosis

COVID-19 among the neurosis and non-neurosis groups were 6.8 ± 2.1 , 5.9 ± 1.6 , respectively. Amongst the level of worry towards COVID-19, there were statistically significant differences between the two groups. In addition, GAD and MDD participants were the 1st and 2nd groups who had high to moderate levels of worry towards COVID-19. (Table 2)

The association between demographic characteristics, knowledge, risk perception, precautionary behavior towards COVID-19, and level of worry

Variables, whose p-values from the univariate analysis were lower than 0.2, were included in multivariate analysis. From the multivariate analysis it was indicated that income, psychiatric disorder, and risk perception towards COVID-19 were statistically significant associated factors related to level of worry.

Finally, the participants who had lower income reported more level of worry than the higher income and

unemployed groups. Comparing with GAD participants, other neurosis and non-neurosis participants had lower level of worry towards COVID-19. (Table 3)

DISCUSSION

This survey indicated that the majority of psychiatric outpatients had good knowledge towards COVID-19 as well as which, they perceived that they had a low risk perception towards COVID-19 infection. However, almost all psychiatric outpatients still had good precautionary behavior towards COVID-19. The reason for this outcome might be that all participants were psychiatric outpatients, who might have a few psychological symptoms and more ability to get news or health information than psychiatric inpatients. Besides, all participants were university hospital outpatients who might get more medical data towards COVID-19 than general psychiatric hospital patient. In addition, the majority of schizophrenia and bipolar outpatients at Songklanagarind Hospital had

TABLE 3. Factors associated with moderate to high level of worry towards COVID-19.

Factors	Crude OR (95%CI)	Adjusted OR (95%CI)	P-value LR-test
Income			0.016
≥ 25,000	Reference	Reference	
15,001-25,000	1.34 (0.74,2.42)	1.81 (0.84,3.90)	
≤ 15,000	1.92 (0.95,3.89)	2.83 (1.06,7.51)*	
No income	0.39 (0.20,0.76)	0.70 (0.28,1.72)	
Psychiatric disease			<0.001
GAD	Reference	Reference	
Panic	0.34 (0.17,0.66)	0.18 (0.07,0.46)*	
MDD	0.78 (0.42,1.45)	0.55 (0.22,1.36)	
BD	0.30 (0.15,0.58)	0.30 (0.12,0.80)*	
Schizophrenia	0.22 (0.11,0.45)	0.16 (0.06,0.44)*	
Risk perception			<0.001
Moderate to high risk	Reference	Reference	
Low risk	0.02 (0.01,0.05)	0.03 (0.01,0.06)*	

*Statistical significance

fair to good quality of life, low level of stigma as well as having self-esteem and self-actualization.^{24,25} Moreover, most of the psychiatric patients' caregivers were either; their mother or father or close relatives; who had a low feeling of burden in caring. Hence, they could take care of and help the psychiatric patients to cope or protect themselves towards COVID-19 via adequate caution very well.²⁶ Therefore, the participants in this study had good precautionary behavior and low level of worry towards COVID-19, which was different from the previous study conducted as to the SARS epidemic, in which it reported that psychiatric inpatients attempted to reduce the effect of stress by denying the significance of these stressors.¹⁶

However, the study found the prevalence of moderate to high level of worry towards COVID-19, among the psychiatric outpatients, was 33.0%. Moreover, the GAD participants reported the highest level of worry towards COVID-19, which might be the nature of the disorder. As the previous study, during the COVID-19 epidemic in China, 23.6% neurosis patients with, major depressive disorder, anxiety disorders, mixed anxiety and depressive disorder reported a score of 10 or higher in the DASS-21 anxiety score, indicating the presence of moderate to severe anxiety symptoms.²⁷ Moreover, the related factors to level of worry towards COVID-19 were risk perception towards COVID-19. The higher risk perception of infection was associated with a higher level of worry and protective behavior.^{28,29} Those results were the same as the findings from this study.

In addition, our study identified that unemployed status was significantly associated with low level of worry towards COVID-19. The reason might be due to spending more time at home, so as the risk perception was lower. On the other hand, employed status and stay-at-home orders were associated with greater health anxiety, financial worry and loneliness.³⁰ Therefore, the employed group should be considered as part of the mental health crisis. Furthermore, a high education level was significantly associated with a high level of worry towards COVID-19. More educated patients may have more knowledge, can get more information, so their over-concern might lead to a higher level of worry towards COVID-19. As the previous study showed that the more level of epidemic knowledge, the more level of epidemic worry.²² In contrast; however, some studies have shown that improving knowledge of the epidemic could reduce the fear and anxiety.³¹

Finally, this study showed 91.8% of participants had a good score of COVID-19 knowledge. Moreover, 97.5% of the participants had good precautionary behavior towards COVID-19. In our opinion, Thailand is a country that has

an excellent, primary health care system, which provides for a good capacity to distribute health knowledge, health promotion and prevention towards COVID-19, for all of those living in the Thai population. Hence, all over Thai people can perceive the current health information correctly and in a real time process.

Strengths and limitations

This study had strengths and limitations. To our knowledge, it is the first study that explored coping strategies, knowledge, and levels of psychological problems in people with mental disorders. The study also involved a considerable sample size of the participants with various diagnoses. However, there were some limitations to this study. Regarding the cross-sectional survey, this study employed self-reporting questionnaire's, for individual evaluation via telephone. Because of social distancing policy, we could not perform a face to face interview, so the information might have been led into a bias. In addition, restriction of inpatient admission, therefore, we could not evaluate the inpatient who assumed having more active symptoms. Moreover, this study was quantitative, and the sample size was restricted to only psychiatric outpatients from the university hospital in the lower part of Southern Thailand and psychiatric outpatients from other general psychiatric hospital or clinic were not included. Furthermore, this study surveyed only GAD, panic disorder, MDD, BD and schizophrenia patients whereas, healthy control group was not compared. Thus, it is too soon to generalize nation-wide, or cannot be used for summing up all Thai psychiatric outpatients or inpatients. Besides these factor, the study surveyed in the nearly 'repair' phase of the COVID-19 epidemic in Thailand, thus saying it may not cover all related matters to patient stress, during all phases of this epidemic.

Future recommendations and implications

Henceforward, studies have been recommended to include additional psychiatric outpatients and inpatients at other hospitals, within Thailand. In other words, a multi-center study should be introduced. Furthermore, comparing with normal people, and including other psychiatric patients such as obsessive-compulsive disorder, schizoaffective disorder should be performed. Moreover, other studies should retain more qualitative or in depth methods for specific psychiatric disorders, and survey them during all epidemic phases.

CONCLUSION

Most psychiatric outpatients had good knowledge, good precautionary behavior and a low level of worry

towards COVID-19. Associated factors, as to the level of worry; being income, risk perception and being diagnosed with GAD. However, MDD were the patient whom should be as of as concern.

ACKNOWLEDGEMENTS

This study was fully supported by the Faculty of Medicine, Prince of Songkla University, Thailand. The data analysis were provided by Mrs. Nisan Werachattawan and Ms. Kruewan Jongborwanwiwat. In addition, we would like to show our gratitude to all psychiatric outpatients who collaborated in this survey.

Conflict of interest: The authors declare no conflict of interest.

REFERENCES

- Wang C, Horby P, Hayden F, Gao G. A novel coronavirus outbreak of global health concern. *Lancet* 2020;395:470-3.
- Mahase E. China coronavirus: WHO declares international emergency as death toll exceeds 200. *BMJ* 2020;368: m408.
- World Health Organization. Coronavirus disease (COVID-19) outbreak [Internet]. 2020 [cited 2020 Jan 12] Available from: <https://www.who.int/csr/don/14-january-2020-novel-coronavirus-thailand>.
- Chong M, Wang W, Hsieh W, Lee C, Chiu N, Yeh W, et al. Psychological impact of severe acute respiratory syndrome on health workers in a tertiary hospital. *Br J Psychiatry* 2004;185: 127-33.
- Wang C, Pan R, Wan X, Tan Y, Xu L, Ho C, et al. Immediate psychological responses and associated factors during the initial stage of the 2019 Coronavirus Disease (COVID-19) epidemic among the general population in China. *Int J Environ Res Public Health* 2020;17:1729.
- Rubin G, Wessely S. The psychological effects of quarantining a city. *BMJ* 2020;368: m313.
- Lima C, Carvalho P, Lima I, Nunes J, Saraiva J, Souza R, et al. The emotional impact of coronavirus 2019-Ncov. *Psychiatry Res* 2020;287:112915.
- Reynolds D, Garay J, Deamond S, Moran M, Gold W, Styra R. Understanding, compliance and psychological impact of the SARS quarantine experience. *Epidemiol Infect* 2008;136:997-1007.
- Brug J, Aro A, Oenema A, de Zwart O, Richardus J, Bishop G. SARS risk perception, knowledge, precautions, and information sources, the Netherlands. *Emerg Infect Dis* 2004;10: 1486-9.
- Siegrist M, Zingg A. The role of public trust during pandemics. *European Psychologist* 2014;19:23-32.
- Bish A, Michie S. Demographic and attitudinal determinants of protective behaviors during a pandemic: A review. *Br J Health Psychol* 2010;15:797-824.
- Lau J, Griffiths S, Choi K, Tsui H. Avoidance behaviors and negative psychological responses in the general population in the initial stage of the H1N1 pandemic in Hong Kong. *BMC Infect Dis* 2010;10:139.
- Smith B, Kay V, Hoyt T, Bernard M. Predicting the anticipated emotional and behavioral responses to an avian flu outbreak. *Am J Infect Control* 2009;37:371-80.
- Maunder R, Hunter J, Vincent L, Bennet J, Peladeau N, Leszcz M, et al. The immediate psychological and occupational impact of the 2003 SARS outbreak in teaching hospital. *CMAJ* 2003;168:1245-51.
- Switaj P, Anczeweska M, Chrostek A, Sabariego C, Cieza A, Bickenbach J, et al. Disability and schizophrenia: a systematic review of experienced psychosocial difficulties. *BMC Psychiatry* 2012;9:193.
- Lancu I, Strous R, Poreh A, Kotler M, Chelben Y. Psychiatric inpatients' reactions to the SARS epidemic: an Israeli survey. *Isr J Psychiatry Relat Sci* 2005;42:258-62.
- Xiang Y, Zhao Y, Liu Z, Li X, Zhao N, Cheung T, et al. The COVID-19 outbreak and psychiatric hospitals in China: managing challenges through mental health service reform. *Int J Bio Sci* 2020;16:1741-4.
- Kang L, Ma S, Chen M, Yang J, Wang Y, Li R, et al. Impact on mental health and perceptions of psychological care among medical and nursing staff in Wuhan during the 2019 novel coronavirus disease outbreak. *Brain Behav Immun* 2020;87: 11-7.
- Greenberg N, Docherty M, Gnanpragasam S, Wessely S. Managing mental health challenges faced by healthcare workers during covid-19 pandemic. *BMJ* 2020;368: m1211.
- Chen Q, Liang M, Li Y, Guo J, Fei D, Wang L, et al. Mental health care for medical staff in China during the COVID-19 outbreak. *Lancet Psychiatry* 2020;7: e15-6.
- Takkonen L, Vehkalahti K. Measurement errors in multivariate measurement scales. *J Multivar Anal* 2005;96:172-89.
- Varti A, Oenema A, Schreck M, Uutela A, de Zwart O, Brug J, et al. SARS knowledge, perception, and behaviors: A comparison between Finns and the Dutch during the SARS outbreak in 2003. *Int J Behav Med* 2009;16:41-8.
- Department of Mental Health. Mental Health Crisis Assessment and Treatment Team: MCATT COVID-19 [Internet]. [cited 2020 Jan 12] Available from: <http://galya.go.th/2020/PDF/6manulADMCAATTCOVID19.pdf>
- Wiwattanaworaset P, Pitanupong J. Bipolar patients' quality of life in Songklanagarind hospital. *J Psychiatr Assoc Thailand* 2017;62:229-308.
- Agrasuta T, Pitanupong J. Perceived stigma in patient with schizophrenia and caregiver in Songklanagarind hospital. *Songkla Med J* 2017;35:37-45.
- Pitanupong J, Rueangwiriyanan C. Caregiver burdens in patients with schizophrenia and related factors. *J Ment Health Thai* 2019;27:95-106.
- Fengyi H, Wanqiu T, Li J, Ling Z, Xinling Z, Yiran Z, et al. Do psychiatric patients experience more psychiatric symptoms during COVID-19 pandemic and lockdown? A case-control study with service and research implications for immunopsychiatry. *Brain Behav Immun* 2020;87:100-6.
- Liao Q, Cowling B, Lam W, Ng D, Fielding R. Anxiety, worry and cognitive risk estimate in relation to protective behaviors during the 2009 Influenza A/H1N1 pandemic in Hong Kong: Ten cross-sectional surveys. *BMC Infect Dis* 2014;14:169.
- Leung G, Lam T, Ho L, Ho S, Chan B, Wong I, et al. The impact

- of community psychological responses on outbreak control for severe acute respiratory syndrome in Hong Kong. *J Epidemiol Community Health* 2003;57:857-63. Res 2020;289:113098.
30. Tull M, Edmonds K, Scamaldo K, Richmond J, Rose J, Gratz K. Psychological outcomes associated with stay-at-home orders and the perceived impact of COVID-19 on Daily Life. *Psychiatry Res* 2020;289:113098.
31. Xiang Y, Yang Y, Li W, Zhang L, Zhang Q, Cheung T, et al. Timely mental health care for the 2019 novel coronavirus outbreak is urgently needed. *Lancet Psychiatry* 2020;7:228-9.

Outcomes of Percutaneous Drainage vs. Antibiotic Therapy Alone or Emergency Surgery in Periappendiceal Abscess

Walailak Chaiyasoot, M.D.*, Nunn Jaruthien, M.D.**

*Department of Radiology, Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok, Thailand, **Department of Radiology, Ramathibodi Chakri Naruebodindra Hospital, Mahidol University, Bangkok, Thailand.

ABSTRACT

Objective: To compare the treatment outcomes in patients with periappendiceal abscess who underwent percutaneous drainage, antibiotics therapy alone, or emergency surgery in a single hospital.

Methods: From January, 2013 to December, 2018, a retrospective cohort study was done in 124 patients who were diagnosed as periappendiceal abscess or phlegmon by CT scan in Siriraj Hospital, Bangkok. We evaluated patients' demographics, the abscess characteristics, and the outcomes of treatment including one of the three therapeutic options: image-guided percutaneous drainage, antibiotics alone, or emergency surgery.

Results: Among 124 patients, 44 (35.5%) underwent percutaneous drainage, 57 (46.0%) were treated with antibiotics alone, and 23 (18.5%) underwent emergency surgery. The percentages of patients with successful outcomes were 84.1% in percutaneous drainage, 98.2% in antibiotics treatment alone, and 95.7% in surgery. Antibiotics treatment alone was significantly associated with more successful outcome, with odds ratio (OR) of 9.882 (95% CI 1.162-84.066; P value 0.036), as compared with percutaneous drainage, while surgery showed no significant difference. The length of stay in the percutaneous drainage group (median of 10 days, minimum or maximum of 3 or 67 days) was significantly longer than the antibiotics group (median of 6 days, minimum or maximum of 1 and 53 days) with a P value of 0.008.

Conclusion: The antibiotics treatment alone was significantly associated with more successful outcome and shorter hospital stay than percutaneous drainage in patients with a periappendiceal abscess or a phlegmon. We suggest percutaneous drainage in the patients with larger sized abscess and show no improvement after antibiotics treatment.

Keywords: periappendiceal abscess; phlegmon; percutaneous drainage (Siriraj Med J 2021; 73: 10-16)

INTRODUCTION

Perforated appendicitis resulting in periappendiceal abscess occurs approximately 20% in patients with acute appendicitis and often causes morbidity.¹ A contrast-enhanced computed tomography (CT) scan is a diagnostic tool that can evaluate the feasibility of percutaneous abscess

drainage and can guide the access route of drainage, either transabdominal or transgluteal approach.²

There is no definite treatment guideline for these group of patients, either conservative management (antibiotic therapy alone or antibiotics combined with percutaneous drainage) or emergency surgery.³

Corresponding author: Walailak Chaiyasoot

E-mail: wchaiyasoot@gmail.com

ORCID ID: <http://orcid.org/0000-0003-2892-4064>

Received 13 August 2020 Revised 25 September 2020 Accepted 26 September 2020

<http://dx.doi.org/10.33192/Smj.2021.02>

Percutaneous drainage with intravenous (IV) antibiotics in periappendiceal abscess is an effective and minimally invasive treatment.⁴⁻⁹ However, some patients develop complications after percutaneous drainage leading to prolonged hospitalization or emergency appendectomy. An algorithm for the management of periappendiceal abscesses indicated that, if there is diffuse peritonitis, the patient should undergo immediate surgery. But if there is no peritonitis, the feasibility of percutaneous drainage should determine the management.²

Objectives

The purpose of this study was to compare the outcomes of patients with periappendiceal abscess or phlegmon who were treated by percutaneous drainage, antibiotics alone or emergency surgery, in our university hospital.

MATERIALS AND METHODS

Patient selection

The study protocol was approved by the Institutional Review Board (IRB) of Siriraj Hospital, Mahidol University (Si 423/2019). We retrospectively analyzed all patients who were diagnosed as periappendiceal abscess based on CT findings and confirmed by the patients' discharge summary from January, 2013 to December, 2018. Those patients underwent one of these three treatment options: ultrasound (US) or CT-guided percutaneous drainage, IV and oral antibiotics therapy alone, or surgery. The treatment choice was judged individually by the referring physicians based on the patients' imaging findings. All patients had been treated with antibiotics before and after drainage/surgery until complete course. The patients were classified as percutaneous drainage group if drainage was done within three days after the diagnosis, as recommended by Richmond.² The feasibility of drainage was decided by on-call interventional radiologists.

Among a total of 137 patients whose CT showed periappendiceal abscess or phlegmon, ten patients were excluded due to being transferred to other hospitals. Three were excluded because their final pathological diagnoses resulted in appendiceal or cecal tumor. The remaining 124 patients were included in our study.

Preprocedure CT

A diagnostic CT scan (120 kVp; 300 mA; section thickness, 1.25 mm; pitch, 1.735:1) was conducted on a 64-slice CT scanner (GE Light speed VCT), (GE Discovery), and a 256-MDCT (GE revolution CT). Intravenous contrast-enhanced CT (non-ionic iodinate contrast media 350 mg I/ml) was performed with a dose of 2 ml/kg, and an injection rate of 3 ml/second.

Data collection

The demographic data, abscess characteristics, time interval between percutaneous drainage and surgery, and type of surgical procedures were all recorded.

A periappendiceal abscess is defined as a fluid collection adjacent to the appendix, which has an attenuation of 0-20 Hounsfield units (HU) on CT scan. A phlegmon is defined as an area measuring 20 HU or greater within the periappendiceal fat.

We graded abscess based on Jeffrey, et al.'s classification system.¹⁰ Grade 1 is defined as periappendiceal phlegmon or abscess smaller than or equal to 3 cm. Grade 2 is a well-circumscribed periappendiceal abscess larger than 3 cm. Grade 3 is a large, poorly defined periappendiceal abscess extending to a distant location (pelvic cavity or interloop spaces) and multiple abscesses.

Percutaneous drainage procedures were performed by four experienced interventional radiologists. The details of each procedure are shown in Table 1. The sizes of the catheter (SKATER™ Drainage System, ARGON Medical Devices, Athens) were between 8-12 Fr, depending on the viscosity of the aspirated fluid. Almost all access routes were transabdominal (Fig 1); only one patient had transgluteal route.

TABLE 1. The detail of percutaneous abscess drainage procedures.

Variables	n = 44
Image guidance	
CT guided	8 (18.2%)
US guided	11 (25.0%)
CT and US guided	25 (56.8%)
Technical approach	
Transabdominal	43 (97.7%)
Transgluteal	1 (2.3%)
Catheter size (Fr)	
8 Fr	12 (27.3%)
10 Fr	26 (59.1%)
12 Fr	6 (13.6%)

Data are expressed as number (percentage)

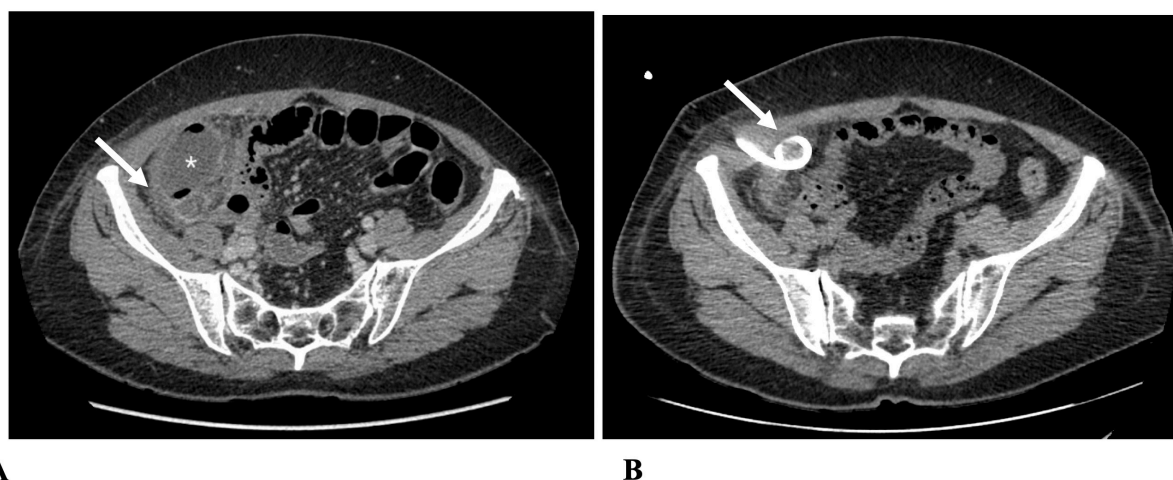


Fig 1. Grade 2 abscess in a 58-year-old female with abdominal pain and diarrhea for 1 week.

(A) Contrast CT showed a well-circumscribed periappendiceal abscess, size 6.1x3.5 cm. with internal air bubbles (*asterisk*) at right lower abdomen. (B) The patient underwent percutaneous transabdominal drainage of abscess. Follow up CT showed resolution of the abscess. Note the drainage catheter (*arrow*)

A successful outcome for percutaneous drainage is defined as the patient recovering after a single drainage by decreasing fluid output (less than 10 ml/day x 3 consecutive days), with a follow-up CT and/or US showing a decreasing size of the abscess, and the patient being discharged from the hospital without surgery. Percutaneous drainage failure is defined when clinical worsening after drainage and need urgent surgery. The patients who later had elective surgery were not classified as percutaneous drainage failure. A successful outcome for antibiotics treatment is defined as the patient's clinical improvement and/or follow-up imaging shows abscess resolution, and the patient being discharged after IV antibiotics given for seven days.² A failed outcome for antibiotic treatment alone are a clinically worsening after treatment and need further percutaneous drainage or urgent surgery. A successful outcome for surgery is defined as patient recovery after a surgery and can be discharged from the hospital. After the first surgical procedure, if a patient required re-admission for antibiotics treatment, percutaneous drainage, or re-surgery, it is defined as surgical failure outcome.

The antibiotic protocols in our hospital were Ceftriaxone, 2 grams IV OD, with Metronidazole; 500 milligrams IV q 8 hours; or Piperacillin/ Tazobactam, 4.5 grams IV q 8 hours for 5-7 days. In the percutaneous drainage group and the surgery group, IV antibiotics were continued after drainage/surgery until 14 days. After discharge from the hospital, all patients received oral antibiotics: Cefdinir, 200 milligrams PO q 12 hours, with Metronidazole, 400 milligrams PO q 8 hours for 7 days.

Statistical analysis

Data were prepared and analyzed using PASW Statistics 18.0 (SPSS Inc., Chicago IL USA). Patients' clinical characteristics were summarized as median (minimum, maximum) for quantitative variables, while numbers and percentages were summarized for qualitative variables. The Mann-Whitney U test was used to compare quantitative variables between the successful and failed groups. The Pearson Chi-square test or Fisher's Exact test was used to compare the qualitative variables between the groups. Backward conditional-binary logistic regression was used to adjust any confounding variables between the treatment and the outcome.

RESULTS

Among 124 patients, 68 were male (54.8%) and 56 were female (45.2%), with a mean age of 53 (a range from 7-93 years). Symptoms onset until admission was 1-30 days (a mean of 5 days).

We categorized the patients into three groups according to the treatment options: 44 people (35.5%) underwent percutaneous drainage; 57 (46.0%) were treated with antibiotics alone, and the remaining 23 patients (18.5%) underwent emergency surgery. The characteristics of the abscesses in each group are shown in Table 2. The abscess size was largest in the percutaneous drainage group (a median size of 6.0 cm.), which had statistically significant difference as compared with the antibiotics-alone and surgery groups.

For the abscess grade, a Grade 1 abscess was found least frequently in the percutaneous drainage group, as compared to the other two groups, with a statistical

TABLE 2. Comparison of patients' demographics and characteristics of abscess in each treatment option; percutaneous drainage, antibiotic (ATB) therapy alone and surgery alone.

Variables	Percutaneous drainage (n = 44)	ATB alone (n = 57)	Surgery (n = 23)	P-value
Abscess size (cm)	6.0 (2.5, 12.3)	3.7 (0.9, 12.0)	3.6 (0.9, 11.0)	<0.001
Abscess grade				
Grade 1	2 (4.5%)	17 (29.8%)	6 (26.1%)	0.005 ^{a,b}
Grade 2	29 (65.9%)	35 (61.4%)	14 (60.9%)	0.875
Grade 3	13 (29.5%)	5 (8.8%)	3 (13.0%)	0.019 ^a
Number of abscess				0.173
Single	35 (79.5%)	52 (91.2%)	18 (78.3%)	
Multiple	9 (20.5%)	5 (8.8%)	5 (21.7%)	
Phlegmon	0 (0.0%)	21 (36.8%)	1 (4.3%)	<0.001
Abscess location				0.021
Right lower quadrant	32 (72.7%)	53 (93.0%)	18 (78.3%)	
Extend to distant location	12 (27.3%)	4 (7.0%)	5 (21.7%)	
Extraluminal air	27 (56.2%)	10 (20.8%)	11 (22.9%)	<0.001
Appendicolith	7 (28.0%)	9 (36.0%)	9 (36.0%)	0.043
Small bowel obstruction	2 (40.0%)	1 (20.0%)	2 (40.0%)	0.352
Length of stay (days)	10 (3, 67)	6 (1, 53)	6 (2, 16)	0.008
Recurrent appendicitis	1 (2.3%)	3 (5.3%)	0 (0.0%)	0.438

Data are expressed as number (percentage), median (minimum, maximum)

^a=Percutaneous drainage and ATB alone, ^b=Percutaneous drainage and surgery

difference (P value 0.005). A Grade 2 abscess was found most frequently in every group, with no statistically significant differences (P value 0.875). A Grade 3 abscess was significantly found much more in the percutaneous drainage group than in the antibiotics-alone group (P value 0.019). The number of abscesses was single more than multiple in every group, with no significant difference. Phlegmon was found most frequently in the antibiotics-alone group. The length of stay for the percutaneous drainage group was significantly longer than for the antibiotics and surgical group.

The successful and failed outcomes for each treatment modality are summarized in Table 3. One patient who failed antibiotics treatment alone underwent appendectomy 15 days later. Another patient had a 6-cm intra-abdominal

collection post-surgery but was successfully treated with antibiotics. After adjusting the confounding variables (abscess grade, location, phlegmon, extraluminal air, appendicolith, and length of stay), the results showed that the antibiotics-alone group had a significantly more successful outcome, with an OR of 9.882 (95% CI 1.162-84.066; P value 0.036) while the surgery group had no significance, with an OR of 4.529 (95% CI 0.521-39.386; P value 0.171), as compared with the percutaneous drainage group.

Total of 124 patients, 65 (52.4%) had an imaging follow-up either CT and/or US and 59 (47.6%) had no imaging follow-up. For the antibiotics-alone group, 26/57 (45.6%) had CT and/or US follow-up. For the percutaneous drainage group, 36/44 (81.8%) had CT

and/or US follow-up before the catheter removal. For the surgical group, 5/23 (21.7%) had CT and/or US follow-up. Table 4 shows the outcomes after percutaneous drainage, indications and types of surgery. The majority of patients with a successful outcome after percutaneous drainage did not undergo surgery (31/44, 70.5%), but 6/44 (13.6%) had an interval appendectomy.

DISCUSSION

Perforated acute appendicitis resulting in periappendiceal abscess can cause major morbidity. The definite treatment guidelines for this disease remain controversial. In our study, we divided patients who were diagnosed as ruptured appendicitis with periappendiceal abscess or phlegmon into three groups by the treatment options: percutaneous drainage, antibiotics therapy

alone, or emergency surgery. In a study by Marin, et al.⁴, percutaneous drainage in patients with perforated acute appendicitis had high clinical and technical success rates up to 90% (37 of 41 patients), with no procedure-related complications. Similar to our study, there was a high successful outcome in percutaneous drainage treatment, 37 out of 44 patients (84.1%), and 56 out of 57 patients (98.2%) who were treated by antibiotics alone. Our study agreed with previous studies that percutaneous drainage resulted in good treatment outcome ranged from 78.6% to 100%.⁵⁻⁸

A meta-analysis by Anderson and Petzold⁹ found that antibiotics treatment alone for periappendiceal abscess had a successful outcome in 93% of the cases, and percutaneous drainage was needed for only 20%. Furthermore, a study by Miftaroski et al.¹¹ found only

TABLE 3. Outcome within treatment options.

Choice	Successful outcome	Failure outcome
Percutaneous drainage (n = 44)	37 (84.1%)	7 (15.9%)
Antibiotics alone (n = 57)	56 (98.2%)	1 (1.8%)
Surgery (n = 23)	22 (95.7%)	1 (4.3%)

TABLE 4. Outcomes after percutaneous drainage.

Outcome	n = 44
Successful outcome	37 (84.1%)
Failure outcome	7 (15.9%)
Time from drainage to surgery (days)	42 (2-298)
Indications and types of surgery	
Interval appendectomy	6 (13.6%)
Exploratory laparotomy with drainage (Failed drainage)	3 (6.8%)
Hemicolectomy (Failed drainage)	4 (9.1%)
Surgery not done	31 (70.5%)

Data are expressed as number (percentage), median (minimum, maximum)

1 out of 15 patients (7%) who had initially successful treatment via combining antibiotics and CT-guided drainage for a perityphlitic appendiceal abscess had recurrent appendicitis. Similar to our study, the risk of recurrent appendicitis was very low as 1 out of 44 patients (2.3%) in the percutaneous drainage group and 3 out of 57 (5.3%) in the antibiotics-alone group, but with no statistical significance (P value, 0.438).

The purpose of our study was to retrospectively compare the outcomes of treatment in patients with periappendiceal abscess or phlegmon who underwent: percutaneous drainage, antibiotics therapy alone, or emergency surgery. Until recently, studies have mostly compared the treatment outcomes between two groups: immediate surgery and non-surgical treatment.^{3,7,12} Those studies revealed a better outcome for the conservatively treated group, with a lower incidence of complications. Kim JK, et al.³ compared the treatment outcomes between emergency operation and antibiotics groups, with or without percutaneous drainage. They showed a good outcome (91.7%) for the conservatively treated group. The only prospective, randomized, controlled trial study that compared the outcomes between percutaneous drainage group and antibiotics-only group was by Zerem et al.,¹³ which included periappendiceal abscesses equal to or >3 cm in diameter. Those researchers concluded that percutaneous drainage with antibiotics treatment was more efficient than antibiotics alone because an appendectomy was less performed in the combined antibiotics and percutaneous drainage group than in the antibiotics-alone group.

In contrast to our study, after adjusting the confounding variables (i.e., abscess grade, location, phlegmon, extraluminal air/ appendicolith, and the length of stay), we found that antibiotics treatment alone was significantly associated with a more successful outcome, with an OR of 9.882 (95% CI 1.162-84.066; P value 0.036), as compared with the percutaneous drainage group. But surgery showed no statistical difference to percutaneous drainage, given its OR of 4.529 (95% CI 0.521-39.386; P value 0.171). As compared the successful outcomes among the three groups, antibiotics treatment alone had a successful outcome of 48.7% (56 out of 115 patients), while the percutaneous drainage group had a successful outcome of 32.2% (37 out of 115 patients), and the surgery group had a successful outcome of 19.1% (22 out of 115 patients). Our result is different from that of Zerem et al.¹³ because we included patients who were diagnosed as phlegmon in 21 out of 57 patients (36.8%) in the antibiotics-alone group, but none of the patients were diagnosed as phlegmon in the percutaneous drainage group. Furthermore, patients

with varying sizes of abscesses were included in our study. We found that the abscess size was largest in the percutaneous drainage group (median size of 6.0 cm.) as compare to the antibiotics-alone and surgical groups which (median size of 3.7 cm. and 3.6 cm. respectively) with a statistically significant difference (P value <0.001). It means that if the abscess is large (equal to or >6 cm), the clinician tends to choose percutaneous drainage as the treatment option rather than giving antibiotic alone or surgery.

Abscess size and grade are according to each other. Table 2 shows that a Grade 1 abscess (equal or <3 cm.) was found least frequently in the percutaneous drainage group, as compared to the other two groups, with a statistical difference. It represents the clinicians' preferring antibiotic or surgical treatment in cases of small sized abscess. In contrast to a Grade 3 abscess (a large abscess or multiple locations) which was significantly found much more in the percutaneous drainage group than in the antibiotics-alone group. It implies that the clinicians tend to consult percutaneous drainage in patients with large sized abscess. Because antibiotics therapy alone may not be effective to get rid of those abscesses and surgical technique may be more difficult in multiple abscesses leading to post-operative recurrence. For a Grade 2 abscess (>3 cm. but localize), which was found equally in every group, without significant differences. So, the choice of treatment in Grade 2 abscess should depend on clinical judgement either percutaneous drainage, antibiotic treatment or surgery.

The study by Zerem et al.¹³ found that the length of hospital stay was significantly shorter in the percutaneous drainage group. But we found longer hospital stay in the percutaneous drainage group (a median of 10 days) than in the antibiotics group (a median of 6 days), with a P value of 0.008. This was due to the fact that some patients with post-percutaneous drainage were hospitalized until no drainage output or imaging follow-up showed abscess resolution, then the drainage catheters were removed before they were discharged.

The limitations in our study are that it's retrospective and has a single-center design. The patients' sample size in each group was rather small. Our result which indicated that antibiotics treatment alone was significantly associated with more successful outcome as compared with percutaneous drainage had an OR of 9.882 and very wide range of confidence interval (95% CI 1.162-84.066). Further research with more sample size is needed to make the results more reliable. Lastly, some of the patients had an incomplete clinical-data record, and approximately 50% of them did not have imaging follow-up.

CONCLUSION

The antibiotics treatment alone was significantly associated with more successful outcome and shorter hospital stay than percutaneous drainage in patients with a periappendiceal abscess or a phlegmon. We suggest percutaneous drainage in the patients with larger sized abscess and show no improvement after antibiotics treatment.

ACKNOWLEDGEMENTS

The authors would like to thank all the interventional radiologists at the Siriraj Center of Interventional Radiology for their support. And also thankful Dr. Sasima Tongsaï for assistance in the statistical analysis.

Conflict of interest: No potential conflict of interest relevant to this article was reported.

REFERENCES

1. Wenzke DR, Jacobs JE, Balthazar EJ, Wehr N. Diseases of the appendix. In: Gore RM, Levine MS, eds. *Textbook of Gastrointestinal Radiology*, Vol 1, 4th ed. United States: Elsevier, 2015.p. 955-83.
2. Richmond B. The appendix. In: Townsend CM, Evers BM, Beauchamp RD, Mattox KL. Sabiston, eds. *Textbook of Surgery*, 20th ed. Canada: Elsevier, 2017.p.1296-311.
3. Kim JK, Ryoo S, Oh HK, Kim JS, Shin R, Kyung E, et al. Management of appendicitis presenting with abscess or mass. *J Korean Soc Coloproctol* 2010;26:413-9.
4. Marin D, Ho LM, Barnhart H, Neville AM, White RR, Paulson EK. Percutaneous abscess drainage in patients with perforated acute appendicitis: effectiveness, safety, and prediction of outcome. *AJR* 2010;194:422-9.
5. Fagenholz PJ, Peev MP, Thabet A, Michailidou M, Chang Y, Mueller PR, et al. Abscess due to perforated appendicitis: factors associated with successful percutaneous drainage. *Am J Surg* 2016;212:794-8.
6. Lasson A, Lundagards J, Loren I, Nilsson PE. Appendiceal abscesses: primary percutaneous drainage and selective interval appendicectomy. *Eur J Surg* 2002;168:264-9.
7. Seif HMA, Reyad HA, Korany M, Metwally M, Ahmed AI. Immediate operation versus percutaneous drainage for treatment of appendicular abscess. *Egypt J Radiol Nucl Med* 2015;46:999-1002.
8. Zhang H, Bai Y, Wang W. Nonoperative management of appendiceal phlegmon or abscess in children less than 3 years of age. *World J Emerg Surg* 2018;13:10.
9. Andersson R, Petzold MG. Nonsurgical treatment of appendiceal abscess or phlegmon: a systematic review and meta-analysis. *Ann Surg* 2007;246:741-8.
10. Jeffrey RB Jr, Federle MP, Tolentino CS. Periappendiceal inflammatory masses: CT-directed management and clinical outcome in 70 patients. *Radiology* 1988;167:13-16.
11. Miftaroski A, Kessler U, Monnard E, Egger B. Two-step procedure for complicated appendicitis with perityphlitic abscess formation. *Swiss Med Wkly* 2017;147:w14422.
12. Gavriilidis P, Angelis ND, Katsanos K, Saverio SD. Acute appendicectomy or conservative treatment for complicated appendicitis (phlegmon or abscess)? A systematic review by updated traditional and cumulative meta-analysis. *J Clin Med Res* 2019;11:56-64.
13. Zerem E, Salkic N, Imamovic G, Terzic I. Comparison of therapeutic effectiveness of percutaneous drainage with antibiotics versus antibiotics alone in the treatment of periappendiceal abscess: is appendectomy always necessary after perforation of appendix? *Surg Endosc* 2007;21:461-6.

The Impact of Glaucomatous Visual Field Defects on Speed and Eye Movements during Reading

Ai-Hong Chen, Ph.D.^{*}, Shauqiah M Jufri, M.Sc.^{*}, Nathan G Congdon, Ph.D.^{**,***}

^{*}Department of Optometry, Faculty of Health Sciences, Universiti Teknologi MARA, Cawangan Selangor, Kampus Puncak Alam, Malaysia,

^{**}Translational Research for Equitable Eyecare (TREE) Center, Centre for Public Health, Queen's University Belfast, United Kingdom, ^{***}Zhongshan Ophthalmic Center, Sun Yat-Sen University, Guangzhou, China.

ABSTRACT

Objective: To investigate the link between glaucomatous visual field defects and reading performance by assessing reading speed and eye movements in reading.

Methods: Eight glaucoma patients and 8 normal-sighted participants were recruited using convenience sampling in this cross-sectional study. The visual field was evaluated using the Humphrey Matrix 24-2. Reading speed was assessed in words per minute using Buari-Chen Malay Reading Chart and the SAH reading passages compendium. Eye movements in reading were recorded using 3D video-oculography.

Results: Glaucoma and control groups displayed significant differences in reading speed ($t=3.12$; $p<0.05$) and fixation ($t=-2.59$; $p<0.05$). Reading speed was significantly correlated with the total defect areas ($r=+0.62$, $p<0.05$) and the types of glaucomatous field defects (Analysis of Variance, ANOVA: $F=4.65$, $p<0.05$). No correlation was apparent in eye movements ($p>0.05$).

Conclusion: The association of defect areas and types with reading speed but not with eye movements might suggest a different coping strategy between eye movement adjustment and reading adaptation in response to visual field defects. Significant association with fixation but not with saccades might indicate that the disengaged and engaged mechanisms of visual attention are affected differently by visual field defects.

Keywords: Glaucoma; visual field defect; reading speed; eye movements (Siriraj Med J 2021; 73: 17-25)

INTRODUCTION

Reading involves the integration of visual information, encompassing visual-spatial skills in locating information, visual recognition of text, and visual encoding of letters, words, and sentences.^{1,2} Intact visual field facilitates visual navigation to locate the text and lines during reading. Visual field defect has been reported to contribute to daily living difficulties among glaucoma patients.^{3,4} Reading ability is generally found to deteriorate in glaucomatous eyes with increasing severity.⁵

The link between glaucomatous visual field loss and reading problems had been established using either a questionnaire approach or experimental design.⁶⁻¹¹ Some studies reported more reading difficulties among glaucoma patients; while other studies found glaucoma patients displayed similar reading performance or better than normal subjects.^{8,12} The discrepancy might denote that the complex mechanism of the relationship. Reading speed varies widely among patients with glaucomatous visual field loss, but does not appear to be predicted by

Corresponding Author: Ai-Hong Chen

E-mail: aihong0707@yahoo.com

Received 25 August 2020 Revised 2 October 2020 Accepted 7 October 2020

ORCID ID: <http://orcid.org/0000-0003-4568-0495>

<http://dx.doi.org/10.33192/Smj.2021.03>

standard measures of visual function such as contrast sensitivity, visual acuity, and visual field damage.^{8,10,12-14} Certain regions of the binocular visual field impairment were associated with reading performance even in patients with preserved visual acuity.¹⁴ The inferior left region of patient integrated visual fields was suggested as important for changing lines during reading.¹⁴

We aimed to further investigate this link between glaucomatous visual field loss and reading performance. In this study, we explored the practicality of examining the reading speed together with the defect types, total defect area, and eye movements simultaneously in patients with glaucomatous visual field loss. We hypothesized that patients with glaucomatous visual field loss would be affected differently by the types of visual field defects and the total defect areas. Different types of reading eye movements were probed to reveal how the eyes navigated during reading. Tracking words during reading is imperative to retrieve information.^{11,15} Visual information is neatly integrated during reading by positioning the eyes to text location.^{8,12} Discontinuities are hardly noticed by readers as the eye moves from one viewing location to the next.^{16,17} The parafoveal information from one fixation is integrated with information from the fovea during the next fixation. Peripheral visual impairment has been reported to compromise reading performance even in readers with preserved central visual acuity.^{8,12} A peripheral vision problem may functionally inhibit a person seeing both ends of the line during reading.^{8,12} Information processing primarily controls when the eyes move, while the oculomotor system control where the eyes move.¹³ Eye movements represent the interface between high-level cognition (language) and the perceptual-motor loop (visual-oculomotor). Reading skills are associated with spatial reading parameters, such as the number of fixations per word, the total number of saccades, and saccadic amplitudes.¹⁷ The eyes are relatively stationary during fixation and all visual input occurs at this time. The reading eye fixates on most content words in a rapid series of fixations (range 50-500 millisecond, ms) and saccades (20-35 ms).¹⁸ When fixated, the eye remains immobile for a brief period on a content word and takes in a span of about seven to nine letters to the right of the fixation and three to four letters to the left before it jumps to the next fixation point.¹⁸ Saccades typically move the eyes forward 7-9-character spaces. More letters are processed to the right of the fixation if the eye is scanning from left to right.¹⁸ Both the detection of words in the center field of vision and awareness of words in the periphery is essential for proficient reading.¹⁹ Diminished function of certain patterns of peripheral visual field

defects might induce more challenges to move from word to word across the line for fluent reading. Different configurations might hurl different levels of struggles to enable readers to process a whole word at once. Visual field defects very close to fixation inhibit reading to a greater extent than peripheral defects, and the central 5° is particularly important for reading.^{11,15} Defects in the inferior left hemifield and peripheral superior hemifield regions of the binocular visual field are related to reading difficulty, with damage to the inferior visual field slowed reading rates more than abnormalities in the superior, nasal or temporal field.^{7,20} Information about the role of eye movements in mediating the effect of the visual field defects on reading difficulty remains inconclusive.

MATERIALS AND METHODS

Ethical approval was obtained from the Research Ethics Committee of University (IRB/IEC Certification 600-RMI (5/1/6) REC/108/15). Our study adhered to the declaration of Helsinki. Written informed consent was obtained. A sample size of 16 participants with an effect size of 1.38 was based on the actual power of study 84% and an α error of 0.05. Sixteen participants were divided into experimental and control groups in this cross-sectional study. The experimental group consisted of eight patients with a diagnosis of glaucoma from the ophthalmology clinic at a public university. The inclusion criteria for the experimental group was the best-corrected LogMAR (Logarithm of the Minimum Angle of Resolution) visual acuity of 0.8 or better; no known neuro-ophthalmic or other retinal or optic nerve conditions likely to affect the visual field. Eight normal sighted subjects with no known vision disorders, no known ocular diseases, and normal visual fields were assigned to the control group. The mean age of participants for experimental and control groups was 64 ± 8 years old and 56 ± 8 years old respectively. Any patients who were unable to read in the Malay language fluently were excluded.

Reading performance was evaluated using "Buari and Chen AH Reading Investigation Apparatus" (BaCA RIA with copyright registration code of CR001460). BaCA RIA consisted of the standardized Malay language reading materials, the Buari-Chen Malay Reading Chart (BCMRC), and the SAH reading passages compendium (SAHRPC).^{21,22} Subjects were instructed to read the BCMRC aloud monocularly from the largest to the smallest print size. The critical print size was the smallest print size as reading speed constant across the larger print sizes from the plateau plot.²³ Critical print size was obtained from a graph plotted using reading speed to determine the print

size for the SAHRPC assessment. Four reading passages from the SAHRPC were employed. The passages from the SAHRPC subtend $41^\circ \times 28^\circ$ of the visual field. The passages contained upper- and lower-case letters and standard punctuation marks. Each had 50 words over 4-5 lines each, printed on A4 matte paper in landscape orientation at a size of 30 x 21 cm in 10-point Arial font, and subtending a visual angle of 0.28° in the lowercase letters. They were randomly selected and positioned at eye level on a reading stand inclined at 45° at a working distance of 40 cm. The total time used to read the whole text was measured. Reading errors (mispronunciations, substitutes, refusals, additions, omissions, and reversals) were recorded. The reading speed was quantified as correct words subtracting the total number of reading errors and divided by the total time taken to read the text in words per minute (wpm). Digital recordings were used for post-reading evaluation of reading time and reading errors.

Eye movements during reading were video recorded using a 3D Video-oculograph (3D-VOG, SensoMotoric Instruments GmbH version 5.0 SP8® 1991-2003, Berlin, Germany). A head-mounted eye tracking device with a built-in infrared light video camera was attached to a goggle and linked to a computer workstation. The computer workstation was integrated with MS Windows version 5.04.02 with stimulus software. The monitor screen resolution was set at 1024 x 768 pixels with a refresh rate of 60Hz and 32-bit color depth. The eye position was calibrated on a target positioned at eye level at the primary gaze. Eye movement data were extracted automatically from the 3D-VOG into the spreadsheet.

The visual field was assessed using a Humphrey Matrix visual field analyzer (Carl Zeiss Meditec, Dublin, Calif) with frequency doubling technology program 24-2 threshold protocol. All measurements were taken monocularly. Participants were instructed to press the response button when a stimulus appeared from any direction in the periphery while maintaining central fixation. Visual field result was considered reliable when fixation losses were $<20\%$, false positives were $<15\%$ and false negatives were $<25\%$. The field defects were determined from the pattern deviation plot. The 16 glaucoma eyes were categorized into one of five pre-determined field defect categories: nasal step, arcuate defect, centrocecal, pre-perimetric, or advanced.

The statistical analysis was conducted using SPSS comparing normal and glaucoma using independent t-test depending on the test of normality Shapiro-Wilk. Further analysis of the types of glaucomatous visual field defects was performed using Analysis of Variance

(ANOVA). The relationship of total defect area with eye movements and reading speed was examined using Pearson correlation analysis. A p-value ≤ 0.05 was used as the criterion of statistical significance.

RESULTS

A comparison between experimental and control groups was summarized in Table 1. Fixation in reading is a point where the eyes come to rest during reading. In this study, the total number of eye fixations during the reading of the entire text was recorded to indicate the efficiency of reading performance. Readers with fewer eye fixations were assumed to take in more words with each fixation. Fixation counts showed a significant increase in glaucoma eyes. Therefore, glaucoma eyes were less efficient in reading than normal eyes due to higher fixation count. Meanwhile saccadic and regression showed no significant difference between glaucoma and normal eyes. Reading speed was significantly lower in glaucoma eyes.

The contributing factors for the difference found between control and glaucoma eyes were dissected from the perspectives of total defect area in percentages (Table 2) and the types of visual field defects (Table 3). The main feature of glaucoma pathogenesis is the progressive degeneration of retinal ganglion cells that leads to irreversible optic nerve damage and eventually vision field loss. The progression of visual field loss can be captured in terms of threshold sensitivity changes and total field defect areas. Hypothetically, those with more field defect areas should have experienced the defect for a longer period. In contrast, those at the early stage of glaucoma (early arcuate and pre-perimetric) supposedly had experienced the defect for a shorter period. The faster reading speed might connect to the duration of adaptation concerning the progressive degeneration of retina ganglion cells. The advanced glaucoma eye displayed the least fixation counts and the fastest reading speed seemed to support further the adaptive reading ability to longer duration of adaptation.

The arcuate defect was the most common ($10/16=62.5\%$), followed by pre-perimetric and nasal step ($2/16=12.5\%$ each). The reading speed differed significantly for the various types of glaucomatous field defects (ANOVA: $F_{(2,1985)} = 4.90, p < 0.05$). Post-hoc analysis showed slower reading speed in pre-perimetric and early arcuate defects; while advanced defects displayed the fastest reading speed. Fixation counts also differed significantly in different field defects (ANOVA: Welch's $F_{(3,5,965)} = 5.32, p < 0.05$). Post-hoc analysis revealed higher fixation counts in nasal steps, followed by pre-perimetric, centrocecal, and

TABLE 1. Comparison of reading speed and eye movements between normal and glaucomatous eyes.

Parameters of investigation		Control Mean $\pm$ SD	Glaucoma Mean $\pm$ SD	t-test
Reading speed (wpm)		101.0 $\pm$ 29.8	71.9 $\pm$ 22.7	t=3.12; p<0.05
Eye movement [counts (n)]	Fixation	46.3 $\pm$ 14.2	61.3 $\pm$ 18.2	t=-2.59; p<0.05
	Saccadic	28.9 $\pm$ 8.82	24.4 $\pm$ 9.62	t=1.39; p>0.05
	Regression	14.1 $\pm$ 6.13	12.2 $\pm$ 7.16	t=0.82; p>0.05

Abbreviations: SD - standard deviation; wpm - words per minute

TABLE 2. Comparison of total defect area and the relationship with eye movement counts and reading speed measurements for 16 glaucomatous eyes.

Eye Code	Total defect area* (%)	Eye movements (counts, n)			Reading speed (wpm)
		Fixations	Saccades	Regressions	
G01	44	37	16	4	114
G02	39	65	24	24	84.0
G03	33	77	26	10	105
G04	19	73	36	11	93.0
G05	44	81	34	24	77.4
G06	43	88	26	18	44.9
G07	35	69	27	2	99.9
G08	28	69	15	8	57.2
G09	22	36	17	13	70.9
G10	35	49	21	7	76.2
G11	22	55	11	10	76.1
G12	13	28	16	6	44.9
G13	6	62	41	21	49.1
G14	11	62	41	21	49.1
G15	24	85	12	7	48.5
G16	69	45	25	9	114

*Calculated as the number of depressed points in the field/54 x 100%

Abbreviation: wpm - words per minute

TABLE 3. Comparison of the types of glaucomatous field defects and the relationship with eye movement counts and reading speed measurements for 16 glaucomatous eyes.

Types of Glaucomatous Field Defect	n	Percentages from a total of 16 eyes	Eye movements (counts, n)			Reading Speed (words/min)
			Fixation	Saccade	Regression	
Nasal step	2	12.5%	81	19	8.5	77.0
Arcuate defect*	10	62.5%	64	25	14	76.7
• Early arcuate	(1)	6.25%	62	41	21	49.1
• Partial arcuate	(6)	37.5%	59	22	13	80.5
• Full Arcuate	(3)	18.8%	73	25	11	78.2
Centrocecal	1	6.25%	49	21	7	76.2
Pre-perimetric	2	12.5%	45	29	14	47.0
Advanced	1	6.25%	45	25	9	114

*Arcuate defect was subcategorized to early arcuate, partial arcuate, and full arcuate according to progression stages

Abbreviation: Min- minutes

advanced glaucomatous visual field defects (Games-Howell test=31.8, 95% CI [3.74, 59.85], $p<0.05$). However, the saccadic and regression counts showed no significant difference (ANOVA: Saccadic, $F_{(3, 61.55)}=0.598$, $p>0.05$; and regression, $F_{(3, 17.05)}=0.284$, $p>0.05$).

Further analysis was conducted to examine the directional element of glaucomatous defects and their impact on reading speed and eye movements. Two eyes [early arcuate (G14) and pre-perimetric (G13)] were excluded due to the nature of the defect that was unable to be categorized. For horizontal defect impact analysis, 7 eyes suffered defect in the right region, and 7 eyes displayed in the left region. For vertical defect impact analysis, 6 eyes were categorized as visual field defect at the superior region, 5 eyes were categorized as visual field defect at the inferior region and 3 eyes were categorized as mixed. Neither reading speed ($t = -0.97$, $p>0.05$) nor eye movements differed significantly by horizontal locality of visual field defect [Fixation ($t=-0.66$, $p>0.05$); Saccadic ($t=-0.40$, $p>0.05$); Regression ($t=0.99$, $p>0.05$)]. Vertical defect impact analysis concluded similarly [ANOVA: Fixation ($F=0.07$, $p>0.05$); Saccadic ($F=1.14$, $p>0.05$); Regression ($F=0.41$, $p>0.05$); Reading speed ($F=1.09$, $p>0.05$)].

The correlation of the total percentages of the defect areas with eye movements and reading speed was shown in Fig 1. The total defect area caused a significant positive correlation with reading speed ($r=+0.62$, $p<0.05$). Reading speed was found to be faster with an increment of the total defect area. Meanwhile, none of eye movements was found to correlate with total defect area [fixation ($r=+0.05$, $p>0.05$); saccadic ($r= -0.16$, $p>0.05$); regression ($r= -0.11$, $p>0.05$)].

DISCUSSION

Difficulties with reading in glaucoma affect quality of life.²⁴ Glaucomatous VFD has been associated with more fixations, longer search time, more errors, shorter fixation durations, and longer reading duration.^{8,16} Our finding is in agreement with previous studies that reported slower reading speed in glaucoma than normal.^{8,9} Normal eyes in our study read 30 words more per minute than glaucoma eyes using SAHRPC. Decrement of reading speed in glaucoma eyes might due to the restricted visual span (field of view) during reading. Glaucoma eyes with peripheral visual field defects have a smaller field of view than normal eyes, which might cast difficulty to read from one word to another word efficiently.

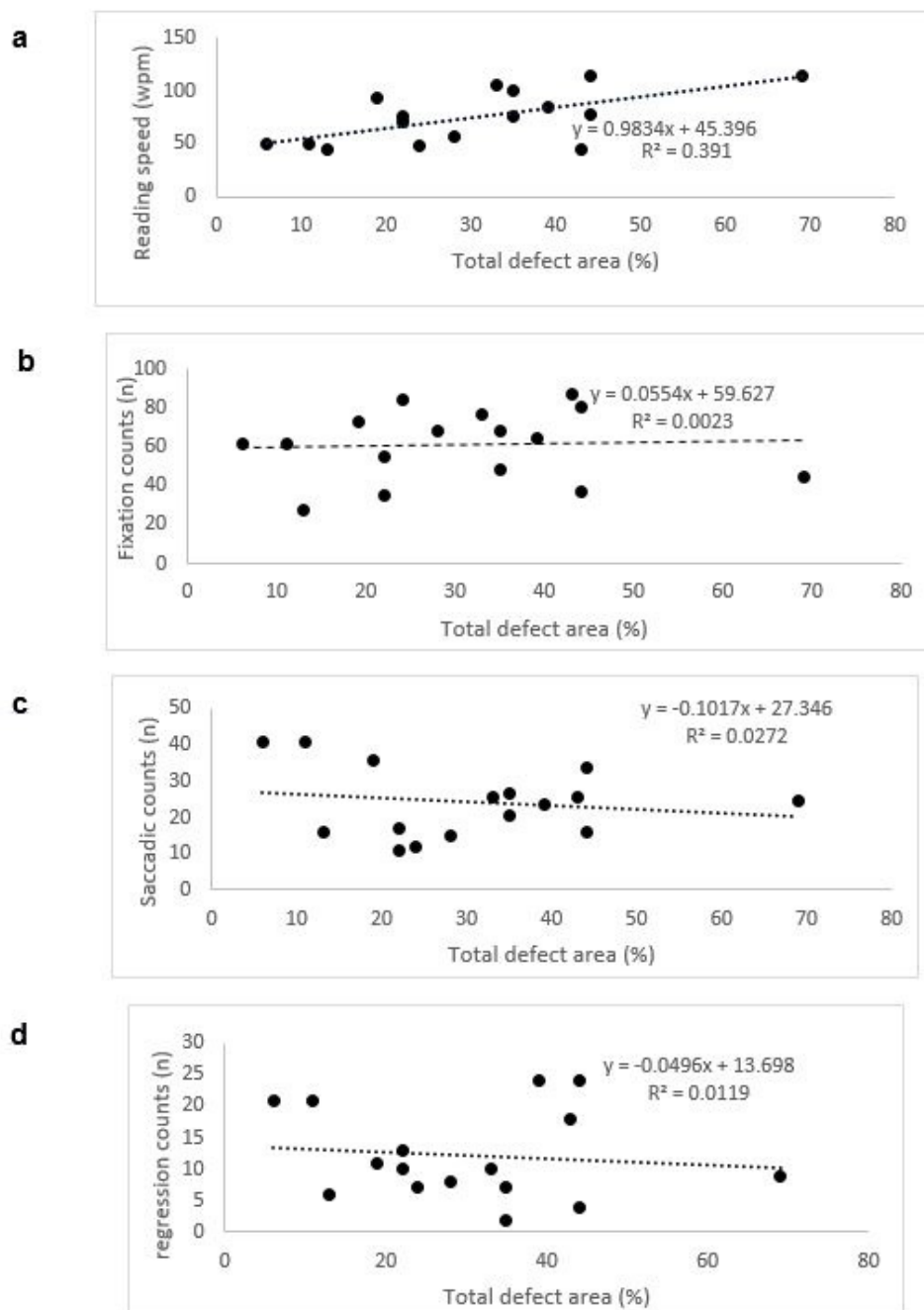


Fig 1. Correlation of total defect area with eye movements and reading speed. (a) reading speed, (b) fixation, (c) saccade, and (d) regression

Undeniably that some readers with glaucomatous visual field defects experienced more difficulties with reading; while others remained the same or better than readers with normal vision.^{3,8,9,12} This ambiguity probed us to further examine the eye movements and reading speeds concerning different types of glaucomatous visual field defects and different sizes of defect areas in comparison to normally sighted subjects. Our findings seem not to align fully with previous studies because eye movements remained the same as the increment of the total defect area. We expect otherwise because the peripheral visual

defect was reported to compromise reading performance despite preserved fovea acuity.¹⁶ The slower reading speed in glaucoma was reported to correlate with the reduction of the visual field.⁹ Greater visual field defects had been associated with greater self-reported difficulty finding the next line of text while reading.^{5,9} This dissimilarity of our findings with previous studies might indicate the potential of visual adaptation. The key feature of glaucoma pathogenesis is the progressive degeneration of retinal ganglion cells.²⁵ Understandably, visual defect worsens over time. The progression of visual field loss is

usually reported as threshold sensitivity changes and total field defect areas.²⁶ Those with more field defect areas logically has experienced the defect for a longer period. The faster reading speed might connect to the duration of adaptation concerning the progressive degeneration of retina ganglion cells. Adaptation might happen to cope with the visual challenges in daily activities. Our findings might denote the possibility of visual adaptation in glaucoma. Glaucoma was associated with a reduction in contrast detection and discrimination adaptation in the early stages.²⁷ Reduction of visual acuity or contrast sensitivity caused slower reading speed in glaucoma.²⁸ Our findings might suggest that reading speed reduction in the early stages of glaucoma might be just transient evidence of coping mechanisms being established. The brain can be rehabilitated.²⁹⁻³⁰ Neuroplasticity research reveals the ability of the brain to adapt continuously throughout life.³¹⁻³² The brain exhibited enormous capacities to adapt to damage. The repetitive visual training in daily activities might give an impact on visual learning in glaucoma.³³

Our analysis of reading speed and eye movements concerning glaucomatous field defects also revealed something interesting about the relationship. Besides reading speed, only fixation but not saccades or regressions were found to vary significantly with different types of glaucomatous field defects. Fixation in reading is a point where the eyes come to rest during reading. Reading is not just fixating on one word after another, but rather requires a complex series of fixations to see complete texts.³⁴ Readers who make fewer eye fixations read faster because they take in more words with each fixation. The visualization of a complete text during reading can benefit from an intact visual field and efficient eye movements. Peripheral visual field defect has been reported to obstruct readers to see both ends of the line during reading.¹⁶

Before the reader begins to fixate at the first word in the text, the eyes scan across the reading materials to locate the first word of a text. Spatial reading parameters, such as the number of fixations per word, the total number of saccades have been tied to reading performance.¹⁷ If visual search plays a role in reading performance, the left or superior defect areas would have reduced the reading speed more than right or inferior defect areas with the presumption that more efforts are required to locate the text situated at the left and superior region due to the defect. The inferior field has been regarded as an important positioning for reading.^{7,11,14} The inferior left region has been indicated as important for changing lines during reading.¹⁴ Reading speed had been reported to be faster in the inferior field compared to other areas in normal readers.⁷ Hypothetically, the right-field defect or inferior field defect should have a more negative impact on reading speed.^{7,35} Conversely, our findings were not in agreement with the previous report that reading was neither more affected with the presence of right than left field defects nor more affected in the inferior field defect.³⁵ Our horizontal and vertical field analyses revealed that the location of field defects did not seem to play a significant role in determining reading speed. Perhaps not the locality or sizes that determined the outcomes but the individual reading difficulty coping or adaptation mechanism that dictated the outcome. Parafoveal information from one fixation is connected to the information from the fovea in the next fixation during readings.¹⁶ The integrated activities between the fovea and parafoveal during fixations are illustrated in Fig 2.^{14,36,37} Parafoveal view gives readers partial information of what is to come next. If this reading assumption is correct, the right visual field defect would affect the reading performance too.

```

+++++
+++++Research in pe+++++
+++++pediatric vision ca+++++
+++++triv vision care+++++
+++++

```

Fig 2. Illustration of the integrated activities between fovea and parafovea during fixations. Bold letters denote fixations (what the eye is seeing directly in its foveal view). Underlined letters signify what is subconsciously processed during a fixation (not what readers see directly)

One possible explanation of our findings was visual adaptation through perceptual learning.³³ Different coping mechanism might be used to overcome the hindrances caused by visual field defect strategy. When the central vision was compromised, eccentric fixation might be used in the visual rehabilitation of the visual field defect. Scanning involving parafoveal and peripheral visual field is crucial to navigating reading. Patients with visual field defects might have adapted to the condition with adjusted eye and head movements or compensatory gaze strategies to improve reading performance.^{33,38,39}

Fixations and saccades denote how readers acquire information. Visual attention can be in an engaged or disengaged state.⁴⁰ To move from one point to another, visual attention should be in the disengaged state. During engaged visual attention, saccades were inhibited to provide steady central fixation. The disengaged mechanism seemed to be intact (insignificant saccadic finding in our study) during visual search in reading despite visual field defects. A different coping inclination between eye movement adjustment and reading adaptation might occur in response to visual field defects. Future research with additional measurements on the time length of each eye movement is essential. Time length for saccade can estimate how fast the eye moves between fixations. Time length for regression predicts the effort required to reread a line of text.

In conclusion, reading speed and fixation were affected by different types of glaucomatous visual field defects patterns. The association of defect areas with faster reading speed but not significant in eye movements might suggest a possible different coping strategy between eye movement adjustment and reading adaptation in response to visual field defects.

ACKNOWLEDGMENTS

This study was funded by the Research Entity Initiative [600-IRMI/REI 5/3 (016/2018)]. Thanks to Prof Liza-Sharmini Ahmad Tajudin for constructive comments. Special thanks to Noor Halilah Buari & Ethan Hoe Tzong Shuen for technical supports.

Conflict of interest: All authors have no conflict of interest.

REFERENCES

1. Pammer K, Hansen PC, Kringelbach ML, Holliday IE, Barnes G, Hillebrand A, et al. Visual word recognition: the first half second. *Neuroimage* 2004;22:1819-25.
2. Singleton C, Henderson LM. Visual factors in reading. *London Rev Education* 2006;4:89-98.
3. Maharajah KR, Tet CM, Yaacob A, Tajudin LSA, Foster PJ. Modified Bahasa Malaysia version of VF-14 questionnaire: assessing the impact of glaucoma in rural area of Malaysia. *Clin Exp Ophthalmol* 2008;36:222-31.
4. Ramulu P. Glaucoma and disability: which tasks are affected, and at what stage of disease? *Curr Opin Ophthalmol* 2009;20:92-8.
5. Lester M, Zingirini M. Quality of life in patients with early, moderate and advanced glaucoma. *Eye* 2002;16:44-9.
6. Freeman EE, Muñoz B, West SK, Jampel HD, Friedman DS. Glaucoma and quality of life: the Salisbury Eye Evaluation. *Ophthalmol* 2008;115:233-8.
7. Murata H, Hirasawa H, Aoyama Y, Sugisaki K, Araie M, Mayama C, et al. Identifying areas of the visual field important for quality of life in patients with glaucoma. *PLOS ONE* 2013;8:e58695.
8. Ishii M, Seki M, Harigai R, Abe H, Fukuchi T. Reading performance in patients with glaucoma evaluated using the MNREAD charts. *Jpn J Ophthalmol* 2013;57:471-4.
9. Ramulu PY, West SK, Munoz B, Jampel HD, Friedman DS. Glaucoma and reading speed. *Arch Ophthalmol* 2009;127:82-7.
10. Roberts K, Haymes S, Leblanc R, Nicoletta M, Chauhan B, Artes P. Contrast sensitivity, visual acuity, reading speed and macular visual field damage in glaucoma. *Investig Ophthalmol & Vis Sci* 2005;46:4665.
11. Tabrett DR, Latham K. Important areas of the central binocular visual field for daily functioning in the visually impaired. *Ophthalmic Physiol Opt* 2012;32:156-63.
12. Altangerel U, Spaeth GL, Steinmann WC. Assessment of Function Related to Vision (AFREV). *Ophthalmic Epidemiol* 2006;13:67-80.
13. Burton R, Crabb DP, Smith ND, Glen FC, Garway-Heath DF. Glaucoma and reading: exploring the effects of contrast lowering of text. *Optom Vis Sci* 2012;89:1282-7.
14. Burton R, Saunders LJ, Crabb DP. Areas of the visual field important during reading in patients with glaucoma. *Jpn J Ophthalmol* 2015;59:94-102.
15. Whittaker SG, Lovie-Kitchin J. Visual requirements for reading. *Optom Vis Sci* 1993;70:54-65.
16. Burton R, Smith ND, Crabb DP. Eye movements and reading in glaucoma: observations on patients with advanced visual field loss. *Graefes Arch Clin Exp Ophthalmol* 2014;252:1621-30.
17. Krieger M, Bartl-Pokorny K, Pokorny F, Einspieler C, Langmann A, Korner C, et al. The Relation between reading skills and eye movement patterns in adolescent readers: evidence from a regular orthography. *PLoS One* 2016;11:e145934.
18. Rayner K. Eye movements in reading and information processing: 20 years of research. *Psychol Bull* 1998;124:372-422.
19. Jampel HD, Friedman DS, Quigley H, Miller R. Correlation of the binocular visual field with patient assessment of vision. *Invest Ophthalmol Vis Sci* 2002;43:1059-67.
20. Cummings R, Rubin G. Reading speed and saccadic eye movements with an artificial paracentral scotoma. *Invest Ophthalmol Vis Sci* 1993;34:1318.
21. Buari NH, Chen AH. Buari-Chen Malay Reading Chart (BCMRC): Contextual Sentence and Random Words 2-in-1 Design in Malay Language. *Pertanika J Sci & Technol* 2017;25:135-50.

22. Chen AH, Buari NH, Jufri S. The development of SAH reading passage compendium: A tool for the assessment of reading performance related to visual function. *Int Educ Stud* 2017;10: 30-37.
23. Legge GE, Pelli DG, Rubin GS, Schleske MM. Psychophysics of reading: I. Normal vision. *Vis Res* 1985;25:239-52.
24. Goldberg I. Visual disabilities and quality of life in glaucoma patients. *Clin Exp Ophthalmol* 2004;32:18-20.
25. Wilson MR. progression of visual field loss in untreated glaucoma patients and suspected in St Lucia, West Indies. *Trans Am Ophthalmol Soc* 2002;100:365-410.
26. Su WW, Hsieh SS, Cheng ST, Su CW, Wu WC, Chen HSL. Visual Subfield Progression in Glaucoma Subtypes. *J Ophthalmol* 2018;2018:7864219. <https://doi.org/10.1155/2018/7864219>.
27. Lek J, Vingrys A, Mckendrick A. Rapid contrast adaptation in glaucoma and aging. *Invest Ophthalmol Vis Sci* 2014;55: 3171-8.
28. Rubin GS, Legge GE. Psychophysics of reading. VI--The role of contrast in low vision. *Vis Res* 1989;29:79-91.
29. Livingston LB. Brain mechanisms in conditioning and learning. *Neurosci Res Program Bulletin* 1966;4:349-54.
30. Sasmita AO, Kuruvilla J, Ling APK. Harnessing neuroplasticity: modern approaches and clinical future. *Int J Neurosci* 2018; 128:1061-77.
31. Voss P, Thomas ME, Cisneros-Franco JM, Villers-Sidani E. Dynamic Brains and the Changing Rules of Neuroplasticity: Implications for Learning and Recovery. *Front Psychol* 2017;8:1-11.
32. Hess RF, Thompson B. New insights into amblyopia: binocular therapy and noninvasive brain stimulation. *J AAPOS* 2013;17: 89-93.
33. Mueller I, Mast H, Sabel BA. Recovery of visual field defects: a large clinical observational study using vision restoration therapy. *Restor Neurol Neurosci* 2007;25:563-72.
34. Mishra RK. Attention in sentence processing: a review. *Psychological Stud* 2013;58:308-17.
35. Rayner K, Well AD, Pollatsek A. Asymmetry of the effective visual field in reading. *Percept Psychophys* 1980;27:537-44.
36. Moats LC, Tolman C. Language essentials for teachers of reading and spelling (LETRS), Module 1: the challenges of learning to read, 2nd ed. Longmont: Sopris West, 2009.
37. Weekley TW. The impact of word-study intervention strategies on students' measures of reading comprehension and fluency. *Electronic Theses and Dissertations* 2017. [Cited 2020 April 18] Available from: <https://egrove.olemiss.edu/etd/493>.
38. Sabel BA, Gudlin J. Vision restoration training for glaucoma: a randomized clinical trial. *JAMA Ophthalmol* 2014;132:381-9.
39. Proudlock FA, Shekhar H, Gottlob I. Coordination of eye and head movements during reading. *Invest Ophthalmol Vis Sci* 2003;44:2991-8.
40. Fisher B, Breitmeyer BG. Mechanisms of visual attention revealed by saccadic eye movements. *Neuropsychologia* 1987; 25:73-83.

Relationship Between Vesicoureteral Reflux and Renal Scarring in Children with Urinary Tract Infection

Preeyacha Pacharn, M.D., Benjapa Khiewvan, M.D., Utarat Kaewumporn, M.D.

Department of Radiology, Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok 10700, Thailand.

ABSTRACT

Objective: To evaluate the association of vesicoureteral reflux (VUR) in comparison with the development of renal scarring in child patients with urinary tract infection (UTI).

Methods: This study involved a retrospective review. Patients under 14 years old with a diagnosis of UTI with a positive urine culture and who had a voiding cystourethrogram (VCUG) and technetium 99 m dimercaptosuccinic acid (Tc-99m-DMSA) renal scintigraphy performed within 4-6 months after acute UTI were included in the study. The VCUG results were classified as positive or negative for vesicoureteral reflux (VUR). If reflux was present, the severity was graded according to the recommendation of the International Reflux Study in children.¹ The Tc-99m DMSA results were interpreted as positive or negative for renal scarring. Statistical analysis was performed using the χ^2 test or Fisher's exact test and Mann-Whitney test to compare the presence of VUR and renal scarring as well as the grading of the VUR and renal scarring. Positive and negative likelihood ratios (LR) were calculated.

Results: In total, 185 patients (74 girls and 111 boys; mean age, 3.5 years old) were included in the study. There were five children with only a single kidney, resulting in 365 kidneys for analysis. Vesicoureteral reflux was found in 203 (55.6%) kidneys, classified as grades 1, 2, 3, 4, and 5 in 19, 31, 81, 38, and 34 kidneys, respectively. Scarring was found in 110 of 203 kidneys (54.2%) with VUR and in 18 of 162 kidneys (11.1%) without VUR ($p < 0.0001$). The LR positive was 2.2 (95%CI, 1.9-2.5) and LR negative was 0.23 (95% CI, 0.1-0.4).

Conclusion: There was a significant correlation between positive VUR and the development of renal scarring. Patients with positive VUR should be considered for a Tc99m-DMSA scan to evaluate them for the development of renal scarring.

Keywords: Vesicoureteral reflux; VUR; renal scar; urinary tract infection; UTI (Siriraj Med J 2021; 73: 26-31)

INTRODUCTION

Urinary tract infection (UTI) is a common cause of acute illness in infants and children. The infection may involve the upper part of the urinary tract (kidneys and ureters) or the lower urinary tract (bladder and urethra). Patients with renal infection or pyelonephritis may develop renal scarring, hypertension, and end-stage

renal dysfunction later in life. It is mandatory to identify these patients with acute pyelonephritis to prevent further renal damage. Clinically, urinary tract infection with the presence of fever increases the probability of renal involvement. Moreover, there is an increased risk of underlying urologic abnormalities as well as a greater risk of consequent renal scarring.²

Corresponding author: Preeyacha Pacharn

E-mail: ppacharn@gmail.com

Received 18 May 2020 Revised 23 June 2020 Accepted 22 July 2020

ORCID ID: <http://orcid.org/0000-0003-3696-9107>

<http://dx.doi.org/10.33192/Smj.2021.04>

Renal scarring is considered a cause of long-term morbidity. The prevalence has been reported to be about 10-40%.³ Young age, delayed treatment, the presence of vesicoureteral reflux (VUR), and recurrent episodes of pyelonephritis are associated with an increased risk of renal damage.

In children with UTI, the most important reason for performing an investigation is to identify abnormalities of the genitourinary tract that may require additional evaluation and management.

Renal and bladder ultrasonography is a noninvasive procedure and is always the first line of investigation. The size and shape of the kidneys, dilatation of the ureters, and the presence of gross anatomic abnormalities can be demonstrated with this technique. However, it is not reliable in diagnosing renal scarring.⁴

Technetium-99m dimercaptosuccinic acid (Tc-99m DMSA) renal scintigraphy can be used to detect acute pyelonephritis and renal scarring in acute and chronic settings. However, using DMSA as the initial test is more expensive and involves radiation exposure. According to the American Academy of Pediatrics guidance, DMSA is not recommended as a routine evaluation for children with a first UTI.⁵

Voiding cystourethrogram (VCUG) is the study of choice to establish the presence and degree of vesicoureteral reflux (VUR). A prior study reported an approximately 25% to 30% incidence of VUR in children (0 to 18 years old) with a first UTI.⁶ Even though VUR is a significant risk factor for the development of renal scarring, the exact relationship between VUR and scarring is still undetermined.⁷ Therefore, VCUG cannot directly diagnosis renal scarring.

The purpose of this study was to determine if the presence and severity of VUR can predict the development of renal scarring in children with febrile UTI.

MATERIALS AND METHODS

The study was approved by the Institutional Ethics Committee of Siriraj Hospital (Si 283/2019). This study was a retrospective single-center study. Medical records were searched using the keywords "febrile UTI" in patients less than 14 years old from January 2016 to July 2018. Only patients with a positive urine culture and who had both VCUG and a DMSA scan done within 4-6 months of each other were included in this study.

Demographic data and blood urea nitrogen (BUN) as well as creatinine result were recorded. The VCUG results were reviewed by a pediatric radiologist and a radiology resident who were unaware of the patients' test results. The results were classified as positive or

negative for VUR. The degree of vesicoureteral reflux was graded according to the recommendations of the International Reflux study in children¹:

Grade 1: Reflux into a non-dilated ureter.

Grade 2: Reflux into the upper collecting system but non-dilated.

Grade 3: Mild or moderate dilatation and/or tortuosity of the ureter and mild or moderate dilatation of the renal pelvis.

Grade 4: Moderate dilatation and/or tortuosity of the ureter and moderate dilatation of the renal pelvis and calyces.

Grade 5: Gross dilatation and tortuosity of the ureter. Gross dilatation of the renal pelvis and calyces and the loss of papillary impressions.

Dimercaptosuccinic acid renal scintigraphy was performed using a standard procedure. The patients were injected with DMSA 0.1 mCi/kg (minimum dosage of 0.3 mCi and maximum dosage of 3 mCi). Data were acquired on a dual-head, large field of view, gamma camera equipped with a low-energy high-resolution collimator in 256 × 256 matrices.

Relative tracer uptake (RU) was calculated as the mean value of uptake in the anterior and posterior projections, corrected for background activity. The presence of focal defects in the renal cortex with distortion or indentation of the normal renal outline, renal volume loss, and cortical thinning were classified as renal scarring. If the result was undetermined, DMSA was repeated in the next six months, and the final result was used for interpretation.

Statistical analysis

The Mann-Whitney test and chi-square test were used for statistical analysis between the groups of children with VUR and without VUR, and between the different grades of VUR, considering a *p*-value of less than 0.01 as statistically significant.

Positive and negative likelihood ratios (LR) along with 95% confidence intervals (CI) were calculated for VCUG using DMSA as the gold standard for permanent renal damage.

RESULTS

Overall, there were 598 children aged 0-14 years old with febrile UTI. Of those, 185 children (74 girls and 111 boys; mean age, 3.5 years old) met all the criteria with a positive urine culture and had had both diagnostic studies performed (Table 1). There were five children with only a single kidney each, resulting in 365 kidneys for analysis.

Vesicoureteral reflux was found in 203 kidneys (55.6%). Refluxes were classified as grades 1, 2, 3, 4, and 5 in 19, 31, 81, 38, and 34 kidneys, respectively

DMSA scintigraphy showed normal renal uptake in 237 kidneys (65%) and renal scarring in 128 kidneys (35%). In 6 kidneys, the result was equivocal in the first study, but subsequently demonstrated renal scarring on the following examination.

Scarring was shown in 110 of 203 (54.2%) kidneys with VUR and in 18 of 162 (11.1%) kidneys without VUR (Table 2). The incidence of DMSA renal scarring was significantly associated with the presence of a refluxing kidney ($p < 0.001$). The sensitivity of VCUG in the prediction of renal scarring was 85.94% (95% CI, 78.7-91.4), and the specificity was 60.76% (95%CI, 54.2-67.0).

The number of kidneys with renal scarring compared

with the different grades of VUR was calculated (Table 3). The positive and negative likelihood ratios (LR) of VUR in detecting renal scarring was calculated according to VUR grading. The cumulative data for the presence of VUR from grades 1-5 caused a positive LR of 2.2 (95% CI, 1.9-2.5), and a negative LR negative of 0.23, (95%, CI 0.1-0.4) (Table 4).

One hundred and sixty-six patients had BUN and creatinine in medical records. Five in 166 patients (9 in 365 kidneys) had high creatinine levels indicating impaired renal function. Four kidneys in these patients were associated with vesicoureteral reflux, grade 2 in 1 kidney, grade 3 in 1 kidney and grade 4 in two kidneys. There were 5 kidneys in patients with abnormal renal function that were not associated with vesicoureteral reflux.

TABLE 1. Demographic data of the study patients with UTI.

Age (year)	Sex		Total
	Male	Female	
0-5	88	55	143 (77.3%)
>5-10	20	14	34 (18.4%)
>10-15	3	5	8 (4.3%)
Total	111	74	185 (100%)

TABLE 2. Comparison of the VUR results with renal scarring.

	Scar	No scar	Total
VUR	110	93	203
Non-VUR	18	144	162
Total	128	237	365

Sensitivity 85.9% (95% CI: 78.7-91.4), Specificity 60.8% (95%CI 54.2-67.0)

TABLE 3. Comparison of the kidneys with negative and positive VUR in different grades for testing for renal scarring.

VUR	Scar	No scar	Total kidneys	% of kidneys with a scar
No VUR	18	144	162	11.1
Grade 1	9	10	19	47.4
Grade 2	12	19	31	38.7
Grade 3	45	36	81	55.6
Grade 4	21	17	38	55.3
Grade 5	23	11	34	67.6
Total	128	237	365	

TABLE 4. Likelihood ratio (LR) for renal scarring in different grades from VUR.

	+LR	-LR
Grade 1-5	2.2 (95%CI 1.9-2.5)	0.2 (95%CI 0.1-0.4)
Grade 2-5	2.3 (95%CI 2.0-2.6)	0.3 (95%CI 0.2-0.5)
Grade 3-5	2.6 (95%CI 2.2-3.0)	0.4 (95%CI 0.3-0.6)
Grade 4-5	2.9 (95%CI 2.3-3.7)	0.7 (95%CI 0.5-1.1)
Grade 5	3.9 (95%CI 2.7-5.6)	0.9 (95%CI 0.5-1.5)

DISCUSSION

Urinary tract infection is one of the most common causes of bacterial infections in childhood. The diagnosis and management of UTI continue to be controversial with many challenges in clinical practice.

In terms of imaging investigations in patients with UTI, there is no consensus on a single guideline in the pediatric population. The method and timing of imaging to evaluate for urinary tract anatomical abnormalities and renal scarring after a febrile UTI vary between institutions.

Technetium-99m DMSA seems to be the most reliable method for the diagnosis of chronic cortical renal scarring. Prior studies suggested that DMSA may obviate VCUG in the evaluation of febrile UTI.^{8,9} However, this method requires nuclear medicine specialists and may not be available in all institutions. VCUG is an optimal method to diagnose VUR as well as for assessing the degree

of VUR and the anatomy of the male urethra. However, VCUG cannot detect renal scarring or pyelonephritis.

In our study, we wanted to assess if the presence and severity of VUR could predict the development of renal scarring in children with UTI. We found that the incidence of DMSA renal scarring was significantly associated with the presence of vesicoureteral reflux. Renal scars were found in 54.2% of kidneys with VUR and 11.1% of kidneys with no VUR.

Our study findings concurred with prior research. For instance, Canoe et al. found renal damage in 67% of kidneys with VUR and in 16% of kidneys with no VUR, and concluded that the presence of VUR was associated with renal damage.¹⁰

However, some prior studies do not concur with our results.^{11,12} For instance, Moorthy et al. found that only 16% of children with VUR had an abnormal kidney on

DMSA scan. The heterogeneity of the published results may depend on several factors, such as the ages and types of patients, the timing between UTI and investigation, and the antibiotic treatments applied.

Our study also compared the incidence of renal scarring with the VUR results according to the severity of VUR using VUR grading. We found that there was a slight increase in the percentages of the kidneys with renal scars as the grade of the VUR increased; from 47.4% with VUR grade 1 to 67.6% in VUR grade 5. However, from our results, the percentage of renal scarring in grade 2 reflux was less than in grade 1.

Prior studies also reported VUR as a risk factor for developing a renal scar and increased renal scarring in patients with a higher grading of VUR.^{13,14} Other risk factors of renal scarring included recurrent UTI, bladder-bowel dysfunction, and delayed treatment.¹⁵

Interestingly, we also observed BUN and creatinine levels in comparison with VUR and scarring. We found that most patients (161 of 166) had normal BUN and creatinine levels. There were 5 patients with 9 kidneys with impaired renal function. In these patients, less

than 50% of kidneys had reflux on VCUG in different grades from 2 to 4. We suggested that there was no direct correlation between VUR and renal function, which can be explained by the fact that patients have two kidneys. Severe VUR or scarring in one kidney will not lead to abnormal renal function with high BUN and creatine levels. It could be different if the patient had a single kidney. In fact, we had one patient with a single kidney with VUR grade 4 and had renal failure.

To evaluate the significance of VUR, we also looked at the likelihood ratio with the different VUR grades. We found that the positive likelihood ratio was slightly increased if we included only higher grades of VUR. However, the ranges of positive LR were between 2.2 and 3.9. A low number positive LR presumes that VCUG may not be a useful diagnostic test to detect renal scarring. From our study, 11.1% of scarred kidneys would have been missed if Tc-99m DMSA was not performed in patients with no VUR and 14.9% would have been missed if we had avoided Tc-99m DMSA in patients with no VUR and VUR grade 1 (Figs 1 A, B, and C).

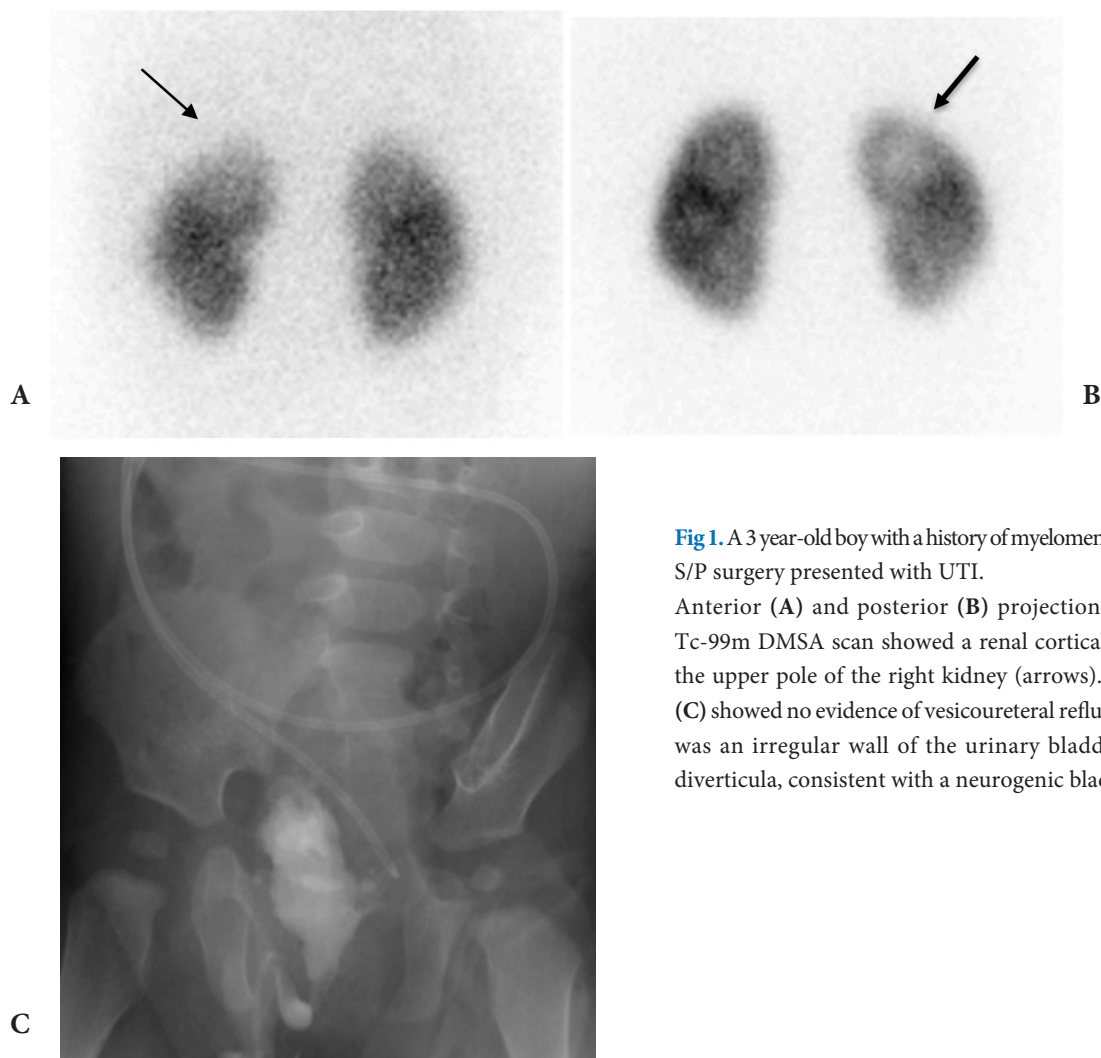


Fig 1. A 3 year-old boy with a history of myelomeningocele S/P surgery presented with UTI.

Anterior (A) and posterior (B) projections of the Tc-99m DMSA scan showed a renal cortical scar at the upper pole of the right kidney (arrows). VCUG (C) showed no evidence of vesicoureteral reflux. There was an irregular wall of the urinary bladder with diverticula, consistent with a neurogenic bladder.

Our study has several limitations. First, this was a retrospective study. There was a diversity of patients in terms of VCUG techniques. Some patients might have a cyclic filling of the contrast medium. The different kinds and durations of the antibiotic treatments might also have affected the results. A large prospective result would be useful for the homogeneity of the population.

CONCLUSION

From our study, we found that there was a significant correlation between positive VUR and the development of renal scarring. The number of scarred kidneys also slightly increased as the grade of VUR increased. Moreover, the presence of low-grade VUR cannot exclude renal scarring and these cases should be considered for further evaluation and a follow up with Tc99m- DMSA.

REFERENCES

1. Lebowitz RL OH, Parkkulainen KV, Smellie JM, Tamminen-Mobius TE. International system of radiographic grading of vesicoureteric reflux. International Reflux Study in Children. *Pediatr Radiol* 1985;15:105-9.
2. Montini G, Tullus K, Hewitt I. Febrile Urinary Tract Infections in Children. *N Engl J Med* 2011;365:239-50.
3. Yilmaz S OZ, Kurt Sukur ED, Bulum B, Kavaz A, Elhan AH. Vesicoureteral Reflux and Renal Scarring Risk in Children after the First Febrile Urinary Tract Infection. *Nephron* 2016;132:175-80.
4. Massanyi EZ PJ, Gupta A, Lin SM, Wang MH Utility of screening ultrasound after first febrile UTI among patients with clinically significant vesicoureteral reflux. *Urology* 2013;82:905-9.
5. Subcommittee on Urinary Tract Infection SCoQIaM, Roberts KB. Urinary tract infection: clinical practice guideline for the diagnosis and management of the initial UTI in febrile infants and children 2 to 24 months. *Pediatrics* 2011;128:595-610.
6. Shaikh N EA, Bhatnagar S, Hoberman A Risk of renal scarring in children with a first urinary tract infection: a systematic review. *Pediatrics* 2010;126:1084-91.
7. Mattoo TK CR, Greenfield SP, Hoberman A, Keren R, Mathews R. Renal Scarring in the Randomized Intervention for Children with Vesicoureteral Reflux (RIVUR) Trial. *Clin J Am Soc Nephrol* 2016;11:54-61.
8. Hansson SI DM, Sigström O, Sixt R, Stokland E, Wennerström M, Jodal U. Dimercapto-succinic acid scintigraphy instead of voiding cystourethrography for infants with urinary tract infection. *J Urol* 2004;172:1071-3.
9. Preda II JU, Sixt R, Stokland E, Hansson S. Normal dimercaptosuccinic acid scintigraphy makes voiding cystourethrography unnecessary after urinary tract infection. *J Pediatr* 2007;151:581-4.
10. Caione P CG, Collura G, Morano S, Capozza N. Renal damage in vesico-ureteric reflux. *BJU Int* 2004;93:591-5.
11. Wheeler D VD, Hodson EM, Roy LP, Smith G, Craig JC. Antibiotics and surgery for vesicoureteric reflux: a meta-analysis of randomised controlled trials. *Arch Dis Child* 2003;88:688-94.
12. Moorthy I EM, McHugh K, Ridout D, Biassoni L, Gordon I. The presence of vesicoureteric reflux does not identify a population at risk for renal scarring following a first urinary tract infection. *Arch Dis Child* 2005;90:733-6.
13. Sevgi Mir PE, Nese Ozkayin. Risk factors for renal scarring in children with primary vesicoureteral reflux disease. *Saudi J Kidney Dis Transpl* 2013;24:54-59.
14. González E PJ, Girardin E. Impact of vesicoureteral reflux on the size of renal lesions after an episode of acute pyelonephritis. *J Urol* 2005;173:574-5.
15. Tej K. Mattoo M, DCH, FRCP. Vesicoureteral Reflux and Reflux Nephropathy. *Adv Chronic Kidney Dis* 2011;18:348-54.

Correlation of Transient Elastography and Biliary Cirrhosis in Longterm Survivors of Biliary Atresia

Witsanee Srisuwan, M.D.*, Wison Laochareonsuk, M.D.*, Panu Wetwittayakhleng, M.D.***, Supika Kritsaneepaiboon, M.D.***, Surasak Sangkhathat, M.D.*

*Department of Surgery, **Department of Internal Medicine and NKC Institute of Gastroenterology and Hepatology, ***Department of Radiology, Faculty of Medicine, Prince of Songkla University, Hat Yai, Songkhla 90110, Thailand.

ABSTRACT

Objective: This study aimed to use transient elastography (TE) to evaluate the correlation between liver stiffness measure (LSM) and functional status of native liver in longterm follow-up of pediatric patients with biliary atresia (BA).

Methods: Twenty cases of BA who had undergone hepatic portoenterostomy and had good initial outcome (total bilirubin < 2 mg/dL) were enrolled for a transient elastography. The LSMs derived from the study were analyzed with clinical and radiological parameters and endoscopic findings of esophageal varices.

Results: The median age at enrollment of the 20 cases was 8.4 years. Of the 20 cases, 15 were diagnosed as cirrhosis by ultrasonography and 9 had esophageal varices detected by an endoscopy. Parameters that were significantly associated with LSM were history of cholangitis, splenomegaly, cirrhosis and esophageal varices. Significantly higher LSM was found to be correlated with hyperbilirubinemia, transaminitis, alkaline phosphatemia, thrombocytopenia and prolonged INR. On linear regression, LSM was significantly correlated with pediatric end-stage liver disease score at the r^2 of 0.32 and correlated with the aspartate transaminase to platelet ratio index at the r^2 of 0.70. The area under the receiver operating characteristic curve that reflected the performance of LSM in predicting esophageal varices was 0.97. At the cut-off value of 10.2 kPa, the sensitivity and specificity of LSM in predicting esophageal varices were 100% and 72.7%, respectively.

Conclusion: TE can be useful as a non-invasive, point-of-care evaluation of liver fibrosis in long term follow-up of BA. A high LSM indicates surveillance for esophageal varices in these patients.

Keywords: Transient elastography; biliary atresia; liver stiffness measurement (Siriraj Med J 2021; 73: 32-37)

INTRODUCTION

Biliary atresia (BA) is a progressive inflammatory cholangiopathy occurring during infancy period that can lead to liver cirrhosis and death within 2 years of life.¹ The incidence of BA is reported at approximately 1 in 10,000-20,000 live births with a higher incidence in Asians.^{2,3} The etiology of BA remains unclear although

some evidence suggests genetic involvement. Currently, hepatic portoenterostomy (HPE, also known as Kasai's operation) is the initial surgical treatment of choice and gives a good longterm outcome in 30%-50% of cases.⁴ The procedure replaces a fibrotic extrahepatic bile duct with an intestinal conduit interposed between the hepatic portal plate and the jejunum.

Corresponding author: Surasak Sangkhathat

E-mail: surasak.sa@psu.ac.th

Received 17 August 2020 Revised 8 October 2020 Accepted 9 October 2020

ORCID ID: <http://orcid.org/0000-0003-3622-3233>

<http://dx.doi.org/10.33192/Smj.2021.05>

About 40% of BA cases who undergo HPE receive no benefit from the surgery. However, among the cases who achieve biliary drainage after the surgery, progression of cirrhosis continues at varying rates. About half of the patients who have long term survival after HPE later develop biliary cirrhosis, portal hypertension, esophageal varices and/or liver failure.⁴ Long term follow-up of the liver functions and surveillance for esophageal varices and cirrhosis are mandatory in BA cases. Various laboratory tests are used as indices of liver function reserve in pediatric chronic liver diseases. The aspartate transaminase to platelet ratio index (APRI) has been proposed as an indicator for liver fibrosis in pediatric patients with chronic hepatitis C and also BA.^{5,6} The Pediatric End-stage Liver Disease (PELD) score has been widely used to predict life-year benefit from a liver transplantation.⁷ Imaging evaluation of cirrhosis is usually performed by an ultrasound study while evaluation of esophageal varices needs an esophagoscopy. In our institute, an esophagoscopy is usually considered when a child with BA reaches 2-3 years of age or when there are clinical signs of portal hypertension.

The recent development of transient elastometry (TE) provides a non-invasive technique to evaluate the extent of liver fibrosis.⁸ TE emits a 50-MHz ultrasound wave from its probe and measures the velocity of the shear wave passing through the liver parenchyma. The shear wave velocity is then converted into a liver stiffness measurement (LSM), which is expressed in kilopascals (kPa).⁹ TE has been widely used in various chronic liver diseases in adults including chronic hepatitis and fatty liver.^{10,11} The scanning procedure can be performed on an out-patient basis and usually takes less than 10 minutes. Studies involving BA patients have shown a correlation between liver stiffness and degree of liver fibrosis in both before and after HPE.¹²⁻¹⁵ In 2011, a study of liver stiffness in post-HPE patients suggested that the stiffness value was correlated well with the presence of esophageal varices. A more recent study of liver stiffness measurements performed at 3 months post-HPE significantly predicted the risk of liver cirrhosis and the need for a transplantation.¹⁵ To our knowledge, to date there have been only a few studies of TE in longterm BA survivors and these have focused on the correlation between the liver stiffness and the risk of developing portal hypertension or esophageal varices. This study aimed to evaluate the correlation between liver stiffness measurement by Fibroscan and clinical/laboratory profiles of liver functions in cases of BA who had good outcome after HPE with more than 2 years of follow-up period.

MATERIALS AND METHODS

Patients

This cross-sectional study included 20 cases of BA who underwent HPE in our institute between 2001-2015 and had good initial outcome defined as having post-operative bilirubin level of less than 2 mg/dL. On enrolment under informed consent of the parents or other guardians, the patients were clinically examined for growth anthropometry and signs of portal hypertension by the attending surgeon. Additional evaluation consisted of liver function study (total bilirubin, direct bilirubin, total protein, albumin, alkaline phosphatase, aspartate aminotransferase (AST) and alanine aminotransferase), platelet count, hepatobiliary ultrasonography and upper gastrointestinal endoscopy. Clinically significant esophageal varix was defined as the varix grade 2 or more according to the Japanese Research Society for Portal Hypertension definition (1991).¹⁶ The aspartate transaminase to platelet ratio index (APRI) was calculated as $\text{AST} (\times 40) \times 100 / \text{platelet count} (109/L)$. A Fibroscan was then performed within 1 month of the laboratory and endoscopic tests. The study was approved by the Human Research Ethics Committee of the Faculty of Medicine, Prince of Songkla University.

Transient elastography

The TE procedures were performed by trained internists using a Fibroscan 502 Touch system (Echosens, Paris, France). Two types of probe were used in this study: an S probe for thoracic diameters < 45 cm and an M probe for thoracic diameters > 45 cm. Scanning was performed in a supine position with maximal abduction of the right arm. For quality control, the median values of liver stiffness measurements from 10 validated measurements with interquartile range (IQR) < 25% and reliability measured as $\text{IQR}/\text{M} < 25\%$ were used.¹⁷ All studies were performed without sedation and under non-fasting conditions.

Statistical analysis

Data are presented as arithmetic means with ranges when they have normal distribution and medians with interquartile ranges otherwise. LSMs from the Fibroscan studies were cross tabulated with various clinical and investigative factors that are indicators of cirrhosis and portal hypertension including the PELD scores. Association analysis used Student t-test or Mann Whitney U test as appropriate. Correlations between the LSMs and liver cirrhosis as diagnosed by an ultrasonography and also the presence of esophageal varices were analysed by using a receiver operating characteristic (ROC) curve. Correlations between LSMs and PELD scores were analysed

by linear regression analysis. A P-value of less than 0.05 was considered statistically significant.

RESULTS

The twenty BA patients enrolled in this study consisted of 10 male and 10 female patients in an age range from 2.3 years to 21.0 years. The median age at enrolment was 8.4 years (IQR 5.6 - 21.0 years). The mean age at HPE in these patients was 73 days (range 30-119 days) with 2 cases having their operation later than 90 days of age. Twelve cases had ever had at least 1 episode of cholangitis. Three patients had growth parameters of less than the tenth percentile of the normal growth curve of Thai children. Ultrasound diagnosed liver cirrhosis in 15 cases, splenomegaly in 11 cases and presence of ascites in 2 cases. Esophagogastrosocopy detected esophageal/gastric varices in 9 cases.

The median LSM was 12.4 kPa (IQR 6.0-32.4 kPa). Clinical and radiologic parameters that were significantly associated with LSM were history of cholangitis, splenomegaly, cirrhosis and presence of esophageal varices (Table 1). When LSM was analysed with the liver function test, significant associations were found between the stiffness value and total bilirubin, direct bilirubin, serum albumin, aspartate aminotransferase, alanine aminotransferase and alkaline phosphatase (Table 2). Higher LSM values were also significantly associated with thrombocytopenia and high prothrombin time INR. On linear regression, LSM was significantly correlated with the PELD score at the p-value of 0.02 and r^2 at 0.32. In addition, there was significant correlation between LSM and APRI at the p-value of < 0.01 and r^2 at 0.70.

To determine the diagnostic performance of LSM and cirrhosis diagnosed by ultrasonography, an ROC curve was plotted between sensitivity and 1-specificity to predict esophagogastric varices by each LSM value. The area under the ROC curve was 0.97 and the cut-off value that best predicted the presence of esophageal varices was at 10.2 kPa (sensitivity 100.0 % and specificity 72.7%) (Fig 1). The area under the curve when analysed against APRI in predicting esophageal varices was 0.99.

DISCUSSION

Gradual deterioration of liver function is a natural history after surgery in BA patients. Even in cases that had achieved good bile flow after surgery, cirrhosis and portal hypertension were eventually occurred. Ascending cholangitis may accelerate the cirrhotic changes. Evaluation of the severity of cirrhosis usually relies on

clinical evaluation and ultrasonography. In general, an esophagoscopy is indicated when there are clinical or radiological signs of portal hypertension. In this study, we evaluated the values of transient elastography in BA related cirrhosis by studying the association between LSM and liver profiles in good outcome BA cases who had been followed more than 2 years. The study demonstrated significant associations between LSM and both APRI and radiologic diagnosis of liver cirrhosis. In addition, LSM was significantly associated with other signs of liver decompensation and portal hypertension including hyperbilirubinemia and presence of esophageal varices.

In 2011, a study by Chongsrisawat and colleagues has reported that both LSM and APRI could equally predict the esophageal varices in BA cases with an acceptable accuracy.¹² Consistent with that report, our data showed good correlation between LSM and APRI and near perfect performance of both parameters in predicting significant esophageal varices. The data suggested that screening for esophageal varices during BA follow-up can be performed in particular cases and Fibroscan is the effective tool for case selection. Our study also suggests that an LSM of 10.2 kPa is a practical cut-off value for variceal prediction, a value which is similar to the value range of 9.7-12.5 kPa as suggested by the previous studies.^{12,18,19}

One of limitations in this study was its cross-sectional design which meant that all variables analysed were measured at a single time-point during the wide range follow-up period. Chronological changes over time of the LSM might be more useful in following the rate of deterioration of the native liver function. The timing of scanning has varied among earlier reports. One study in pre-operative BA cases suggested that LSM was superior to APRI in predicting histologically confirmed high-grade fibrosis (F4 by the Metavir scoring system).¹⁴ Another study performed at 3 months post HPE demonstrated good correlations between high LSMs and liver-related events such as ascites, variceal bleeding or death during the follow-up period which suggested the earlier need of transplantation.¹³

CONCLUSION

In conclusion, our study performed transient elastography during long term follow-up in BA patients who achieved good biliary drainage after HPE. As in other studies, we found correlations between LSMs and other clinical/radiological evidence of portal hypertension. Using a cut-off of 10.2 kPa, TE predicted esophageal varices with high sensitivity.

TABLE 1. Association between liver stiffness measure (LSM) by a transient elastography and clinical signs, esophagogastrosopic detection of varices and ultrasound findings.

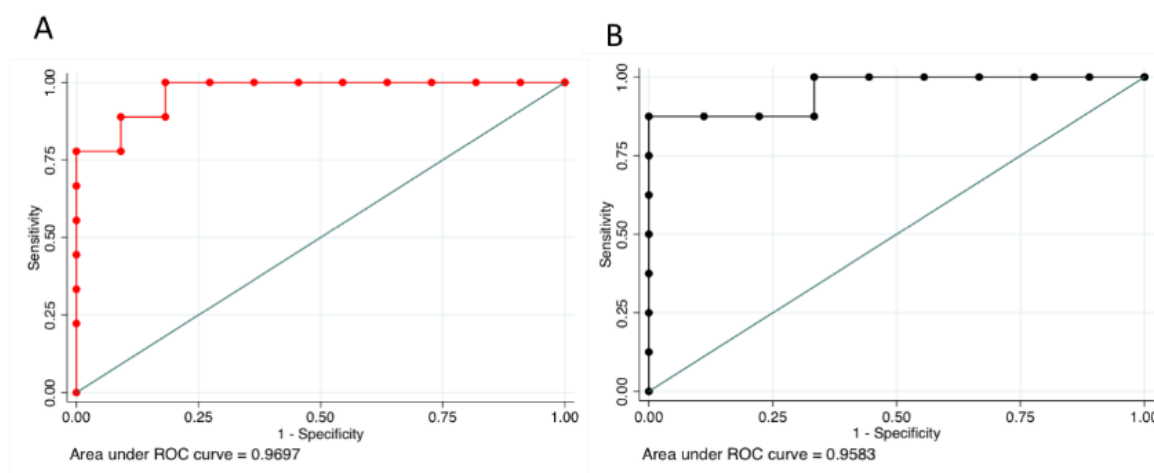
	Cases (%)	LSM (kPa)	P-value*
History of cholangitis			
No	8 (40%)	8.12	0.03
Yes	12 (60%)	30.33	
Weight or height <10 th percentile			
No	17 (85%)	21.75	0.31
Yes	3 (15%)	19.77	
Splenomegaly by examination			
No	12 (60%)	8.22	< 0.01
Yes	8 (40%)	41.29	
Esophageal varices			
Absent	11 (55%)	7.66	< 0.01
Present	9 (45%)	38.30	
Cirrhosis by ultrasound			
Absent	5 (25%)	5.18	< 0.01
Present	15 (75%)	26.87	
Splenomegaly by ultrasound			
Absent	9 (45%)	6.61	< 0.01
Present	11 (55%)	33.59	
Ascites by ultrasound			
Absent	18 (90%)	21.35	0.61
Present	2 (10%)	22.35	
Intrahepatic duct dilatation			
Absent	16 (80%)	17.76	0.32
Present	4 (20%)	36.22	
Fatty change			
Absent	19 (95%)	22.31	-
Present	1 (5%)	5.10	

*Mann Whitney U test

TABLE 2. Association between liver stiffness measure (LSM) by a transient elastography and liver function profiles, prothrombin time-INR and platelet count.

	Cases (%)	LSM (kPa)	P-value*
Total bilirubin (mg/dL)			
TB < 2.0	16	12.45	< 0.01
TB > 2.0	4	57.45	
Direct bilirubin (mg/dL)			
DB < 2.0	17	16.13	0.02
DB > 2.0	3	51.60	
Serum albumin (g/dL)			
Alb < 3.5	2	75.00	0.02
Alb > 3.5	18	15.50	
Aspartate aminotransferase (U/L)			
AST < 35	15	7.30	0.04
AST > 35	5	26.17	
Alanine aminotransferase (U/L)			
ALT < 35	8	7.15	< 0.01
ALT > 35	12	30.98	
Akaline phosphatase (U/L)			
ALP < 200	3	5.77	0.04
ALP > 200	17	24.21	
Prothrombin time-INR**			
INR < 1.2	10	13.41	0.04
INR > 1.2	9	32.06	
Platelet count (x 10 ⁹ cells/L)**			
< 150	9	27.8	0.047
> 150	9	9.96	

*Mann Whitney U test, **presence of missing values

**Fig 1.** Diagnostic performance of (A) liver stiffness measure and (B) aspartate transaminase to platelet ratio index in predicting esophageal varices in biliary atresia patients.

ACKNOWLEDGEMENTS

The authors thank the nurses in the NKC Institute of Gastroenterology and Hepatology, Songklanagarind Hospital for their cooperation in performing the transient elastography. Dave Patterson edited the English Language in the manuscript.

REFERENCES

- Hartley JL, Davenport M, Kelly DA. Biliary atresia. *Lancet* 2009;374:1704-13.
- Lee KJ, Kim JW, Moon JS, Ko JS. Epidemiology of Biliary Atresia in Korea. *J Korean Med Sci* 2017;32:656-60.
- Sanchez-Valle A, Kassira N, Varela VC, Radu SC, Paidas C, Kirby RS. Biliary Atresia: Epidemiology, Genetics, Clinical Update, and Public Health Perspective. *Adv Pediatr* 2017;64:285-305.
- Sangkhatat S, Patrapinyokul S, Tadtayathikom K, Osatakul S. Peri-operative factors predicting the outcome of hepatic porto-enterostomy in infants with biliary atresia. *J Med Assoc Thai* 2003;86:224-31.
- Wai CT, Greenon JK, Fontana RJ, Kalbfleisch JD, Marrero JA, Conjeevaram HS, et al. A simple noninvasive index can predict both significant fibrosis and cirrhosis in patients with chronic hepatitis C. *Hepatology* 2003;38:518-26.
- Kim SY, Seok JY, Han SJ, Koh H. Assessment of liver fibrosis and cirrhosis by aspartate aminotransferase-to-platelet ratio index in children with biliary atresia. *J Pediatr Gastroenterol Nutr* 2010;51:198-202.
- Wiesner RH, McDiarmid SV, Kamath PS, Edwards EB, Malinchoc M, Kremers WK, et al. MELD and PELD: application of survival models to liver allocation. *Liver Transpl* 2001;7:567-80.
- Rockey DC, Bissell DM. Noninvasive measures of liver fibrosis. *Hepatology* 2006;43:S113-20.
- Sandrin L, Fourquet B, Hasquenoph JM, Yon S, Fournier C, Mal F, et al. Transient elastography: a new noninvasive method for assessment of hepatic fibrosis. *Ultrasound Med Biol* 2003;29:1705-13.
- Yoneda M, Yoneda M, Fujita K, Inamori M, Tamano M, Hiriishi H, et al. Transient elastography in patients with non-alcoholic fatty liver disease (NAFLD). *Gut* 2007;56:1330-1.
- Castera L, Le Bail B, Roudot-Thoraval F, Bernard PH, Foucher J, Merrouche W, et al. Early detection in routine clinical practice of cirrhosis and oesophageal varices in chronic hepatitis C: comparison of transient elastography (FibroScan) with standard laboratory tests and non-invasive scores. *J Hepatol* 2009;50:59-68.
- Chongsrisawat V, Vejapipat P, Siripon N, Poovorawan Y. Transient elastography for predicting esophageal/gastric varices in children with biliary atresia. *BMC Gastroenterol* 2011;11:41.
- Hahn SM, Kim S, Park KI, Han SJ, Koh H. Clinical benefit of liver stiffness measurement at 3 months after Kasai hepatopuertoenterostomy to predict the liver related events in biliary atresia. *PLoS One* 2013;8:e80652.
- Shen QL, Chen YJ, Wang ZM, Zhang TC, Pang WB, Shu J, et al. Assessment of liver fibrosis by Fibroscan as compared to liver biopsy in biliary atresia. *World J Gastroenterol* 2015;21:6931-6.
- Wu JF, Lee CS, Lin WH, Jeng YM, Chen HL, Ni YH, et al. Transient elastography is useful in diagnosing biliary atresia and predicting prognosis after hepatopuertoenterostomy. *Hepatology* 2018;68:616-24.
- Idezuki Y. General rules for recording endoscopic findings of esophagogastric varices (1991). *Japanese Society for Portal Hypertension. World J Surg* 1995;19:420-2.
- Ziol M, Handra-Luca A, Kettaneh A, Christidis C, Mal F, Kazemi F, et al. Noninvasive assessment of liver fibrosis by measurement of stiffness in patients with chronic hepatitis C. *Hepatology* 2005;41:48-54.
- Chang HK, Park YJ, Koh H, Kim SM, Chung KS, Oh JT, et al. Hepatic fibrosis scan for liver stiffness score measurement: a useful preendoscopic screening test for the detection of varices in postoperative patients with biliary atresia. *J Pediatr Gastroenterol Nutr* 2009;49:323-8.
- Colecchia A, Festi D, di Biase AR. Noninvasive parameters for predicting esophageal varices in children: their sequential use provides the best accuracy. *Gastroenterology*. 2012;142:e32.

Parental Stress-Coping Skills and Resilience among Parents of Children with Specific Learning Disorders

Pitcha Janha, M.Sc., Sirinadda Punyapas, M.D., Woraphat Ratta-apha, M.D., Ph.D.

Department of Psychiatry, Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok 10700, Thailand.

ABSTRACT

Objective: Parental stress may affect parents' health, behavior, and children. The use of coping styles and resilience can help parents handle stress. The aim of this study was to examine the relationships among the demographic data, coping styles, resilience, and stress levels of the primary caregivers of children with Specific Learning Disorders (SLD)

Methods: 160 primary caregivers of children aged 6 to 17 with SLD who attended the Child and Adolescent Psychiatric Clinic at Siriraj Hospital were asked to complete the four-part questionnaires. The data were analyzed to find any correlations.

Results: 91.9% of participants had parenting stress at a typical stress level, and 68.8% were rated normal on the resilience quotient. With regard to coping style, the participants rated highest in problem-focus coping (mean score 3.8 ± 0.5), followed by seeking social support (3.0 ± 0.8), and avoidance (2.3 ± 0.6). The score on the Parenting Stress Index correlated with social support ($r = 0.207, p < 0.01$) and avoidance ($r = 0.538, p < 0.01$). The resilience quotient score demonstrated a negative association with parenting stress ($r = -0.291, p < 0.01$), emotional stability ($r = -0.242, p < 0.01$), encouragement ($r = -0.297, p < 0.01$), and problem-solving ($r = -0.189, p < 0.05$).

Conclusion: Most of the parents had typical stress. Social support and avoidance -coping skills were significantly correlated with parenting stress and resilience. This suggests that one's coping style and resilience are crucial to parents' or primary caregivers' quality of life.

Keywords: Parenting stress; coping; resilience; specific learning disorders (Siriraj Med J 2021; 73: 38-45)

INTRODUCTION

Specific Learning Disorder (SLD) is one of the neurodevelopmental disorders which can be identified from a demonstration of slower cognitive development in three areas: writing, reading, and math calculation, when compared to other children or those of the same age.¹ These three characteristics of SLD affect children significantly in their daily life, learning skills, and mental state, since these children can develop a negative feeling about their cognitive abilities.² According to several studies, children who are diagnosed with SLD will eventually

have lower psychosocial health, plus more anxiety and depression.^{3,4} Ginieri-Coccosis et al.⁵ have also concluded that children diagnosed with SLD have lower mental health, self-esteem, and relationship satisfaction. Moreover, it was found that the parents of SLD children also have a lower satisfaction with their environment and society at large. And these effects can also cause stress and sickness among parents and/or caretakers of children with SLD.⁶

Parenting stress is defined as distress as a result of the parental role, and is influenced by life events, environment, sociological factors, the child's characteristics,

Corresponding author: Woraphat Ratta-apha

E-mail: woraphat.rat@mahidol.ac.th

Received 3 July 2020 Revised 14 September 2020 Accepted 15 September 2020

ORCID ID: <http://orcid.org/0000-0001-8776-2427>

<http://dx.doi.org/10.33192/Smj.2021.06>

and those of the parents. Particularly, families of children with disabilities report a high level of parenting stress. Previous studies have found that parents of children with SLD have a higher stress level than parents of children without such disorders. This association also extends to IQ level, behavioral problems, and emotional problems in children.^{2,3,7-10} Children with disabilities need more attention and special care¹¹ such as daily expenses, educational fees, and other costs, which makes parents significantly change their daily routine. Altogether with these mentioned factors, it may increase more tension and stress level that affects their well-being,¹² their capacities to manage and also their relationships toward their children.¹³ High-stress levels may result in very negative feelings, poor well-being, induced depression, and strain on the relationships between parents themselves and with their children^{13,14} and other relatives. Learning to effectively cope is absolutely essential.

When a stressor becomes a threat to people, it affects their emotional, behavioral, and physical aspects, as well as their ability to adapt.¹⁵ Lazarus and Folkman defined coping as the adaptation of a person, enabling him or her to understand, reduce, and endure stress from external or internal resources including work, the social environment, high self-expectations, and emotional conflicts.¹⁶ The weight of the stress increases in parents who feel less equipped to handle it. Parents of children with a disability of course cope with their stress differently.¹⁷ Benson¹⁸ reported that mothers of children with Autism Spectrum Disorder (ASD) who use avoidance-coping mechanisms have higher levels of depression and anger, and mothers who use reframing-cognitive coping have a better well-being. There is limited evidence on which types of coping are used by parents of children with SLD, and whether those types are associated with the level of parenting stress. However, coping is not the only way to reduce stress. Resilience is another factor that helps anyone dealing with stress.

Resilience is an internal resource used to bounce back from crisis, and some individuals bounce back to normal, whereas some learn to cope with future stress.¹⁹ The concepts of resilience can be perceived as cope or a factor that influences appraisals, emotional reactions and coping of the person. Resilience can be developed through physical, cognitive, self-aware, emotional, social, or risk-organization factors, all of which provide support for adaptation.^{20,21} These characteristics can relieve parental stress, allowing parents to be more patient and to be prepared for the next obstacle to come. For those who have the responsibility of managing the behavior of a child with a disability, higher parental stress levels and

poor well-being, such as depression and anxiety, can undermine the daily-life skills learned by their children. Previous studies have found that families with children diagnosed with ASD who scored high on the resilience test had lower levels of stress.²² In this study, we examine the associations among characteristics of parents, coping styles, parenting stress, and the resilience of parents of children with SLD.

MATERIALS AND METHODS

All procedures performed in studies involving human participants were in accordance with the ethical standards of the Siriraj Institutional Review Board (Si 485/2018), Faculty of Medicine Siriraj Hospital, Mahidol University and with the 1964 Helsinki Declaration and its later amendments. Informed consent was obtained from all individual participants included in the study.

Participants

Convenience sampling was performed. The participants in this study were 160 parents or primary caregivers of children with SLD who attended the Child and Adolescent Psychiatric Clinic at Siriraj Hospital. Regarding the previous studies, Researchers have estimated that the proportion of primary caregivers who were classified as a high-stress level group regarding taking care of children with SLD is approximately 0.50^{7,23}, compared with those who have less stress level. Participants were informed about the research and asked to sign a written consent.

Inclusion criteria

Inclusion criteria included parents or primary caregivers of children with SLD aged 6 to 17 who were diagnosed by child and adolescent psychiatrists. Parents or primary caregivers were required to live with the children, be fluent in Thai, and agree to participate in the study.

Materials

The questionnaires were divided into four parts.

Part 1: Parental characteristics

This part consisted of six questions related to the characteristics of parents or primary caregivers: age, marital status, level of education, income, number of children in their care, and a list of other caregivers who raise the children, as well.

Part 2: Parenting Stress Index-Short Form (PSI-SF)

The PSI-SF developed by Abidin and translated

into Thai version by Nuttorn Pityaratstian.⁸ The Thai PSI-SF used to measure parenting stress which included 36-item self-report using the five-point Likert scale. The PSI-SF included three subscales: the Parental Distress (PD) scale, the Parent-Child Dysfunctional Interaction (P-CDI) scale, and the Difficult Child (DC) scale. The total parenting-stress score ranged from 36 to 180, and all subscales ranged from 12 to 60. Scores higher than those in the 90th percentile indicated clinically significant stress in personal adjustment, relationships between the parent or caregiver and child, and/or handling a child's behavior. The Cronbach's alpha was 0.904.

Part 3: Resilience Quotient (RQ)

The RQ was developed by the Department of Mental Health of Thailand.¹⁹ It consists of 20 questions designed to measure the capacity to recover from stressors. The RQ included three subscales: the Emotional Stability scale, the Encourage scale, and the Problem-Solving scale. The RQ used a four-point Likert scale and was self-reported. The normal ranges of these subscales were 27 to 34 on the Emotional Stability scale, 14 to 19 on the Encourage scale, and 13 to 18 on the Problem-Solving scale. Compared with the mean of each subscale, lower scores indicated lower resilience than normal, and higher scores indicated higher resilience than normal. The Cronbach's alpha was 0.749.

Part 4: Coping scale

Coping scale was developed by Supapan Kotcharat and revised by Prathana Leksomboon.²⁴ A 39-item questionnaire was used to measure three scales of coping: problem-focusing coping, seeking social support, and avoidance. The coping scale consisted of a five-point Likert scale and was self-reported. The average score of each subscale was calculated based on the average of the items associated with that subscale. The total score ranged from 1.00 to 5.00 points. A higher score indicated that the more frequent coping style was used. The Cronbach's alpha was 0.89.

Data analysis

The data were analyzed using SPSS software. The percentage, frequency, mean, and standard deviation of the demographic data were calculated, and coping, resilience, and parenting stress were evaluated using descriptive statistics. The correlations among parenting stress, coping, and resilience were analyzed by using the Pearson correlation coefficient, the *t*-test, and the one-way analysis of variance.

RESULTS

Demographic data

The characteristics of the participants are summarized in Table 1. The study participants were 160 parents or primary caregivers of children with SLD whose ages ranged from 23 to 73. The mean age of participants was 43.7 ± 8.9 .

Most of the participants were married ($n = 112$, 70%) and had a bachelor's degree ($n = 79$, 49.7%), and more than half of participants had an income of less than 20,000 *baht*/month ($n = 89$, 55.6%). Nearly half of the participants ($n = 76$) had two children (42.5%), and most ($n = 113$) were raising children on their own (70.6%).

Parenting stress

Most participants had a typical total stress level (91.9%), with subscales of PD (95%), P-CDI (81.9%), and DC (89.4%). The raw mean scores for the PD ($M = 28.9$, $SD = 6.2$), P-CDI ($M = 29.2$, $SD = 6.5$), DC ($M = 29.8$, $SD = 7.8$), and total stress ($M = 87.9$, $SD = 17.2$) are shown in Table 2.

Resilience

More than half of the participants had a normal level of total resilience (68.8%), as well as Emotional Stability (69.4%), Encourage (77.5%), and Problem-Solving (80%). The scores for total resilience ($M = 62.9$, $SD = 7.3$) and the subscales of Emotional Stability ($M = 30.7$, $SD = 4.1$), Encourage ($M = 16.7$, $SD = 2.3$), and Problem-Solving ($M = 15.4$, $SD = 2.4$) are shown in Table 2.

Coping

More than half of the participants rated problem-focused coping as the coping style they most typically used (66.3%); nearly half of the participants rated seeking social-support coping as generally used (48.8%), and about half of the participants rated avoidance coping as rarely used (50.6%). The mean scores for the subscales of Problem-Focused Coping ($M = 3.8$, $SD = 0.5$), Seek Social Support ($M = 3.0$, $SD = 0.8$), and Avoidance ($M = 2.3$, $SD = 0.6$) are shown in Table 2.

Correlation between demographic characteristics of participants and parenting stress

There wasn't a significant association between parental stress and demographic characteristics of participants.

Correlations between coping and parenting stress

There was a significant association between parental

TABLE 1. Demographic characteristics of participants (N = 160).

Characteristic		N	%
Marital status	Single	17	10.6
	Married	112	70
	Divorced/widow	31	19.4
Education level	Elementary school	31	19.4
	High school	49	30.6
	Bachelor's degree	79	49.4
Income (Baht/month)	<20,000	89	55.6
	20,001-30,000	40	25
	≥30,000	31	19.4
Children	1	68	42.5
	2	76	47.5
	≥3	16	10
Other caregivers	Do not have other caregivers	113	70.6
	Have other caregivers	47	29.4

TABLE 2. Total and subscale scores for parenting stress, resilience, and coping.

Item	Mean ± SD
Parenting stress	
Parenting stress total score	87.9 ± 17.2
Subscale	
Parental Distress (PD)	28.9 ± 6.2
Parent-Child Dysfunctional Interaction (P-CDI)	29.2 ± 6.5
Difficult Child (DC)	29.8 ± 7.8
Resilience	
Resilience total score	62.9 ± 7.3
Subscale	
Emotional Stability	30.7 ± 4.1
Encourage	16.7 ± 2.3
Problem Solving	15.4 ± 2.4
Coping	
Problem Focusing Coping	3.8 ± 0.5
Seek social support	3.0 ± 0.8
Avoidance	2.3 ± 0.6

stress and seeking social-support coping ($r = 0.207$, $p < 0.01$) and avoidance coping ($r = 0.538$, $p < 0.01$), but stress did not correlate with problem-focused coping ($r = -0.059$, $p = 0.46$), as shown in Fig 1.

Correlations between resilience and parenting stress

There was a significant negative association between parental stress and resilience. This indicates that a higher total resilience score is associated with lower parental stress ($r = -0.291$, $p < 0.01$), emotional stability ($r = -0.242$, $p < 0.01$), encouragement ($r = -0.297$, $p < 0.01$), and problem-solving ($r = -0.189$, $p < 0.05$), as shown in Fig 2.

DISCUSSION

Our study showed that most parents and primary caregivers have typical stress, as indicated by the total and all the subscales scores. The results were inconsistent with those in previous studies.^{3,16} The first explanation for this result is related to parents' internal factors. Smith et al.²⁵ found that mothers of toddlers with ASD use less emotional-focused coping and more problem-focused coping, which is associated with well-being. However, resilience might be another factor associated with parents' and caregivers' well-being. The findings of

a study on the effects of social support and resilience on parental stress regarding children with ASD showed that families with high resilience have lower parental stress.²² These studies demonstrated that coping and resilience are important to the well-being of a parent in difficult situations. These factors can help parents relieve stress and minimize the negative effects on their well-being. The second explanation centers on the behavior of the children. Craig et al.⁷ examined the parental stress of those with children who had a neurodevelopmental disorder, and found that parents of children with attention-deficit hyperactivity disorder (ADHD) and ASD have a higher level of stress than parents of children with SLD, which is associated with behavioral problems and IQ level. These results suggest that parents of children with SLD may have a reduced effect on their children's behavior than parents of children with ADHD or ASD. Other explanations deal with the time period. Parents of children with SLD who have a new diagnosis may stress out more than parents of children who have had a diagnosis for some time. Parents of children with a diagnosis have access to a parent-training program, group counseling, or individual therapy from specialists, which may help to reduce their stress.⁹

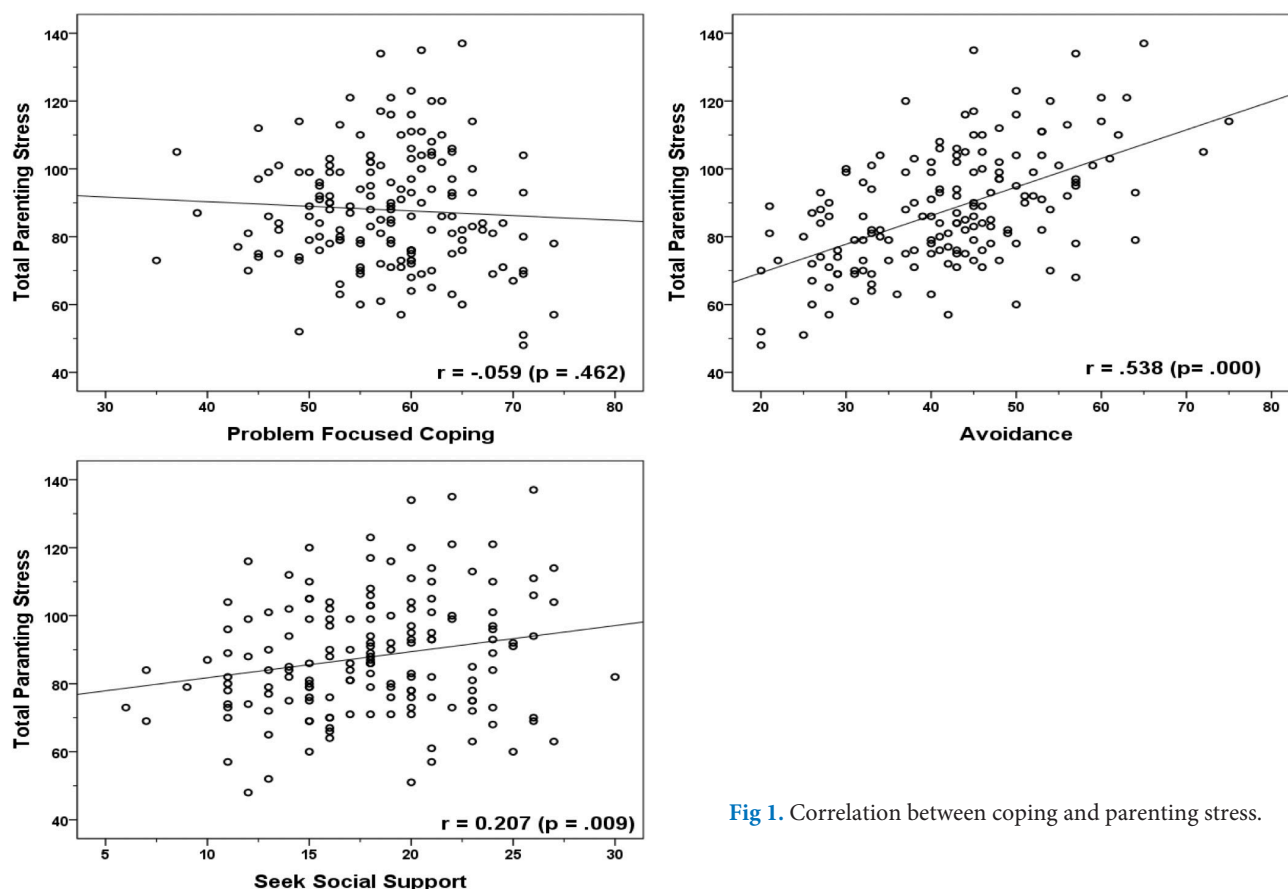


Fig 1. Correlation between coping and parenting stress.

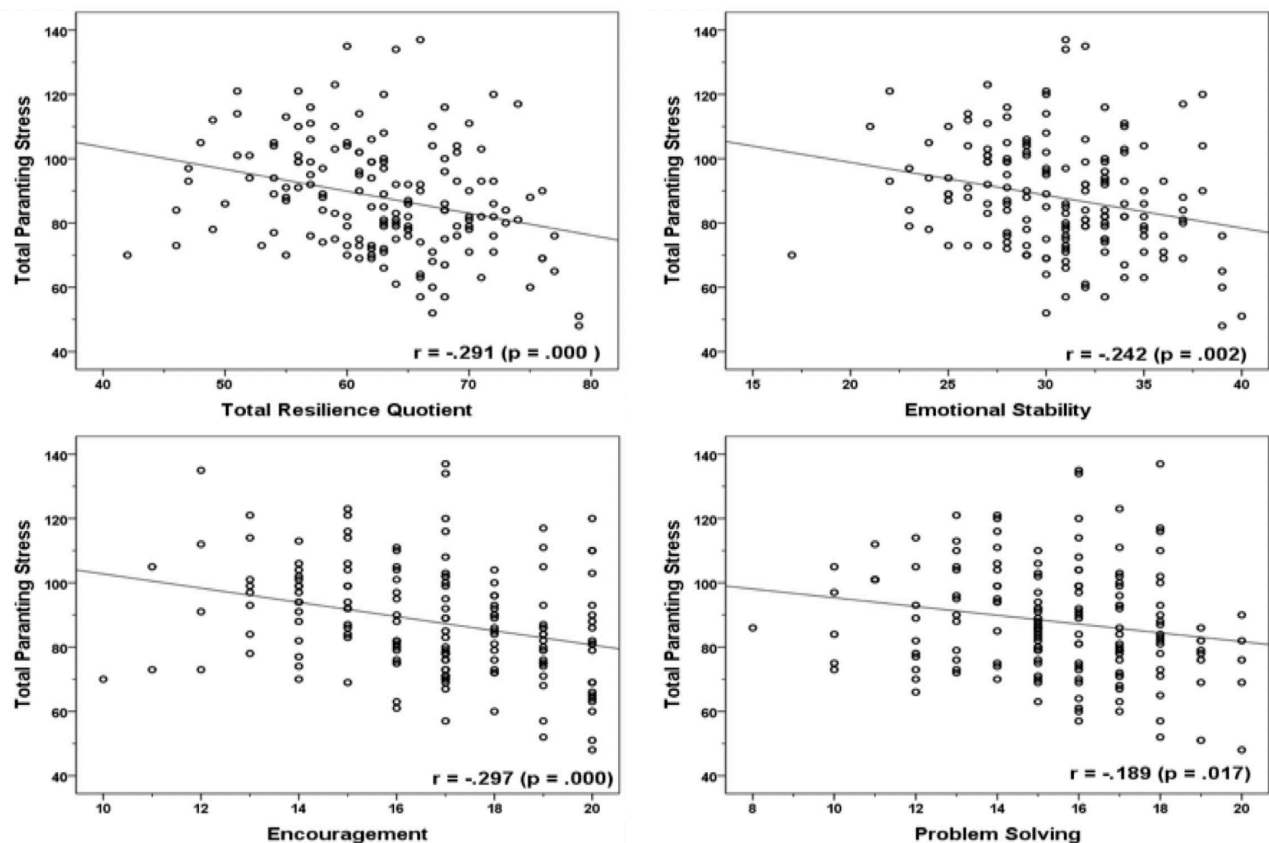


Fig 2. Correlation between resilience and parenting stress.

In terms of the correlations between parental characteristics and parenting stress, we found no correlation between demographic data and parenting stress. From this, we can assume that there are other factors that have a greater impact on parenting stress than parental characteristics. With regard to the correlation between coping and parenting stress, the results indicated that seeking social support was significantly correlated with parental stress ($r = 0.207, p < 0.01$). However, the trend of this study's results differed from that in other studies, which found that greater social support was associated with lower stress.²⁶ The previous study found that parents of children with a disability tend to seek social support more than other parents do,¹⁹ which is associated with high parental stress.²² Social support as an important factor for families dealing with stress, such as exchanging information, as well as advising and encouraging each other.²⁷ Parents should be encouraged to adapt to and select more effective coping methods when dealing with stress, including diseases.²⁸

We found that avoidance is significantly correlated with parenting stress ($r = 0.538, p < 0.01$), which connects to the findings of previous studies that reported that parents who used avoidance coping have greater stress

and more psychological problems.^{20,29} It is possible that handling many stressors that are difficult to resolve can lead to a higher level of stress, which may result in avoidance coping to avoid negative feelings. A previous study found that fathers of children with a disability who dealt with many stressors had less effective coping skills.³⁰ Similarly, Vidyasagar and Koshy³¹ found that the behavioral problems of children with ASD raised their mother's stress levels, and avoidance coping may help these mothers to reduce their stress. However, using avoidance coping skills in situations of long-term stress tends to cause more negative effects on parental well-being.³³

The next examination was the correlations between resilience and parental stress. We found that resilience was significantly and negatively correlated with parental stress ($r = -0.291, p < 0.01$). This is consistent with the results of a previous study, which found a negative relationship between family resilience and parental stress.²² This indicates that parents who have high parental stress also have a lower level of resilience. There are many possible explanations for this outcome. A person with resilience is more tolerant to stressors, mainly because those who possess resilience characteristics, such as prior

experience dealing with a child's behavioral problems or discussing their challenges with others who have the same problem,²⁰ helped to mitigate the problems. One study found that families of children with ASD or disabilities use resilience, for example, to focus on the positive side of a problem, to find a meaning in life,³² to collaborate with family, seek support, solve problems,²² and improve their self-esteem.³³ These characteristics help parents endure various obstacles. Parents of children with SLD may use resilience characteristics when dealing with stress, such as problems in adjusting, problems with the relationship between the parent or caregiver and child, or difficulty handling a child's behavior. These parents may receive encouragement from family members or seek advice from a specialist, which helps to build emotional-control skills, self-esteem, self-efficacy,³⁴ hope, and will depend less on external sources.³⁵

To the best of our knowledge, the present study is the first study investigate the parental stress of children with SLD in this country. However, several limitations should be considered, (1) This study was conducted in a single tertiary-care hospital which might not represent all Thai parents of SLD children or might not be generalizable to other setting, (2) the data was collected from a self-rated questionnaire. Additional clinical information, e.g., duration before and after diagnosis, children's comorbidities and treatment might contribute to level of stress of parents. Therefore, further researches that conduct in the different setting and investigate the factors that may associate with parental stress are required.

ACKNOWLEDGMENTS

This study was supported by a Siriraj Graduate Scholarship, Faculty of Medicine Siriraj Hospital, Mahidol University. The authors would also like to thank the Child and Adolescent Psychiatry Out-Patient Unit for allowing us to collect the data. We would like to thank Dr. Jingswat Sirikunchoat, research fellow, for coordination and document preparation, and Dr. Chulalak Komoltri for advice with sample size calculation and statistical analysis.

Conflict of interest: The authors declare that they have no competing interests.

REFERENCES

1. American Psychiatric Association. *Diagnostic and Statistical Manual of Mental Disorders*. 5th ed. Washington, DC: American Psychiatric Association Publishing; 2013.
2. Wiener J, Timmermanis V. Chapter 4 - Social Relationships: The 4th R. In: Wong B, Butler D, editors. *Learning About Learning Disabilities*. 4th ed. San Diego, CA: Academic Press; 2012. p.89-140.
3. Bonifacci P, Storti M, Tobia V, Suardi A. Specific Learning Disorders: A Look Inside Children's and Parents' Psychological Well-Being and Relationships. *J Learn Disabil* 2016;49:532-45. Available from: <https://doi.org/10.1177/0022219414566681>
4. Matteucci MC, Scalone L, Tomasetto C, Cavrini G, Selleri P. Health-related quality of life and psychological wellbeing of children with Specific Learning Disorders and their mothers. *Res Dev Disabil* 2019;87:43-53.
5. Ginieri-Coccosis M, Rotsika V, Skevington S, Papaevangelou S, Malliori M, Tomaras V, et al. Quality of life in newly diagnosed children with specific learning disabilities (SpLD) and differences from typically developing children: A study of child and parent reports. *Child: Care Health Dev* 2013;39:581-91.
6. Karande S, Bhosrekar K, Kulkarni M, Thakker A. Health-related Quality of Life of Children with Newly Diagnosed Specific Learning Disability. *J Trop Pediatr* 2008;55:160-9.
7. Craig F, Operto FF, De Giacomo A, Margari L, Froli A, Conson M, et al. Parenting stress among parents of children with Neurodevelopmental Disorders. *Psychiatry Res* 2016;242: 121-9.
8. Dangnumkoo D. Parenting stress in caretakers of children with ADHD [Master's thesis]. Bangkok, Thailand: Chulalongkorn University; 2006.
9. Estes A, Munson J, Dawson G, Koehler E, Zhou XH, Abbott R. Parenting stress and psychological functioning among mothers of preschool children with autism and developmental delay. *Autism* 2009;13:375-87.
10. Karande S, Kumbhare N, Kulkarni M, Shah N. Anxiety levels in mothers of children with Specific Learning Disability. *J Postgrad Med* 2009;55:165-70.
11. Heiman T. Parents of children with disabilities: Resilience, coping, and future expectations. *J Dev Phys Disabil* 2002;14:159-71.
12. Costa AP, Steffgen G, Ferring D. Contributors to well-being and stress in parents of children with autism spectrum disorder. *Res Autism Spectr Disord* 2017;37:61-72.
13. Deater-Deckard K. Parenting Stress and Child Adjustment: Some Old Hypotheses and New Questions. *Clin Psychol Sci Pract* 1998;5:314-32.
14. Farmer AY, Lee SK. The Effects of Parenting Stress, Perceived Mastery, and Maternal Depression on Parent-Child Interaction. *J Soc Serv Res* 2011;37:516-25.
15. Rojanapornpant D. Problem-coping strategy and hope in the workplace: A case study of an import-export company [Master's thesis]. Bangkok, Thailand: Thammasat University; 2009.
16. Rice PL. *Stress and Health*. 2nd ed. Belmont, CA: Thomson Brooks/Cole Publishing; 1999.
17. Paster A, Brandwein D, Walsh J. A comparison of coping strategies used by parents of children with disabilities and parents of children without disabilities. *Res Dev Disabil* 2009;30:1337-42.
18. Benson PR. Coping, distress, and well-being in mothers of children with autism. *Res Autism Spectr Disord* 2010;4:217-28.
19. Division of Mental Health Promotion and Development. *Manual: Resilience for school*. Nonthaburi, Thailand: Beyond Publishing; 2009.
20. Suwanmaitri S, Limseau U, Parchong C. *Manual: Mental*

- health care in crisis (continue). Nonthaburi, Thailand: Department of Mental Health; 2007.
21. Youssef-Morgan C, Luthans F. Psychological Capital and Well-being. *Stress Health* 2015;31:180-8.
 22. Plumb JC. The impact of social support and family resilience on parental stress in families with a child diagnosed with an autism spectrum disorder [dissertation]. Philadelphia, PA: University of Pennsylvania; 2011.
 23. Paola B, Michele S, Valentina T, Alessandro S. Specific Learning Disorders: A Look Inside Children's and Parents' Psychological Well-Being and Relationships. *J Learn Disabil* 2016;49:532-45.
 24. Prathana L. Job stress, Coping strategies and Burnout among Helping Practitioners in Public Welfare Centers: A Mixed Methods Research. Bangkok: Chulalongkorn University; 2011.
 25. Smith LE, Seltzer MM, Tager-Flusberg H, Greenberg JS, Carter AS. A comparative analysis of well-being and coping among mothers of toddlers and mothers of adolescents with ASD. *J Autism Dev Disord* 2008;38:876-89.
 26. Huang CY, Costeines J, Ayala C, Kaufman JS. Parenting Stress, Social Support, and Depression for Ethnic Minority Adolescent Mothers: Impact on Child Development. *J Child Fam Stud* 2014;23:255-62.
 27. Bailey AB, Smith SW. Current Topics in Review: Providing Effective Coping Strategies and Support for Families with Children with Disabilities. *Interv Sch Clin* 2000;35:294-6.
 28. Weiss JA, Robinson S, Fung S, Tint A, Chalmers P, Lunskey Y. Family hardiness, social support, and self-efficacy in mothers of individuals with Autism Spectrum Disorders. *Res Autism Spectr Disord* 2013;7:1310-7.
 29. Hastings RP, Kovshoff H, Brown T, Ward NJ, Espinosa FD, Remington B. Coping strategies in mothers and fathers of preschool and school-age children with autism. *Autism* 2005;9:377-91.
 30. Strachan JW. Fathers of Children with Educational Disabilities: The Role of Stress in Life Satisfaction [dissertation]. Tallahassee, FL: Florida State University; 2005.
 31. Vidyasagar N, Koshy S. Stress and Coping in Mothers of Autistic Children. *J Indian Acad Appl Psychol* 2010;36:245-8.
 32. Bayat M. Evidence of resilience in families of children with autism. *J Intellect Disabil Res* 2007;51:702-14.
 33. Strnadová I. Stress and resilience in families of children with Specific Learning Disabilities. *Rev Complut Educ* 2006;17:35-50.
 34. Steeger CM, Gondoli DM, Morrissey RA. Maternal Avoidant Coping Mediates the Effect of Parenting Stress on Depressive Symptoms during Early Adolescence. *J Child Fam Stud* 2013; 22:952-61.
 35. Richardson GE. The metatheory of resilience and resiliency. *J Clin Psycho* 2002;58:307-21.

Life Assets and Substance Use of High School Students in Songkhla

Chalita Khirirat, M.D., Teerapat Teetharatkul, M.D., Jaturaporn Sangkool, M.D.

Department of Psychiatry, Faculty of Medicine, Prince of Songkla University, Hat Yai, Songkhla 90110, Thailand.

ABSTRACT

Objective: To examine the association between life assets (including demographic factors) and substance use among high school students.

Materials and Methods: In this cross-sectional study, 1,713 participating students were asked to fill out questionnaires. Data were analyzed using descriptive statistics (e.g., mean, frequency and standard deviation); associating factors were analyzed via univariate analysis and ordinal logistic regression.

Results: Among the participants, 67.5% were females with a mean age of 16.4 ± 0.96 years. On average, the participants have a good level of overall life assets, except for community power. Those with a mean age of 14.3 years engaged in substance use early, with peer influence being a leading cause (8.1%). 48.0% of the participants had used substance in their lifetime, and 74.7% of them had used only 1 substance, with alcohol being the most prevalent (97.7%). An excellent level of participant life assets, especially wisdom power, was negatively associated with substance use (OOR = 0.48). Other significant factors that discouraged substance use were being an only child (OOR = 0.75), having a high cumulative grade point average (GPA) (OOR = 0.63), and belonging to a two-parent family. (OOR = 0.79)

Conclusion: This study affirms a negative relationship between an excellent level of life assets, especially wisdom power, and substance use. Demographic factors like being an only child, having a high GPA, and belonging to two-parent households also showed a strong negative association with substance use.

Keywords: Life assets; substance; student; high school (Siriraj Med J 2021; 73: 46-54)

INTRODUCTION

Substance use is a substantial public health problem worldwide. The United Nations Office on Drugs and Crime estimates that 271 million people around the globe used substances in 2016. Moreover, the number of substance users who suffered from substance use disorders and who died from substance use was 35 million and more than half a million, respectively.¹ Substance abuse is a social problem in Thailand as well. According to surveys, 2.9 million Thai people were

substance abusers in 2016² (youths aged 12-15 years in Bangkok are exposed to substance use early)³, and 50% of patients at rehabilitation centers were youths who tended to use combinations of substances.⁴ In addition to the propensity for developing health problems, adolescents who use substances excessively are highly susceptible to having irritability and psychosis, leaving schools, having broken families, and committing crimes.^{4,5} Therefore, it is important to identify adolescents at risk for substance use and provide an effective early intervention for them.

Corresponding author: Jaturaporn Sangkool

E-mail: sjaturap@medicine.psu.ac.th

Received 14 September 2020 Revised 8 October 2020 Accepted 9 October 2020

ORCID ID: <http://orcid.org/0000-0002-6395-1394>

<http://dx.doi.org/10.33192/Smj.2021.07>

Prior studies have examined factors that are negatively associated with adolescent substance use. These protective factors-or *assets*-include academic achievement⁶, family support^{6,7}, positive peers^{8,9}, and adult role models.⁷ In particular, adolescents with high academic aspirations⁶, supportive parents⁷, and low substance use among friends⁹ are less inclined to engage in substance use.

Apart from these protective factors, life assets are viewed as positive supports and strengths that may prevent adolescents from engaging in risk behaviors, e.g. substance use. In the United States, the Developmental Assets Framework was developed to evaluate life assets using 40 indicators.¹⁰ Based on this framework, many studies have reported that individuals with many life assets were less likely to use cigarettes, alcohol, and marijuana in the past 30 days.¹¹ In addition, life assets may promote positive behaviors such as high academic achievement, the use of safety belts, and engaging in aerobic exercise.¹¹ In Thailand, using the same framework¹⁰, life assets have been assessed using 48 indicators that are categorized into 5 domains: self-power, family power, peer power, wisdom power, and community power.^{5,12} Thai high school students have been reported to pass the overall criteria for life assets, except community power.¹³⁻¹⁵ However, there is limited evidence showing how life assets may prevent substance use among students in Thailand.

The objective of this study was to examine the relationship between life assets as well as other demographic factors and substance use in high school students in Songkhla province, an endemic area of substance use in Southern Thailand.¹⁶

MATERIALS AND METHODS

The Ethics Committee of the Faculty of Medicine, Prince of Songkla University approved this cross-sectional study (REC.62-032-3-4). It was conducted from June to September, 2019. The sample size was calculated by G*Power that had an effect size as 0.1, the Alpha as 0.05, the Power as 0.8 and the Degree of Freedom (df) as 4. Among 1,713 students studying in grades 10-12 from 7 high schools in Hat Yai, which were selected randomly using cluster sampling and probability proportional to size. To be enrolled in the survey, the students needed to be able to both understand and complete the questionnaires, while students on a leave of absence were excluded.

Methodology

The randomly selected students were first introduced to the rationale of the study, and then they were informed about the acquired information as well as the protection

of their confidential information. If the students agreed to participate in the surveys, they would take a few minutes to complete the questionnaires without the requirement for their signatures in order to ensure their anonymity. After their completion, the questionnaires were placed in boxes in front of the classroom by the students themselves. The results were returned to the participants' e-mail addresses. All participants had the right to request a withdrawal at any time and without repercussion.

Instruments

The questionnaires consisted of 4 parts:

1) Demographic data comprised gender, age, ethnicity, academic year, cumulative grade point average (GPA), child order, religion, area of residence, type of residence, people living with, parent's marital status, and parent's level of education.

2) The Life Assets Questionnaire (youth version) consisted of 48 items enquiring about self-power (15 items), family power (8 items), wisdom power (11 items), peer power (6 items), and community power (8 items). For each item, the responses ranged from "0" (none) to "3" (regularly). The total scores were categorized into 4 levels: excellent ($\geq 80.0\%$), good (70.0-79.9%), moderate (60.0-69.9%), and low ($< 60\%$), which was considered to indicate failure. In this questionnaire, a Cronbach's alpha is 0.89.¹²

3) Substance use information included age at initiation of use, reasons for use, and types of substance used.

4) The ASSIST-Lite Thai version¹⁷ consists of 8 questions related to illicit substances; there are a few questions enquiring in more detail about each substance. In total, it contains 19 items rated with "Yes" (score one) or "No" (score zero). The cut-off score of a likely substance use disorder (SUD) is 2, while the cut-off score of alcohol is 3. The ASSIST-Lite has the AUC [0.8-1.0], sensitivity [0.8-1.0] and specificity [0.7-0.8].¹⁸ In this study, we use the ASSIST-Lite to assess the past-3-month substance use among students.

Statistical analysis

The data were analyzed using descriptive statistics, e.g. percentage, frequency, average, and standard deviation. The factors associated with substance use were scrutinized via univariate analysis. If the p-value from the univariate analysis was less than 0.2, those factors were analyzed using an ordinal logistic regression. Those factors with a p-value of less than 0.05 were indicated as the statistically significant factors.

RESULTS

Demographic data

Of the 1,713 participants, 67.5% were female with mean age of 16.4 ± 0.96 years (range 15-19 years). The students studied in grades 10 (31.9%), 11 (33.0%); and 12 (35.0%). The majority of them was Buddhist (89.6%), had siblings (80.2%), had GPAs in the 3.00-4.00 range (53.1%), lived in urban areas (71.8%), and lived in two-parent households (65.0%).

Substances

Fig 1 shows the details of substance use categorized in 3 groups: students with a lifetime substance use, students with a past-3-month occasional use, and students with a likely substance use disorder (SUD) based on the past-3-month use. The common substances in the lifetime use category were alcohol (97.7%), smoking (21.6%), and stimulants (8.8%). About three quarters (74.7%) of participants used 1 substance, while the remaining quarter (25.3%) were polysubstance abusers. The number

of male students was higher than that of females in terms of using substances in combination.

Fig 2 shows that the proportions of participants who reported substance use by grade were: grade 12 (38.4%), grade 11 (36.4%), and grade 10 (25.2%). 66% of them were identified as female, 32.5% as male, and 1.5% as other.

As shown in Fig 3, approximately half (48.0%) of the participants reported a lifetime substance use. 39.3% of participants were past-3-month substance users and 8.7% of participating students were past-3-month substance non users. Fig 4 shows the past-3-month substance users. 63.4% of them reported occasional substance users, and 36.6% were students with likely SUD.

The average age of the participating students at the initiation of substance use was 14.3 years. Fig 5 shows that the reasons for engaging in substance use were peer influence (8.1%), sadness or stress (7.0%), and curiosity (6.5%).

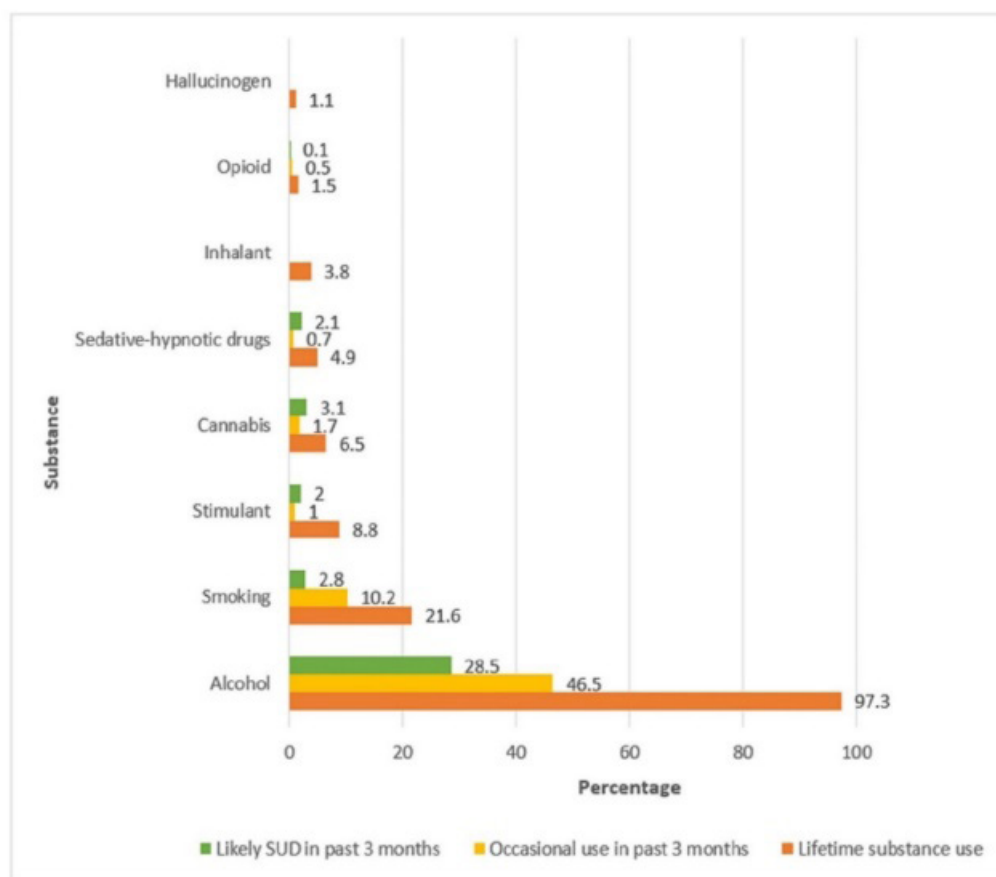


Fig 1. Substances used in the 3 groups: lifetime substance users, past-3-month occasional users, and past-3-month users with likely SUD (n=818).

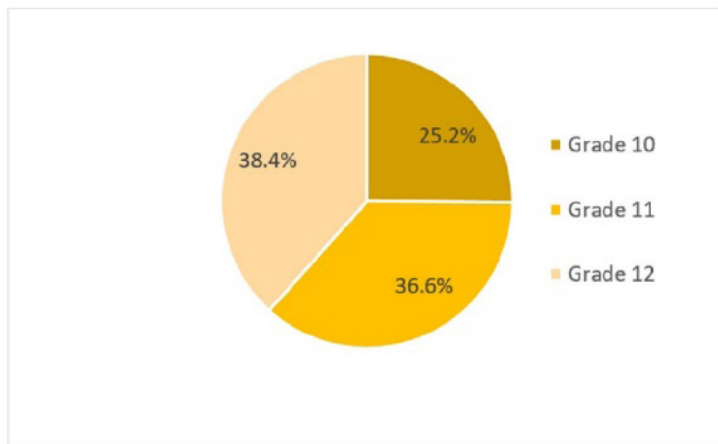


Fig 2. Academic year and substance use.

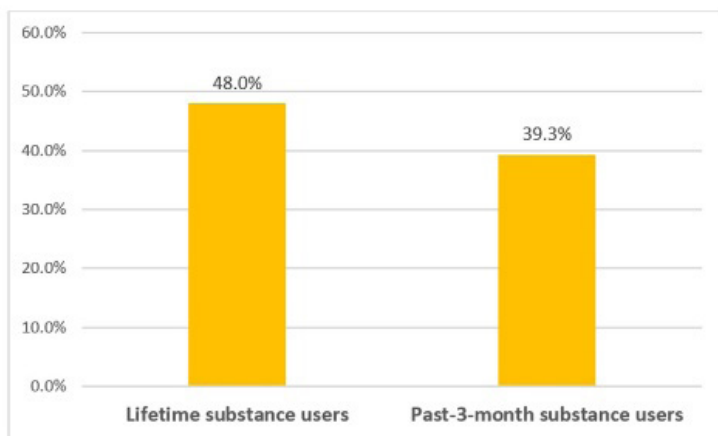


Fig 3. Lifetime and past-3-months substance users.

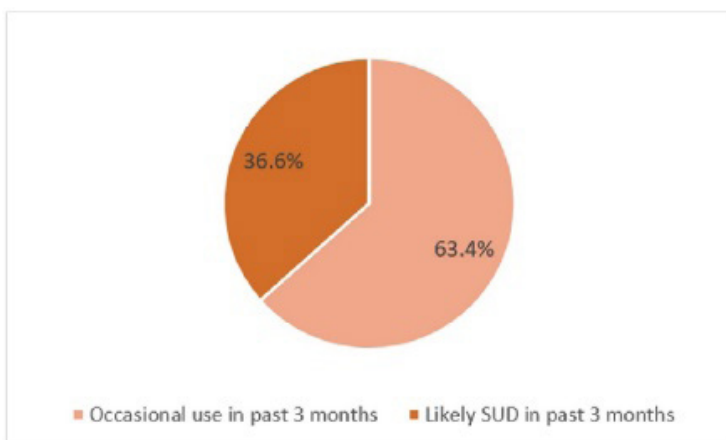


Fig 4. Past-3-months substance users.

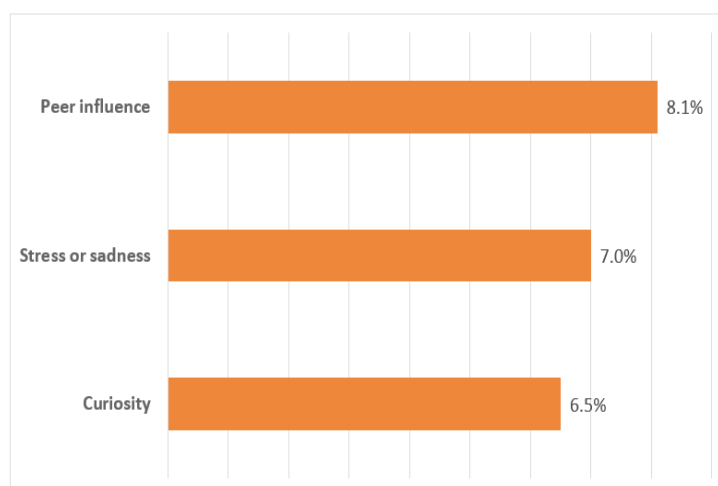


Fig 5. The reasons of substance use.

Life assets

On average, the participants had a good level of life assets; 81.9% of them met the criteria for life assets. In particular, they had an excellent level of family power, a good level of self-power, a moderate level of peer and wisdom power, and a low level of community power.

Table 1 presents the data related to the overall life assets as well as per the 5 life asset domains according to the 3 subgroups: non-users, past-3-month occasional users, and past-3-month users with likely SUD. In terms of the life assets, the majority of non-users and past-3-month occasional users had the good level, while past-3-month users with likely SUD had the moderate level.

The association between life assets, demographic data, and substance use

Tables 1 and 2 show the univariate analysis results of the demographic data and life assets according to the 3 student groups: non-users, past-3-month occasional users, and past-3-month users with likely SUD. The variables that were analyzed using an ordinal logistic regression were gender, siblings, GPA, type of residence, people living with, and life assets (self-power, family power, and wisdom power). The majority of non-users, past-3-month occasional users and past-3-month users with likely SUD had similar trends in terms of demographic factors; for example, the majority of the 3 subgroup lived in two-parent households, had high GPA, and had an excellent level of self-power.

As shown in Table 3, students with an excellent level of life assets were less likely to engage in substance use, and the related factors that were found to discourage substance use statistically were being an only child, having a GPA the range between 3.00 and 4.00, and belonging to a two-parent family (P -value < 0.05). Moreover, a negative relationship between having an excellent level of wisdom power and substance use was detected (OOR = 0.48, 95% CI 0.35-0.66, P -value < 0.001).

DISCUSSION

This research examines the association between life assets and substance use in Thai students. Our results suggest a lower prevalence of substance use among students with an excellent level of life assets (especially wisdom power). According to previous studies in the United States^{8,11}, the number of assets was negatively related to alcohol and substance use, and youths who had any 1 of the assets were approximately 1.5 to 3 times more likely to report nonuse of substances. Our findings support that the demographic factors such as

being an only child, belonging to two-parent households, and having a high GPA are statistically found to deter students from engaging in substance use. The studies in Kenya¹⁹, California²⁰ and Thailand²¹⁻²⁴ also suggest that students who are an only child, who belong to two-parent households, and who have a high academic performance may be less likely to use substances. Possible reasons may be the protection and attention they receive from one or both parents¹⁹, close parental monitoring²⁰, their sound understanding of the negative consequences of substance use²⁴, a good sense of competency, and a healthy level of self-control.²³ According to our results, the students met the overall criteria of life assets; the only exception was community power. Consistent with past surveys in Thailand¹³⁻¹⁵, Thai students also met the overall criteria of life assets, except the community power. These results may be explained by the evolution of individualist societies.

Furthermore, 48% of the participating students reported engaging in lifetime substance use, and 39.3% were past-3-month substance users, of whom 63.4% participated in occasional substance use, and the remaining 36.6% were participants with likely SUD. These results mirror the findings of past studies, which have reported that students tend to try substances rather than use them regularly.²⁵ Alcohol was the most commonly used substance. According to Bangkok survey³, Thai teenagers easily access to alcohol because two-thirds of them purchased alcohol by themselves.

In addition, it was found that, on average, the students initiated their use of substances at the age of 14.3 years due to primarily peer influence, stress or sadness, and curiosity. Consistent studies in Colorado²⁶, peer relationships are positively associated with adolescent substance use. In Thai surveys³, teenagers drank alcohol for social purposes; drank alcohol with peers and drank alcohol alone when they had life problems. Adolescents who have peers that use substances and those experiencing high stress levels tend to use substances because they may observe and decide to imitate close their friends' negative behaviors^{21,27} or substances as self-medication for mood-altering purposes.²⁶

In conclusion, both researchers and healthcare practitioners may find the results of our study useful for the development in preventing substance use among high school students. Finally, national public health policies should focus on developing interventional strategies that aim to boost the students' life assets, and in particular, to promote education related to the dangers of engaging in substance use.

TABLE 1. Univariate analysis of life assets and their 5 domains among past-3-month substance users.

Life assets domains	Number of users (%)				P-value
	Overall Participants (n=1713)	Lifetime non substance users (n=886)	Past-3-month occasional users (n=425)	Past-3-month users with likely SUD (n=245)	
Life assets					0.01
Failure	310 (18.1)	146 (16.5)	94 (22.1)	48 (19.6)	
Moderate level	482 (28.1)	241 (27.2)	121 (28.5)	75 (30.6)	
Good level	525 (30.6)	263 (29.7)	134 (31.5)	72 (29.4)	
Excellent level	396 (23.1)	236 (26.6)	76 (17.9)	50 (20.4)	
Self-power					0.13
Failure	118 (6.9)	63 (7.1)	28 (6.6)	20 (8.2)	
Moderate level	354 (20.7)	162 (18.3)	108 (25.4)	50 (20.4)	
Good level	458 (26.7)	236 (26.6)	109 (25.6)	65 (26.5)	
Excellent level	783 (45.7)	425 (48.0)	180 (42.4)	110 (44.9)	
Family power					0.03
Failure	224 (13.1)	103 (11.7)	61 (14.4)	37 (15.1)	
Moderate level	1163 (9.5)	72 (8.1)	46 (10.8)	29 (11.8)	
Good level	317 (18.5)	152 (17.2)	86 (20.3)	49 (20.0)	
Excellent level	1006 (58.7)	557 (63.0)	231 (54.5)	130 (53.1)	
Wisdom power					<0.001
Failure	541 (31.6)	251 (28.4)	166 (39.2)	88 (35.9)	
Moderate level	502 (29.2)	253 (28.6)	123 (29.0)	70 (28.6)	
Good level	291 (17.0)	141 (16.0)	63 (14.9)	51 (20.8)	
Excellent level	377 (22.0)	239 (27.0)	72 (17.0)	36 (14.7)	
Peer power					0.29
Failure	410 (23.9)	224 (25.3)	98 (23.1)	51 (20.8)	
Moderate level	467 (27.3)	228 (25.7)	128 (30.1)	62 (25.3)	
Good level	390 (22.8)	197 (22.2)	101 (23.8)	60 (24.5)	
Excellent level	446 (26.0)	237 (26.7)	98 (23.1)	72 (29.4)	
Community power					0.33
Failure	939 (54.8)	477 (54.0)	250 (58.8)	129 (52.7)	
Moderate level	257 (15.0)	131 (14.8)	61 (14.4)	38 (15.5)	
Good level	243 (14.2)	122 (13.8)	62 (14.6)	37 (15.1)	
Excellent level	271 (15.8)	154 (17.4)	52 (12.2)	41 (16.7)	

TABLE 2. Univariate analysis of demographic characteristics among past-3-month substance users.

Demographic data	Number of users (%)				P-value
	Overall Participants (n=1713)	Lifetime non substance users (n=886)	Past-3-month occasional users (n=425)	Past-3-month users with likely SUD (n=245)	
Gender					0.002
Male	539 (31.5)	271 (30.6)	117 (27.5)	98 (40.0)	
Female	1157 (67.5)	610 (68.8)	304 (71.5)	142 (58.0)	
Other	17 (1.0)	5 (0.6)	4 (0.9)	5 (2.0)	
Siblings					0.07
Only child	314 (18.3)	178 (20.3)	64 (15.2)	41 (17.1)	
Siblings	1373 (80.2)	697 (79.7)	356 (84.8)	199 (82.9)	
GPA					<0.001
<3.00	450 (26.3)	200 (28.4)	120 (35.9)	83 (41.7)	
3.00-4.00	910 (53.1)	505 (71.6)	214 (64.1)	116 (58.3)	
Residence type					0.13
House	1497 (87.4)	749 (85.3)	338 (80.3)	199 (81.2)	
Dormitory	153 (8.9)	68 (7.7)	48 (11.4)	28 (11.4)	
Other (condominium)	51 (3.0)	61 (6.9)	35 (8.3)	18 (7.3)	
People living with (could choose more than one answer)					
Two-parent household	1114 (65.0)	602 (67.9)	270 (63.5)	139 (56.7)	0.004
One-parent household	335 (19.6)	168 (19.0)	79 (18.6)	58 (23.7)	0.21
Siblings	904 (52.8)	474 (53.6)	226 (53.3)	122 (49.8)	0.57
Friends	58 (3.4)	16 (1.8)	23 (5.4)	15 (6.1)	<0.001
Alone	59 (3.4)	28 (3.2)	19 (4.5)	11 (4.5)	0.4
Parent's marital status					0.43
Married	1263 (73.7)	668 (75.5)	310 (72.9)	171 (69.8)	
Separated	102 (6.0)	53 (6.0)	26 (6.1)	14 (5.7)	
Divorced	253 (14.8)	117 (13.2)	69 (16.2)	46 (18.8)	
Widowed	93 (5.4)	47 (5.3)	20 (4.7)	14 (5.7)	

TABLE 3. Multivariate analysis of demographic factors and life assets among past-3-month substance users.

Factors	Ordinal odds ratio	95% CI	P-value
Only child	0.75	0.55-1.00	0.03
GPA 3.00-4.00	0.63	0.50-0.79	<0.001
Two-parent household	0.79	0.63-0.99	0.02
Life assets			
Moderate level	0.78	0.57-1.07	0.06
Good level	0.79	0.58-1.08	0.07
Excellent level	0.62	0.44-0.87	<0.001

Limitations

There are two main limitations in this study. First, this cross-sectional survey cannot show a clear causal relationship between the students' life assets and substance use because it employed only self-reporting questionnaires. There is a real possibility that the participants might have not provided truthful information regarding their substance use due to it being considered a socially unacceptable behavior. Second, the study population was randomly sampled only from students in Southern Thailand; therefore, these findings might not be valid for all Thai students throughout the country. Furthermore, the majority of the participants were female students, who tend to be less likely to use substances.

Implications and future recommendations

Further studies should examine the life assets of students in alternative schools as well as those pursuing non-formal education. Thus, multi-center cohort studies are recommended.

CONCLUSION

This study investigated the association between individual life assets (including demographic factors) and the use of substance. Its findings revealed a statistically positive relationship between life assets and substance non-use. The students with an excellent level of life assets, especially wisdom power, were significantly less likely to use substances. The related factors that discouraged substance use were being an only child, having a high GPA, and belonging to two-parent households.

ACKNOWLEDGMENTS

This study was fully funded by the Faculty of Medicine, Prince of Songkla University, Thailand. The authors sincerely appreciate the invaluable role Mrs. Nisan Werachattawan and Ms. Kruewan Jongborwanwiwat played in the data analysis. The authors also would like to express their gratitude to the participating students.

REFERENCES

1. United Nations Office on Drugs and Crime. World drug report 2019. Vienna: United Nations publication, 2019.
2. Kanato M, Assanangkornchai S, Charoenratana S. National household survey, estimation of population related with substance abuse. Bangkok: Jaransanitvong Press, 2016.
3. Ruangkanchanasetr S, Plitponkarnpim A, Hetrakul P, Kongsakon R. Youth risk behavior survey: Bangkok, Thailand. *J Adolesc Health* 2005;36:227-35.
4. Choosunthia W, Pinitsuntorn S. The impact of drug addiction on patients admitted to Thanyarakhospital, Udonthani: a case study. *CHDKKU* 2017;5:523-33.
5. Tripathi S, Musikaphan W. Quality of children's life 2013. 1st ed. Bangkok: Appa printing group, 2013.
6. Kodjo CM, Klein JD. Prevention and risk of adolescent substance abuse: the role of adolescents, families, and communities. *Pediatr Clin North Am* 2002;49:257-68.
7. Beebe L, Vesely S, Oman R, Tolma E, Aspy C, Rodine S. Protective assets for non-use of alcohol, tobacco and other drugs among urban American Indian youth in Oklahoma. *Matern Child Health J* 2008;12:82-90.
8. Oman R, Vesely S, Aspy C, McLeroy K, Rodine S, Marshall L. The potential protective effect of youth assets on adolescent alcohol and drug use. *Am J Public Health* 2004;94:1425-30.
9. Hussong A. Differentiating peer contexts and risk for adolescent substance use. *J Youth Adolescence* 2002;31:207-20.

10. PL Benson, EC Roehlkepartain. Tapping the power of community: building assets to strengthen substance abuse prevention. *Search Institute Insights & Evidence* 2004;2:1-14.
11. Murphey D, Lamonda K, Carney J, Duncan P. Relationships of a brief measure of youth assets to health-promoting and risk behaviors. *J Adolesc Health* 2004;34:184-91.
12. Tripathi S, Sungthong P, Salachan S. User Guide on Life Assets Inventory for Thai Children and Youth (youth version). 2nd ed. Bangkok: Appa printing group, 2010.
13. Srichantr-intr N, Ketumarn P, Tripathi S. Life assets in academically talented students: case study of the participants in international mathematics and science Olympiad 2013. *J Psychiatr Assoc Thailand* 2014;59:151-62.
14. Tripathi S. The national survey of life assets (positive youth development) among secondary school students in Thailand. *J Adolesc Health* 2013;52:s6.
15. Petchruschatachart U, Balhip K, Piriyaakontorn S. Life's assets and quality of life of Thai junior high school adolescent, Songkhla province. *Songklanagarind J Nurs* 2016;36:55-69.
16. Office of the Narcotics Control Board: Ministry of Justice. Report of Illicit drug situation in 7 provinces of southern Thailand. Bangkok: Ministry of Justice, 2017.
17. Assanangkornchai S, Tantirungsri N. ASSIST, ASSIST-Lite, ASSIST-Y and e-ASSIST. 1st ed. Songkhla: Prince of Songkla University, 2014.
18. Ali R, Meena S, Eastwood B, Richards I, Marsden J. Ultra-rapid screening for substance-use disorders: The Alcohol, Smoking and Substance Involvement Screening Test (ASSIST-Lite). *Drug and Alcohol Dependence* 2013;132:352-61.
19. Mukangi A. The role of birth order in substance related disorders. *AJOL* 2010;2:221-37.
20. Hemovich V, Lac A, Crano WD. Understanding early-onset drug and alcohol outcomes among youth: The role of family structure, social factors, and interpersonal perceptions of use. *Psychol Health Med* 2011;16:249-67.
21. Hawkins J, Catalano R, Miller J. Risk and protective factors for alcohol and other drug problems in adolescence and early adulthood: implications for substance abuse prevention. *Psychol Bull* 1992;112:64-105.
22. Chinakate S. Factors affection to preventive behavior on drug among the vocational certificate students in college under the provincial vocational education of Ratchaburi [Thesis]. Nakhon Pathom: Silpakorn University; 2010.
23. Schulenberg J, Bachman JG, O'Malley PM, Johnston LD. High school educational success and subsequent substance use: a panel analysis following adolescents into young adulthood. *J Health Soc Behav* 1994;35:45-62.
24. Chagphimai C, Sritanasal P. Self-defense behaviors from drugs of students at King Mongkut's University of technology north Bangkok [Thesis]. Bangkok: King Mongkut's University of Technology North Bangkok; 2001.
25. Srisatchang A. Knowledge, understanding, and factors related to students' drug abuse at Prince of Songkla University [Thesis]. Songkhla: Prince of Songkla University; 2002.
26. Whitesell M, Bachand A, Peel J, Brown M. Familial, social, and individual factors contributing to risk for adolescent substance use. *J Addict* 2013;2013:1-9.
27. Bandura A. Influence of models' reinforcement contingencies on the acquisition of imitative responses. *J Pers Soc Psychol* 1965;1:589-95.

Reliability and Validity of the Thai Version of the Modified Japanese Orthopaedic Association Score (mJOA score)

Sirichai Wilatratsami, M.D., Borriwat Santipas, M.D., Panya Luksanapruksa, M.D., Surin Thanapipatsiri, M.D., Visit Vamvanij, M.D.

Department of Orthopedic Surgery, Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok, Thailand.

ABSTRACT

Objective: To evaluate the reliability and validity of the Thai version of the modified Japanese Orthopaedic Association scale.

Methods: The modified Japanese Orthopaedic Association scale was translated into Thai language to create the Thai version of the Modified Japanese Orthopaedic Association (Thai-mJOA) scale. Translation was performed according to international standards using a forward-backward translation protocol. Translation was performed by 2 expert translators and 1 physician, and the final version was approved by an expert committee. Thai patients with cervical spondylosis with myelopathy were enrolled and evaluated using the Thai-mJOA scale, Nurick Grading, the Thai version of the Neck Disability Index (Thai-NDI), and the Thai version of the Short Form-36 (Thai-SF-36). Reliability and validity of the Thai-mJOA were assessed via comparison with the Nurick Grading and the Thai-NDI.

Results: Ninety-two patients were included. The most common compression level was C5-C6 vertebral disc. Cronbach's alpha of the total Thai-mJOA showed excellent internal consistency (0.991). The intraclass correlation coefficient (ICC) for test-retest reliability was 0.981 (95% confidence interval [CI]: 0.972-0.988). Regarding concurrent validity, the motor dysfunction score of the lower extremities and the total score of the Thai-mJOA were strongly correlated with Nurick Grading ($r=0.825$, $r=0.712$, respectively). The total score of the Thai-mJOA was moderately correlated with the Thai-NDI ($r=0.670$).

Conclusion: The Thai-mJOA was found to be a valid and reliable tool for evaluating symptom severity in Thai patients with cervical spondylosis with myelopathy.

Keywords: Reliability; validity; Thai version; Modified Japanese Orthopaedic Association Score; Thai-mJOA (Siriraj Med J 2021; 73: 55-60)

INTRODUCTION

Cervical spondylosis with myelopathy (CSM) is one of the most common progressive spinal degenerative conditions in elderly patients, and the neurological symptoms of CSM include neck pain, weakness, and numbness of extremities, and gait dysfunction.¹ Functional disability plays a key role in the treatment decision-making

process. Surgery is not superior to conservative treatment in patients with mild symptoms. Law, *et al.* previously described several poor prognostic factors that they found to be associated with conservative treatment, including progression of symptoms, presence of myelopathy for more than six months, a compression ratio approaching 0.4, and transverse area of the cord <40 mm.² However,

Corresponding author: Visit Vamvanij

E-mail: drvisitvam@gmail.com

Received 3 September 2020 Revised 24 September 2020 Accepted 25 September 2020

ORCID ID: <http://orcid.org/0000-0002-6056-0961>

<http://dx.doi.org/10.33192/Smj.2021.08>

these factors include the imaging of the spine, which may not be applicable in some settings.

Currently, the most commonly utilized scales for evaluating the severity of symptoms are Nurick grading,³ the Neck Disability Index (NDI),⁴ and the modified Japanese Orthopaedic Association (mJOA) scale.⁵ The mJOA scale is multidimensional, and it is used to separately assess the function of upper and lower extremities and bladder function in CSM patients. The mJOA has been widely used to standardize the clinical assessment of CSM.⁶

The mJOA has been translated into several languages, including Italian⁷, Brazilian-Portuguese⁸, and Dutch.⁹ This study aimed to translate and adapt the mJOA to the Thai language, and to determine its reliability and validity among Thai patients with CSM.

MATERIALS AND METHODS

Questionnaire

The mJOA scale was designed to assess micturition and motor function and sensation of the extremities in patients with CSM. The mJOA has an 18-point scale that consists of motor dysfunction of upper extremities (5 points), motor dysfunction of lower extremities (7 points), sensory dysfunction of upper extremities (3 points), and sphincter dysfunction (3 points). A score of 18 shows no neurological deficits, whereas an increasingly lower score represents an increasingly greater severity of functional impairment and disability.

The mJOA was translated into the Thai language according to linguistic validation guidelines using a forward-backward translation protocol to create the Thai-mJOA. This process involved independent translation of the mJOA from English to Thai by both a professional English translator and a bilingual physician. The two independent translations were then discussed and combined into a consensus version. The backward translation from Thai to English was performed by a native English speaker who is a professional translator of the Thai language to the English language. The English translation was then compared to the original mJOA questionnaire and checked for mistranslation and misunderstanding.

Participants

This study was approved by the Siriraj Institutional Review Board (SIRB) of the Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok, Thailand [COA no. 328/2016(EC1)], and written informed consent was obtained from all participants. Enrolled patients were prospectively recruited from the in-hospital spinal surgery unit at Siriraj Hospital during December 2016

to November 2019. During this period, 92 patients with CSM that were scheduled for surgical treatment were enrolled. All patients were assessed using the Thai-mJOA, Nurick grading, and the Thai-NDI⁴ on the day of admission, and once again 72 hours after surgery.

Outcome measurement

To assess test-retest reliability, all patients were asked to complete the Thai-mJOA on the day of admission before surgery, and then once again 3 days after surgery. Test-retest reliability was determined using intraclass correlation coefficient (ICC). Reliability was determined by calculating Cronbach's alpha. Internal consistency estimates of >0.70 were considered acceptable for group comparisons.¹⁰

Concurrent validity was evaluated by comparing the Thai-mJOA with the Nurick grading scale and the Thai-NDI. Validity was determined by calculating Spearman's correlation coefficient. Correlation coefficients of 0.1 to 0.3 were considered weak; 0.3 to 0.6, moderate; and >0.6, strong. All statistical analyses were performed using SPSS v.18.0.

RESULTS

Ninety-two patients were enrolled in this study, and most subjects were male (63.04%). Approximately one-third of patients each had 1, 2, and 3 levels of cervical spinal cord compression (34.4% had 1 level, 31.1% had 2 levels, and 31.1% had 3 levels). Demographic and clinical data of patients, including scoring of the Thai-mJOA, the Nurick grading scale, and the Thai-NDI, are shown in Table 1.

The Cronbach's alpha values were acceptable for all domains of the Thai-mJOA, as follows: 0.991 for the total score, 0.990 for Motor dysfunction score of the upper extremities, 0.997 for Motor dysfunction score of the lower extremities, 0.945 for Sensory dysfunction score of the upper extremities, and 0.977 for Sphincter dysfunction score. For the test-retest evaluation, the ICC's were 0.981 (95% confidence interval [CI]: 0.972-0.988) for the total score, 0.98 (95% CI: 0.97-0.987) for the Motor dysfunction score of the upper extremities, 0.995 (95% CI: 0.992-0.997) for the Motor dysfunction score of the lower extremities, 0.896 (95% CI: 0.847-0.930) for the Sensory dysfunction score of the upper extremities, and 0.955 (95% CI: 0.933-0.97) for the Sphincter dysfunction score. These ICC values indicate good repeatability for each domain. Details of ICC and test-retest results are shown in Table 2. We also reported the Cronbach's alpha values and ICCs of a previous study compared to our values from the present study in Table 4.

TABLE 1. Demographic and clinical characteristics of the study population.

Characteristics	(N = 92)
Gender	
Male	58 (63.04%)
Female	34 (36.96%)
Number of neurological compression levels	
1	31 (34.4%)
2	28 (31.1%)
3	28 (31.1%)
4	3 (3.3%)
Level of neurological compression	
C2-C3	1 (1.1%)
C3-C4	37 (41.6%)
C4-C5	55 (61.8%)
C5-C6	63 (70.8%)
C6-C7	24 (27%)
C7-T1	0 (0.0%)
Thai-mJOA score	11.9±3.5 (4-18)
Nurick grading score	2.8±1.2 (0-5)
Thai-NDI score	37.7±17.4 (2-78)

Data presented as number and percentage or mean ± standard deviation (range)

Abbreviations: C = cervical; T = thoracic; Thai-mJOA = Thai version of the modified Japanese Orthopaedic Association; Thai-NDI = Thai version of the Neck Disability Index

TABLE 2. Reliability of the Thai-mJOA scale (N=92).

Scoring parameters	Cronbach's alpha	Test-retest ICC (95% CI)	Floor	Ceiling
Thai-mJOA scale				
Total	0.991	0.981 (0.972-0.988)	0.0%	5.4%
Motor dysfunction score of the upper extremities	0.990	0.980 (0.970-0.987)	0.0%	38.0%
Motor dysfunction score of the lower extremities	0.997	0.995 (0.992-0.997)	1.1%	17.4%
Sensory dysfunction score of the upper extremities	0.945	0.896 (0.847-0.930)	1.1%	14.1%
Sphincter dysfunction score	0.977	0.955 (0.933-0.970)	4.3%	73.9%

Abbreviations: ICC, intraclass correlation coefficient; CI, confidence interval; Thai-mJOA scale, Thai version of the modified Japanese Orthopaedic Association scale

TABLE 3. Correlation coefficients between Thai-mJOA score and Nurick grading score and the Thai NDI score as determined by Spearman's correlation coefficient.

Scoring system	Total score	Thai-mJOA scale			
		Motor dysfunction score of the upper extremities	Motor dysfunction score of the lower extremities	Sensory dysfunction score of the upper extremities	Sphincter dysfunction score
Nurick grading	-0.712	-0.404	-0.825	-0.273	-0.348
Thai-NDI	-0.670	-0.574	-0.570	-0.371	-0.325

Abbreviations: Thai-mJOA = Thai version of the modified Japanese Orthopaedic Association; Thai-NDI = Thai version of the Neck Disability Index

TABLE 4. Cronbach's alpha values and test-retest ICC of present study and previous study.

		Longo, <i>et al.</i> (2016) ⁷	The present study
Language		Italian	Thai
Number of patients		75	92
Cronbach's alpha	Total Score	0.6	0.991
	Motor dysfunction score of the upper extremities	0.45	0.99
	Motor dysfunction score of the lower extremities	0.54	0.997
	Sensory dysfunction score of the upper extremities	0.58	0.945
	Sphincter dysfunction score	0.6	0.977
	Total score	0.91	0.981 (0.972-0.988)
Test-retest ICC (95% CI)	Motor dysfunction score of the upper extremities	0.892	0.980 (0.970-0.987)
	Motor dysfunction score of the lower extremities	0.929	0.995 (0.992-0.997)
	Sensory dysfunction score of the upper extremities	0.924	0.896 (0.847-0.930)
	Sphincter dysfunction score	0.93	0.955 (0.933-0.970)

Abbreviations: ICC = intraclass correlation coefficient; CI = confidence interval

Concurrent validity of the Thai-mJOA compared to Nurick grading and the Thai-NDI is described in Table 3. The most strongly correlated domains were Nurick grading with the Motor dysfunction score of the lower extremities of the Thai-mJOA (-0.825), and Nurick grading with the total score of the Thai-mJOA (-0.712). The Thai-NDI was also shown to be strongly correlated with the total score of the Thai-mJOA (-0.670).

A Bland-Altman plot showing the difference between the pre-operative mJOA and post-operative mJOA plotted against the mean of the two scores is shown in Fig 1. The arithmetic mean difference between the two score (the bias) was 0.1648 (95% CI: -0.01191 to 0.3178). The upper and lower limits of agreement were 1.6041 and -1.2744, respectively.

DISCUSSION

In the present study, the modified Japanese Orthopaedic Association scale was translated into Thai language using a forward-backward translation protocol to create the Thai-mJOA. The results showed good reliability and validity of the Thai-SSS questionnaire, which correlated with both the Nurick grading scale and the Thai-NDI.

The Cronbach's alpha of total score and each domain ranged from 0.945-0.997, which demonstrate excellent internal consistency, and these values are consistent with the Cronbach's alpha values (range: 0.813-0.826) previously reported by Yonenobu, *et al.*¹¹ We also found that the Thai-mJOA has excellent reliability. The ICCs

for test-reliability for all domains ranged from 0.896 to 0.995, which also agreed with the previous findings of Yonenobu, *et al.*¹¹ Our analysis for concurrent validity revealed a significant strongly negative correlation between the Nurick grading scale and the total score of Thai-mJOA, and with the Motor dysfunction score of the lower extremities domain of the Thai-mJOA (Spearman's correlation coefficient: -0.712 and -0.825, respectively). The Thai-NDI was also found to be strongly negatively correlated with the total score of the Thai-mJOA (Spearman's correlation coefficient: -0.67). These findings resulted from differences in interpretation between the Thai-mJOA and the Nurick grading scale, and between the Thai-mJOA and the Thai-NDI. More specifically, severe functional disability is indicated by a lower score on the Thai-mJOA, but by a higher score on the Nurick grading scale and the Thai-NDI.

CONCLUSION

The original modified Japanese Orthopaedic Association scale was successfully translated to Thai language to create the Thai-mJOA. The Thai-mJOA was found to be a valid and reliable tool for evaluating symptom severity in Thai patients with cervical spondylosis with myelopathy.

ACKNOWLEDGMENTS

The authors gratefully acknowledge Professor Dr. Edward C. Benzel for giving us the permission to translate the modified Japanese Orthopaedic Association (mJOA)

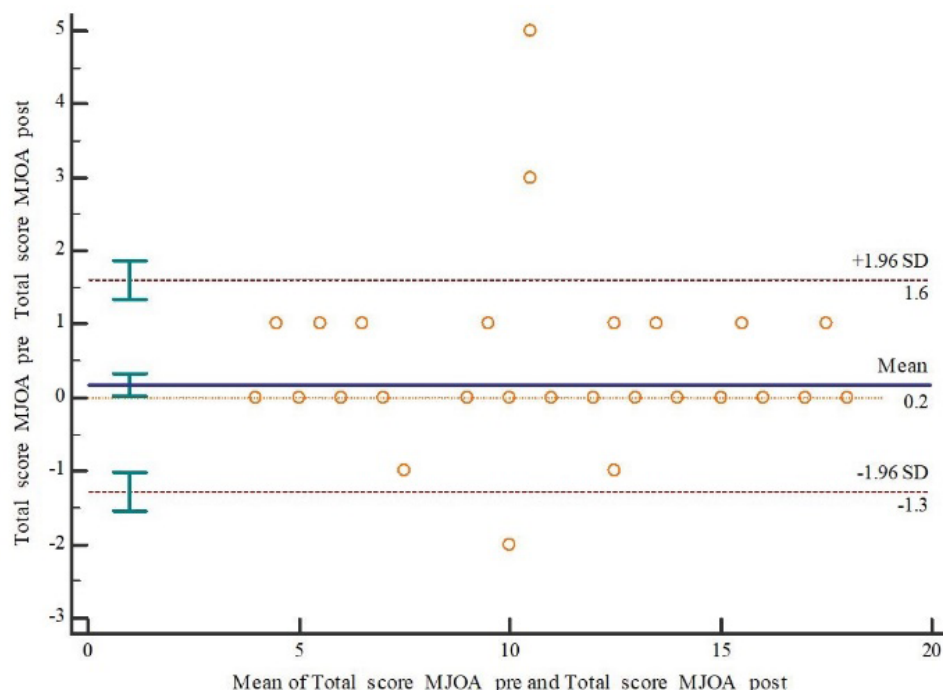


Fig 1. Bland-Altman plot showing the difference between the pre-operative mJOA and post-operative mJOA plotted against the mean of the two scores

scale into Thai language, and Ms. Nhathita Panatreswas of the Division of Research, Department of Orthopaedic Surgery, Faculty of Medicine Siriraj Hospital, Mahidol University for assistance with data collection and statistical analysis.

Conflict of interest declaration

The authors hereby declare no personal or professional conflicts of interest relating to any aspect of this study.

Funding disclosure

This study was funded by a grant from the Faculty of Medicine Siriraj Hospital, Mahidol University [grant no. (IO) R015932036].

REFERENCES

1. Bakhsheshian J, Mehta VA, Liu JC. Current Diagnosis and Management of Cervical Spondylotic Myelopathy. *Global Spine J* 2017;7:572-86.
2. Law MD, Jr., Bernhardt M, White AA, 3rd. Cervical spondylotic myelopathy: a review of surgical indications and decision making. *Yale J Biol Med* 1993;66:165-77.
3. Nurick S. The pathogenesis of the spinal cord disorder associated with cervical spondylosis. *Brain* 1972;95:87-100.
4. Vernon H, Mior S. The Neck Disability Index: a study of reliability and validity. *J Manipulative Physiol Ther* 1991;14:409-15.
5. Benzel EC, Lancon J, Kesterson L, Hadden T. Cervical laminectomy and dentate ligament section for cervical spondylotic myelopathy. *J Spinal Disord* 1991;4:286-95.
6. Tetreault L, Kopjar B, Nouri A, Arnold P, Barbagallo G, Bartels R, et al. The modified Japanese Orthopaedic Association scale: establishing criteria for mild, moderate and severe impairment in patients with degenerative cervical myelopathy. *Eur Spine J* 2017;26:78-84.
7. Longo UG, Berton A, Denaro L, Salvatore G, Denaro V. Development of the Italian version of the modified Japanese orthopaedic association score (mJOA-IT): cross-cultural adaptation, reliability, validity and responsiveness. *Eur Spine J* 2016;25:2952-7.
8. Pratali RR, Smith JS, Motta RL, Martins SM, Motta MM, Rocha RD, et al. A Brazilian Portuguese cross-cultural adaptation of the modified JOA scale for myelopathy. *Clinics (Sao Paulo)* 2017;72:103-5.
9. Bartels RH, Verbeek AL, Benzel EC, Fehlings MG, Guiot BH. Validation of a translated version of the modified Japanese orthopaedic association score to assess outcomes in cervical spondylotic myelopathy: an approach to globalize outcomes assessment tools. *Neurosurgery* 2010;66:1013-6.
10. Hara N, Matsudaira K, Masuda K, Tohnosu J, Takeshita K, Kobayashi A, et al. Psychometric Assessment of the Japanese Version of the Zurich Claudication Questionnaire (ZCQ): Reliability and Validity. *PLoS One* 2016;11:e0160183.
11. Yonenobu K, Abumi K, Nagata K, Taketomi E, Ueyama K. Interobserver and intraobserver reliability of the Japanese orthopaedic association scoring system for evaluation of cervical compression myelopathy. *Spine (Phila Pa 1976)*. 2001;26:1890-4.

Is Online Assessment in Higher Education Institutions during COVID-19 Pandemic Reliable?

Nik Ani Afiqah Tuah, Ph.D.*,**, Lin Naing, M.D.*

*PAPRSB Institute of Health Sciences, Universiti Brunei Darussalam, Brunei Darussalam, **Department of Primary Care and Public Health, Imperial College London, United Kingdom.

ABSTRACT

The online learning helps to minimise disruptions on teaching and compromising students' learning outcomes; however, there is limited evidence on effective online assessment methods used at Higher Education Institutions during pandemics. This paper aimed to summarise online assessment methods and recommend reliable as well as practical approaches used at HEIs during COVID-19 pandemic. We performed a scoping literature review to identify original papers, reviews and reports that examined the online assessment methods used in higher education before and during COVID-19 pandemic. We identified common themes in data analysis. The psychometric theory is useful when designing valid and reliable online assessment methods for online learning, particularly in medical education. The typical online assessment methods used at HEIs include online quizzes, continuous feedback, multiple-choice questions and automated assessment for essays. The online tools for formative assessment in higher education include feedback, self-test quiz and discussion forums. The critical strategies recommended managing online examination involve setting up online questions using freely available software and utilising free video conferencing tool as CCTV on mobile phones for invigilation purposes. Educators must consider readiness among students and teachers, cheating practices and student diversity when employing online assessment at HEIs. They can benefit from training for online learning and the assessment methods to prepare them better when facing global uncertainties such as COVID-19 pandemic. Furthermore, educators must evaluate the methods and their impact on students' learning outcomes.

Keywords: Online assessment; online learning; COVID-19; medical education; online examination (Siriraj Med J 2021; 73: 61-68)

INTRODUCTION

COVID-19 was declared a Public Health Emergency of International Concern by the World Health Organisation on 30 January 2020 following an outbreak in Wuhan China in December 2019. It has high global risk assessment level and has spread to 213 countries globally.¹ In response to COVID-19 pandemic, most governments worldwide have provisionally closed educational institutions, and about 91% of the world's student population is greatly affected.

Distance learning (DL) may able to assist student learning as well as support parents, teachers, schools and school administrators. Also, it offers social care and establishing communication during periods of school closure.² It has also greatly affected higher education institutions (HEIs) all around the world. The specific guidance for higher education (colleges and universities) during COVID-19 pandemic include planning for digital learning (DL) and temporary dismissal or school closure.³

Corresponding author: Nik Ani Afiqah Tuah

E-mail: anni.mohamad@ubd.edu.bn

Received 5 October 2020 Revised 21 October 2020 Accepted 27 October 2020

ORCID ID: <http://orcid.org/0000-0002-7149-4349>

<http://dx.doi.org/10.33192/Smj.2021.09>

The typical methods of DL used include blended learning (BL),^{4,5} live teaching,⁶ flipped classroom (flipped virtual classroom), online practice questions, video conference, teleconference and telehealth.⁷ BL refers to a combination of two instruction modes which are e-learning and didactic (face-to-face) teaching.^{4,5} Live teaching is the delivery of live teaching via online platforms and widely used as an alternative solution for classes cancellations of 'in-person' lectures in universities and colleges.⁶ Flipped or inverted classroom refers to when traditional in-class lectures and homework exercises are reversed⁸ with four core aspects as such pre-class preparation, in-class activities, after-class activities and assessment of student learning. The HEIs have encountered a significant challenge to move forward in teaching and learning activities with minimal disruptions during the pandemic. Although, many HEIs have closed down the institutions for a specific time, others have transitioned to online teaching using technology that is freely available to compromise the students' learning and their learning outcomes minimally. It is a great challenge to manage assessment at a distance for HEIs. The paper aimed to summarise online assessment methods and recommend reliable as well as practical approaches used at HEIs during COVID-19 pandemic. It also examined the advantages and disadvantages of online assessment methods in teaching and learning.

Methods of scoping review

We employed a scoping literature review to identify original papers, review and reports that examined the online assessment methods used in higher education before and during COVID-19 pandemic. The key search terms used include an online assessment, COVID-19, online tests, online examination, concept and other relevant terms, specifically in a higher education context. We used Google Scholar and Pub Med search engines focussing on articles published since the year 2000 and identified common themes during data analysis.

Concepts and frameworks for online assessment

The online and blended learning in higher education confronted educators with several critical issues related to teaching, learning and assessment in an unconventional environment. One of the critical issues is the validity and reliability of assessment using online platforms that met the intended purposes.⁹ The online assessment allows the delivery of constant and real-time feedback that can be given at a time and place appropriate for both the student or the educator.¹⁰ Educators must consider fundamental concepts of assessment in online learning specifically for medical education that include theories of expertise

development and psychometric as well as an assessment framework for learning. The expertise development theory states that the progression from novice to expert showing improvement in the ability to integrate basic facts derives from semantic networks to illness scripts and instance scripts into complex concepts. The processes enable the expert to promptly recognise the problem, develop a precise interpretation of the problem and formulate efficient problem-solving approaches. Psychometric theories emphasis on the validity of the assessment, offer reliable measurement, and reproducible outcomes. The questions can be translated into scores and eventually used to make inferences about the construct of interest.¹¹ A framework employed for online assessment in emergency remote teaching during COVID-19 pandemic highlighted nine guidelines that are highly significant to health professions education. The guidelines include ensuring alignment of assessment activities with learning objectives, considering the diversity of students' circumstances, utilising formative and summative assessments, and stimulating student learning with online assessment. Other components are to consider the format of online assessment, ascertain clear communication to students regarding assessment matters, ensure high-quality feedback, and address assessment validity threats.¹² There are ten principles of best-practice online assessment that comprise of: longitudinal reflection where educators use online formative assessment to improve teaching practice and learning tasks; higher-quality feedback; using readymade tools (such as rubrics or assessment standards) as performance criteria for online assessment tasks; technology-enabled authentic learning that encourages students to have real-life value when attempting online assessment tasks; and enhanced collaboration require discussion and collaboration among students.¹³

Evidence-based strategies of online assessment

The evidence-based strategies for online assessment in HEIs include online quizzes,¹⁴ continuous feedback,¹⁰ multiple-choice questions,^{10,15} simulated clinical skills,¹⁰ clinical examinations or viva-voce using real-time communication technology (such as skype, zoom)^{10,15} and automated assessment for essays.^{14,15} The online quiz is a method to assess the knowledge that promotes self-directed learning and may improve the effectiveness of teaching.¹⁴ The closed-answer type questions (multiple-choice questions) can assess essential knowledge and often used for online educational tool and assessment.^{10,15} For viva-voce or actual clinical examinations conducted over online (via skype or zoom) would enable the assessor to observe and interact from a distance location, thus may

reduce costs (such as accommodation, travel and subsistence for both examiner and student) and eliminate difficulties of traditional clinical assessments (e.g. examination halls and printed paper) in medical education.¹⁰ Arguably, essays are the most effective tool to evaluate learning outcomes that indicate learner aptitude to recall, organise and integrate viewpoints in the form of written work. The essay questions can assess learning outcomes that relate to the evaluation and synthesis levels of Bloom's (1956) taxonomy. Therefore, automated assessment for essays arguably offers a reliable scoring method that can be costly and time savings. The methods of automated assessment of free-text answers include Project Essay Grade (PEG), Intelligent Essay Assessor (IEA), Educational Testing service I, Electronic Essay Rater (E-Rater), C-Rater, BETSY, Intelligent Essay Marking System, SEAR, Paperless School free text Marking Engine and Automark. The main problems encountered in automated essay grading are lacking standard to calibrate human marks and ambiguous set of rules for selecting master texts.¹⁶

Meanwhile, the online tools for formative assessment in higher education include self-test quiz tools, discussion forums and e-portfolios. The critical characteristics of practical online formative assessment are the establishment of a learner and assessment centred focus through formative feedback and enhanced learner engagement with valuable learning experiences. The validity and reliability of an online formative assessment include ongoing accurate assessment activities and interactive formative feedback.⁹

The advantages of online assessment include costs saving (such as for printing costs, examination spaces, travel) and use of freely available online tools, e.g. SurveyMonkey, Google Form, HubSpot Forms, CANVAS free for teachers¹⁷ and educational software products. Meanwhile, the disadvantages of online assessment include software costs to develop educational content and supporting infrastructure, for example, internet servers, data storage, computer-aided learning rooms.^{10,18} Other problems of online assessment are unreliable systems (due to poor network connectivity, hardware, software, power supply), lack of online and physical security systems to safeguard assessments and cheating.¹⁰

Studies showed the benefits of using online assessments are reduction of paper usage, decreased concerns over the security of transporting test papers, flexible time and venue, continuous feedback and random selection and reproducibility of exam questions.^{19,20} The value of online formative assessment tools includes enhancement of learner engagement and the creation of a learning community.⁹ In contrast, some studies argued that online assessments

have negative impacts, mainly psychological stress to both teachers and students due to rigid technological settings, reduced personalised engagement with faculty¹⁹ and negatively influence student's grades.^{20,21} The factors that may influence students' scores and grades for online assessment involve the comparability of identical tests taken in different formats, students' level of preparedness for the mode of test and the quality of the test,²² slow logins to test, delayed loading of a test, and inexperienced teachers.^{21,23} The aspects that may increase acceptance for online assessments among students are students' accustomed to the format, high students' confidence in the system,²⁴ use of online formative assessments for practice before in-class tests²⁵ and technological adoptions.^{21,26} Recent study highlighted that students did not understand the necessity for online assessments due to technological incompetence of students and teachers, mistrust in the technology infrastructure and significant reliance on multiple-choice questions format. The students preferred online assessments that provide constructive, timely and personalised feedback, as well as a gradual transition towards online assessments together with technical training for both students and faculty. They also required active individualised interaction with instructors to incorporate online assessments into higher education²¹ effectively.

Online examination

Before educators decide to go for online examination, they may consider other alternative assessment options such as assignments, writing reports (that require students to choose different titles and different settings from classroom exercises), or open-book examination. Evidence shows that assessment by coursework alone or by blending coursework and examinations tends to produce higher marks than assessment by examinations alone.²⁷ The courses that need alternative assessment poses several challenges when higher-level learning objectives (based on levels of revised Bloom's Taxonomy such as apply, analyse, evaluate and create).²⁸ These methods require more time reading the write-up and checking for plagiarism, and also there is subjectivity issue in marking and grading those materials. Potential problems with coursework assessment include collusion, plagiarism and personation (in particular 'contract cheating' through the use of tailored essays).²⁷ Educators may use online plagiarism checking platform,²⁹ which are freely available at present, such as DupliChecker and Grammarly. Also, educators must recognise that there were differences between sciences and arts-type subjects which indicate distinctive assessment practices.³⁰

Nonetheless, educators have increasingly utilised assessment by coursework that may less likely cause possible risks to academic standards,²⁷ and students prefer them highly for online distance learning.³¹ Educators are required to assess lower-order learning objectives (e.g. remember and understand) in some courses.²⁸ Some educators in many HEIs may have made fewer efforts to assess lower-order learning objectives in the current situation of COVID-19 outbreak and rapid transition from traditional to online learning. These circumstances could lead to some degree of compromise in assessing intended learning outcomes. On the other hand, the

primary challenge for online examination is to prevent or control potential cheating among students. Table 1 shows a comparison between online and traditional assessment, while we present a summary of formative and summative of online assessment methods in Table 2. We use online free software for teaching and learning in the courses. The two key strategies recommended to manage online examination are 1) set up online questions using free software, and 2) use a free video-conferencing tool as closed-circuit television (CCTV) through the candidates' mobile phones for invigilation purposes.

TABLE 1. Comparison between online and traditional assessment.

Items	Online assessment	Traditional assessment
Benefits	Allows delivery of constant and real-time feedback that can be given at a time and place appropriate for both the student or the educator	Assessment by coursework alone or by blending coursework and examinations tends to produce higher marks than assessment by examinations alone
Concept & Framework	Online assessment in emergency remote teaching framework, principles of best-practice online assessment	Theory of expertise development, theory of psychometric and assessment framework for learning
Methods	• Online quizzes, • Built-in continuous feedback, • Multiple-choice questions, • Simulated clinical skills, • Clinical examinations or viva-voce using real-time communication technology, • Automated assessment for essays, • True/false, fill in the blank, fill in multiple blanks, and essay question, • Speed grader • Plagiarism check software	• Multiple-choice questions • Short-answer questions • Short essays • Assignments • Writing reports • Open-book examination • Traditional paper feedback • Traditional paper grading and marking • Checking plagiarism manually
Disadvantage	<i>Student perspectives:</i> • Internet unavailability • Internet instability • Unable to afford internet • Cost of internet/wifi <i>Faculty perspectives:</i> • Require training • Require motivation • Require online platform • Require technical support	<i>Student perspectives:</i> • Cost for paper and other logistics • Slow feedback <i>Faculty perspectives:</i> • More time for grading • More time for checking plagiarism • Logistics for invigilation

TABLE 2. Summary of formative and summative online assessment methods.

	Formative	Summative
Individual	• Online quizzes • Probing short questions to enhance the study, • Interactive formative feedback immediate automatic or built-in feedback • Simulated clinical skills • Self-test quiz tools • Discussion forums • E-portfolios	• Multiple-choice questions • Short answer questions • Clinical examinations • Viva-voce using communication technology (such as skype, zoom) • Automated assessment for essays
Group	• Group online quizzes • Group presentation and feedback	• Group community outreach project online written report • Group community outreach project presentation • Peer-assessment for group interaction

Setting up online questions

Teachers can use several free online tools,¹⁷ SurveyMonkey, Google Form, HubSpot Forms, CANVAS³² to set up online questions. Among all these free tools, we would like to recommend the following features available on CANVAS which are suitable for online examination:

- Set up different types of exam questions such as multiple-choice, true/false, fill in the blank, fill in multiple blanks, multiple answers, multiple dropdowns, matching, numerical answers, formula question, essay question, and file upload questions. Some of these questions are suitable for lower-order learning objectives in online examination, and also for coursework assessment.
- Set up the questions to appear one question at a time that only allows candidates to see and attempt each question while moving forward when answering them. If we set one question at a time, there is an option available to lock each question so that the candidates cannot go back to previous questions and change their answers.
- For multiple-choice questions, there is a function to shuffle answers randomly that enable the sequence or order of answers to choose for each question to be different for each candidate.
- For all question types, educators can set starting available time and date, end time and date, and duration for the examination. The timer is shown

on the screen while the candidate is attempting the examination.

- For multiple-choice and true/false questions, set correct answer so that CANVAS will automatically mark the questions at a set due date and time of examination. The candidate can see the marks immediately after the submission. Therefore, educators may have to set the option to hide the marks if they wish not to show the marks then.

Setting up a CCTV with a candidate mobile phone

Some free video conferencing software³³ (such as Skype, Zoom, ezTalk and Webex) can be downloaded to the candidate's mobile phone and used as CCTV for invigilation tool. The candidate's mobile phone is placed about one meter away at right or left side, while the candidate is sitting facing a computer. The invigilator should be able to see the candidate's computer screen, keyboard and the candidate from the side through the mobile phone during the examination time. The software (e.g. Webex, Skype, Zoom) also can record the entire duration of the examination; thus, it serves as additional deterrent to prevent cheating. Before the start of the examination, the invigilator can use the CCTV mobile phone to check candidate's identity (ID card), and 360-degrees scan view of the room where the candidate is setting up for the examination.

Recommended measures for online examination

The following are recommended measures for the online examination that educators should consider:

- Use the mobile phone as CCTV to check pre-examination room set up for candidate's laptop, table, chair and position. The set up is organised a day, preferably before the examination. It may take time to set the position of the mobile phone that enables invigilator to see clearly on areas mentioned above, and most often the area needs proper lighting.
- Clear rules are given to the candidate in advance
- Mock online examination if the candidate is first-timer.
- Short multiple examination sessions such as for 2 hours session break it down into 30 minutes per session with a 10-minute break is given in between each session. Some free software (like Zoom, ezTalk) may impose usage limit of 40 minutes per session, and then the user must reconnect to the software.
- Candidate must not wear earphone or headset.
- During the examination, the candidate is only allowed to view the computer screen but not a mobile phone, and also not allowed to browse other web page or software. Invigilator monitors the candidate through the CCTV mobile phone.
- Setting up rules, guidelines and backup plan if the internet is interrupted during the examination. Both educator and candidate must take some degree of responsibility to ensure proper internet connection, and stable streaming is available on site.
- Assign one invigilator to observe eight candidates via nine small screens on the computer monitor (screen).
- Conduct few mock online examination sessions to be familiar with procedures, software and testing/checking internet stability. Educators can take roles as invigilators and students during each mock examination.

Considerations for online assessment

Readiness

In the light of pandemic, institutional and educator readiness are essential requirements of the online assessment. Institutional readiness refers to institutional policies, resources and practices, for instance, internet coverage and availability of the IT support team. Internet access is a critical infrastructure for online teaching. IT support team is an essential resource during the transition from traditional to online teaching in many HEIs. Educator readiness refers to educator's acceptance and 'buy-in' when changing to online teaching and learning that include

taking up training for teaching methods, assessment and online applications.^{12,13}

Cheating practices

Evidence³⁴⁻³⁶ shows distinctive cheating practices during online examination such as impersonation, forbidden aids, peeking, peer collaboration, outside assistance and student-staff collusion.³⁶ The common possible cheating practices during the mock online examination include screen sharing among candidates, using multiple monitors, using a mobile phone, using Bluetooth technology headset, impersonation, taking a screenshot and sending to friends, and traditional ways such as notes on their palms or attached notes to computer monitors. The various countermeasures for those cheating practices were using biometry, mingling, shuffling, random drawing, sequencing, broadcasting methods³⁶ and physical screens parting candidates.¹⁰ We recommended affordable and straightforward ways to minimise possible cheating attempts among candidates in low resource settings. The strategies are to check the identity of the candidate, check examination room and setting, record both audio and video throughout the examination, and closely observe on candidate's computer screen or monitor. Nonetheless, we recognise that there is no cheat-proof online and paper-based examinations. In the rapidly shifting situation of COVID-19 pandemic and uncertainties globally, educators in HEIs must explore the best approaches to curtail disruptions on students teaching and learning, and assessment.

Student diversity

There are various types of diversity existed among students in the context of online learning that include: socioeconomic status; access to devices; stability of internet connection; racial and cultural differences; learners with special education needs; and second-language English speakers. Therefore, educators must consider diversity when selecting online assessment methods. Some students may not have internet access and computers for web-based assessments, however able to use mobile for text-based collaborative tools (messaging, WhatsApp). Students with physical and learning impairments may use assistive devices. Students who have English as a second language may utilise technology tools with listening and speaking functions to accommodate diversity in the assessment.^{13,37}

CONCLUSION

Students and educators accept online learning during COVID-19 pandemic that considerably helps to lessen disruptions in teaching, learning and assessment.

This paper has highlighted online assessment methods and recommended reliable and practical approaches that educators can utilise for online learning at HEIs during COVID-19 pandemic. The psychometric theory offers a conceptual framework when designing valid and reliable online assessment methods for online learning, particularly in medical education. The typical online assessment methods used at HEIs include online quizzes, continuous feedback, multiple-choice questions, simulated clinical skills, clinical examinations or viva-voce using real-time communication technology and automated assessment for essays. The online tools for formative assessment in higher education include feedback, self-test quiz, discussion forums and e-portfolios. Educators must consider alternative online assessment and the potential problems before embarking on online examination in HEIs. The critical strategies recommended managing online examination involve setting up online questions using freely available software and utilising free video conferencing tool as CCTV on mobile phones for invigilation purposes. Educators must consider readiness among students and teachers, cheating practices and student diversity when employing online assessment at HEIs. The affordable and straightforward countermeasures for cheating practices among students in low resource settings during online examination include identification of candidate, scan examination room and setting through video conferencing tool and close observation of candidate's computer screen or monitor.

In facing uncertainties of the global pandemic such as COVID-19, educators must familiarise with process, procedures and freely available technology for online learning and assessment. Also, educators must evaluate the methods and their impact on students' learning outcomes.

ACKNOWLEDGEMENTS

We wish to acknowledge the Teaching and Learning Centre, Universiti Brunei Darussalam for offering various training on blended learning.

REFERENCES

- World Health Organization. Coronavirus (COVID-19) Pandemic [Internet]. 2020 [cited 2020 Apr 19]. Available from: <https://www.who.int/emergencies/diseases/novel-coronavirus-2019>
- UNESCO. COVID-19 Educational Disruption and Response [Internet]. 2020 [cited 2020 Apr 19]. Available from: <https://en.unesco.org/covid19/educationresponse>
- Centers for Disease Control and Prevention. Coronavirus Disease 2019 (COVID-19). Colleges & Universities [Internet]. 2020 Mar [cited 2020 Apr 19]. Available from: <https://www.cdc.gov/coronavirus/2019-ncov/community/colleges-universities/index.html>
- Sajid MR, Laheji AF, Abothenain F, Salam Y, AlJayar D, Obeidat A. Can blended learning and the flipped classroom improve student learning and satisfaction in Saudi Arabia? *Int J Med Educ* 2016;7:281-5.
- Kiviniemi MT. Effects of a blended learning approach on student outcomes in a graduate-level public health course. *BMC Med Educ* 2014;14:47.
- Mian A, Khan S. Medical education during pandemics: a UK perspective. *BMC Med* 2020;18:100.
- Chick RC, Clifton GT, Peace KM, Propper BW, Hale DF, Alseidi AA, et al. Using Technology to Maintain the Education of Residents During the COVID-19 Pandemic. *J Surg Educ* 2020; 77:729-32.
- Rotellar C, Cain J. Research, Perspectives, and Recommendations on Implementing the Flipped Classroom. *Am J Pharm Educ* 2016;80:34.
- Gikandi JW, Morrow D, Davis NE. Online formative assessment in higher education: A review of the literature. *Comput Educ* 2011;57:2333-51.
- Walsh K. Online assessment in medical education-current trends and future directions. *Malawi Med J* 2015;27:71-2.
- Schuwirth LWT, van der Vleuten CPM. General overview of the theories used in assessment: AMEE Guide No. 57. *Med Teach* 2011;33(10):783-97.
- Rahim AFA. Guidelines for online assessment in emergency remote teaching during the COVID-19 pandemic. *Education in Medicine Journal* 2020;12:59-68.
- Westhuizen D. Guidelines for online assessment for educators. British Columbia, Canada: Commonwealth of Learning; 2016. p.1-56.
- Reed S, Shell R, Kassis K, Tartaglia K, Wallihan R, Smith K, et al. Applying adult learning practices in medical education. *Curr Probl Pediatr Adolesc Health Care* 2014;44(6):170-81.
- Walsh K, Rafiq I, Hall R. Online educational tools developed by Heart improve the knowledge and skills of hospital doctors in cardiology. *Postgrad Med J* 2007;83:502-3.
- Valenti S, Neri F, Cucchiarelli A. An Overview of Current Research on Automated Essay Grading. *J Inf Technol Educ Res [Internet]*. 2003 [cited 2020 Sep 11];2(1):319-30. Available from: <https://www.learntechlib.org/p/111481/>
- Lally M. The 18 Best Free Survey Tools for Customer Feedback Drive (2020 Edition) [internet]. BLUEADZ. 2019 [cited 2020 Jun 1]. Available from: <https://www.bluleadz.com/blog/10-of-the-greatest-free-survey-tools-you-should-try>
- Sanders J. Cost-effective e-learning in medical education. In: *Cost effectiveness in medical education*. Radcliffe: Abingdon; 2010.
- Betlej P. E-examinations from student's perspective – The future of knowledge evaluation. *Stud Ekon* 2013;152:9-22.
- Spivey MF, McMillan JJ. Classroom Versus Online Assessment. *J Educ Bus* 2014;89:450-6.
- Khan S, Khan RA. Online assessments: Exploring perspectives of university students. *Educ Inf Technol* 2019;24:661-77.
- Gewertz C. Transition to online testing sparks concerns. [Internet]. 2013 [cited 2020 Sep 15]. Available from: https://www.edweek.org/ew/articles/2013/10/30/10pencil_ep.h33.html.
- Ogletree A, Ogletree S, Allen B. Transition to Online Assessments: A Personal Perspective of Meeting Common Core State Standards in an Elementary School in Georgia. *Ga Educ Res [Internet]*.

- 2014;11(1 Article 7). Available from: <http://digitalcommons.georgiasouthern.edu/gerjournal/vol11/iss1/7>
24. Marius Petrisor, Marius Marusteri, Dan Simpalean, Emilian Carasca, Dana Ghiga. Medical Students' Acceptance of Online Assessment Systems. *Acta Medica Marisiensis* 2016;62:30-32.
25. Brown GA, Bice MR, Shaw BS, Shaw I. Online quizzes promote inconsistent improvements on in-class test performance in introductory anatomy and physiology. *Adv Physiol Educ* 2015;39:63-66.
26. Kuriakose RB, Luwes N. Student Perceptions to the Use of Paperless Technology in Assessments—A Case Study Using Clickers. 2nd International Conference on Higher Education Advances, HEAd'16, 21-23 June 2016, València Spain. *Procedia-Social and Behavioral Sciences* 2016;228:78-85. Available from: <http://www.sciencedirect.com/science/article/pii/S1877042816309387>
27. Richardson JTE. Coursework versus examinations in end-of-module assessment: a literature review. *Assessment & Evaluation in Higher Education* 2015;40:439-55. Available from: <http://oro.open.ac.uk/40318/>
28. Armstrong P. Bloom's Taxonomy [Internet]. Vanderbilt University. 2001 [cited 2020 Sep 12]. Available from: <https://cft.vanderbilt.edu/guides-sub-pages/blooms-taxonomy/>
29. Gupta RP. Top 10 Free Online Plagiarism Checkers Tools in 2017 [Internet]. 2017. Available from: <https://yourstory.com/mystory/f65e68ea8c-top-10-free-online-plagiarism-checkers-tools-in-2017>
30. Harland T, Wald N. The assessment arms race and the evolution of a university's assessment practices. *Assessment & Evaluation in Higher Education* 2020, Ahead-of-Print, 1-13. Published online: 31 Mar 2020. Available from: <https://doi.org/10.1080/02602938.2020.1745753>
31. Turner J, Briggs G. To see or not to see? Comparing the effectiveness of examinations and end of module assessments in online distance learning. *Assessment & Evaluation in Higher Education* 2018;43:1048-60.
32. Instructure. CANVAS Free for Teachers [Internet]. 2020 [cited 2020 Jun 1]. Available from: <https://www.instructure.com/canvas/try-canvas>
33. VOIP Review Org. The 11 Best Free Web Video Conferencing and Screenshot Apps of 2020 [Internet]. 2020 [cited 2020 Apr 19]. Available from: <https://www.voipreview.org/free-web-conferencing>
34. Kanchan R. 5 Clever Ways Students Cheat on Online Exams and How to Stop Them [Internet]. 2020 [cited 2020 Sep 11]. Available from: <https://blog.mettl.com/assessment-technology/5-unique-ways-students-cheat-in-online-examination-and-how-to-prevent-it>
35. London M. 5 Ways to Cheat on Online Exams [Internet]. Inside Higher ED. 2017 [cited 2020 Sep 11]. Available from: <https://www.insidehighered.com/digital-learning/views/2017/09/20/creative-ways-students-try-cheat-online-exams>
36. Chirumamilla A, Sindre G, Nguyen-Duc A. Cheating in e-exams and paper exams: the perceptions of engineering students and teachers in Norway. *Assessment & Evaluation in Higher Education* 2020;45:940-57. Available from: <https://doi.org/10.1080/02602938.2020.1719975>
37. Boitshwarelo B, Reedy AK, Billany T. Envisioning the use of online tests in assessing twenty-first century learning: a literature review. *Res Pract Technol Enhanc Learn* 2017;12:16.