

Health Literacy Regarding Infectious Disease Predicts COVID-19 Preventive Behaviors: A Pathway Analysis

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Abstract

Health literacy has been identified as one vital determinant of public health and healthy behaviors, but very few studies regarding infectious disease prevention have been found. This descriptive cross-sectional study aimed to validate the pathway of infectious disease-specific health literacy (IDSHL), COVID-19 (coronavirus disease 2019) preventive behaviors, and their determinants. A sample of 1459 casino workers in Macao was eligible for analysis. The concept model was verified with a comparative fit index of 0.937 and goodness-of-fit index of 0.971. Government responses was a significant determinant of situational factors (helpfulness of health information, resource accessibility, and organizational training adequacy), while situational factors showed a direct effect on COVID-19 preventive behaviors. Education and organization training adequacy was the strongest influencing factor of IDSHL, which should be a key target of intervention programs for COVID-19.

Keywords

coronavirus, COVID-19, prevention and control, health literacy, communicable disease, infectious disease, preventive behaviors

What We Already Know

- The 2019 novel coronavirus disease (COVID-19) has created a major public health threat and emergency worldwide.
- Health literacy was suggested to be a very important investment in our society for better prevention of pandemics such as COVID-19.
- The theory model between health literacy and prevention behaviors in pandemic has not been reported in original studies.

What This Article Adds

- This article verified a systemic theory model of health literacy and preventive behavior for the first time regarding infectious disease in the COVID-19 pandemic.
- Infectious-disease-specific health literacy should be a key target of intervention programs for COVID-19 prevention, especially at the community or organization level.
- Government policies can promote individual preventive behaviors by creating a supportive atmosphere, especially in terms of effective health information delivery.

Introduction

The 2019 novel coronavirus disease (COVID-19) has created a major public health threat and emergency worldwide.¹ To mitigate the spread of the virus and alleviate the loss caused by the pandemic, significant shifts in daily behavior are highly recommended by the relevant guidelines.^{2,3} At the same time, to react more effectively to this “extremely serious incident,” a national emergency response, such as restrictive border control and strict social distancing rules, has been introduced and implemented in many countries and regions,^{4,5} including Macao, China. Macao, famous for its gambling industry, is the most densely populated region in the world but the pandemic has been well controlled,⁶ without new cases confirmed for more than 9 months. The successful experience for pandemic management is an informative reference for other countries and regions.

Health literacy has been identified as one vital determinant of public health at the population level and has become

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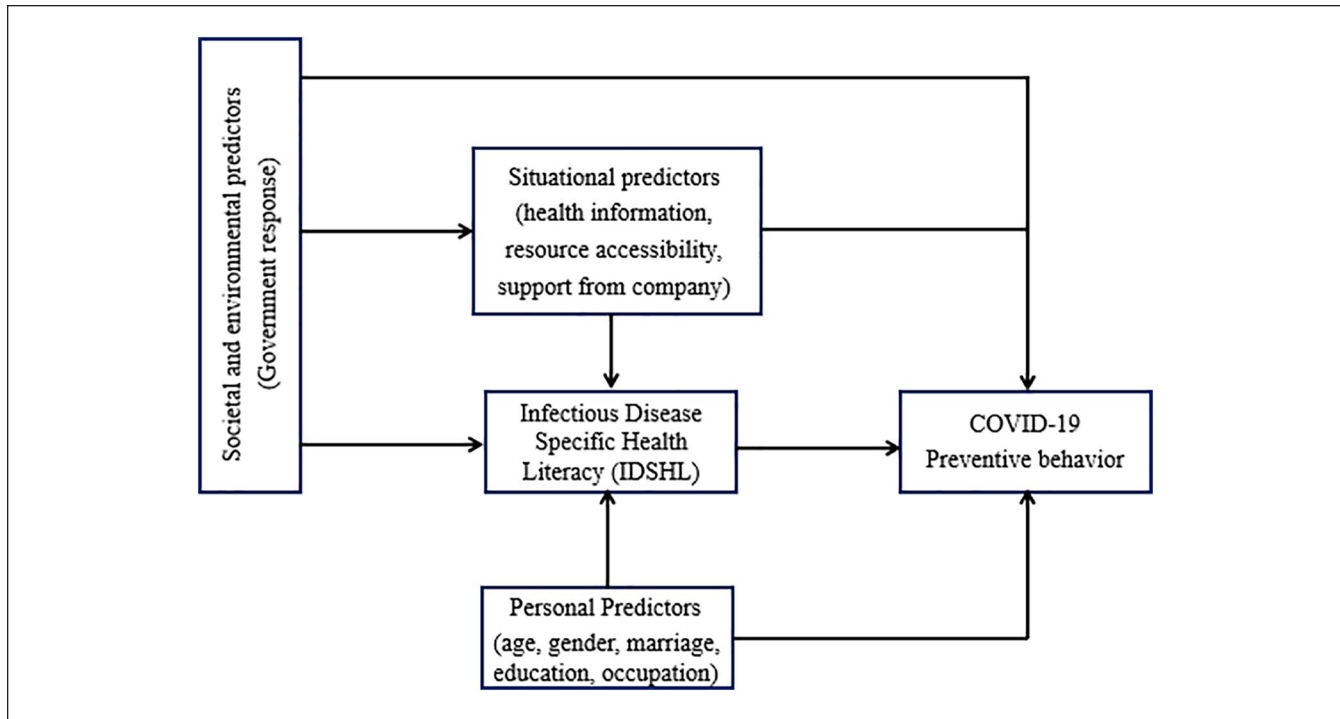


Figure 1. Conceptual model of health literacy and COVID-19 (coronavirus disease 2019) preventive behavior.

a heated topic of research since its introduction in the 1970s.⁷ Recently, many researchers have highlighted the importance of health literacy in the prevention of COVID-19.^{8,9} However, very few studies have been found regarding infectious disease prevention.

Sørensen et al⁷ have composed an integrated definition and conceptual model of health literacy based on systemic literature review. In this model, both distal factors and proximal factors significantly influence health literacy. Societal and environmental predictors are particular distal factors (eg, culture, political forces, and societal systems). Proximal factors include personal demographic predictors and situational predictors (eg, media use and social support). These distal and proximal factors can also have a significant effect on each other and healthy behaviors.⁷ Although this comprehensive model has been proposed based on a systematic review, it needs more statistical validation, similar to other models.¹⁰

The purpose of this study was to verify the conceptual model incorporated by Sørensen et al⁷ in the COVID-19 prevention, as shown in Figure 1, with the hope of providing significant references for future responses to the current pandemic as well as other new infectious disease outbreaks in the future.

Methods

Participants and Data Collection

This descriptive study was approved by the institutional review board at Kiang Wu Nursing College of Macau

(#2020FEB02). The participants were recruited using quota sampling,¹¹ sampled from all 6 concessionaries that operated casinos in Macao between April 20 and May 22, 2020, approximately 1 to 2 months after the casino reopening amid the pandemic. The inclusion criteria were full-time adult employees in casinos who could answer Chinese e-questionnaires online and consent to participate in this study. The minimum sample size was 1067. Considering the efficiency rates of the questionnaire, we recruited at least 1200 participants.

Written consent was confirmed at first by the directors of 6 concessionaries. Then, middle managers related to human resource management were contacted for the sample recruitment process after a target sample size of occupation distribution was provided. All questionnaires with a written consent form were input into an online survey platform, and a poster with a QR code and website link was created. Either emails or printed posters were used to conveniently collect data in the different concessionaries. To achieve a representative occupation composition, the survey ended when the minimum sample size was achieved. Middle managers were contacted to send more invitations to candidates with poorly sampled occupations. The survey ended on the day when the sample size reached 1500, which was approximately 25% higher than planned.

Measurements

Infectious-Disease-Specific Health Literacy (IDSHL) Scale. After thoroughly examining the items of each IDSHL scale

available, we decided to use the questionnaire validated by Tian et al,¹² which seems more stable to examine health literacy regarding infectious diseases during a pandemic.

The IDSHL scale was divided into 2 subscales¹²: skills to prevent infectious disease (22 items, with an overall Cronbach's coefficient of 0.839) and cognitive ability (6 items requiring reading and comprehension). The first subscale contained 4 domains: infectious-disease-related knowledge (7 items), disease prevention (7 items), management or treatment (4 items), and pathogen and infection source identification (4 items). The subscale score was calculated using a weight coefficient by difficulty. The total subscale score was 38.62, and the participant was considered to have adequate IDSHL at the cutoff point of 16.74. In our study, only the first subscale was applied to make the survey more user friendly.¹² The overall Cronbach's coefficient of the subscale in our study was 0.815.

COVID-19 Preventive Behavior Questionnaire (PBQ). A self-made questionnaire measuring COVID-19 preventive behaviors was composed according to the latest guidelines published by the World Health Organization, Chinese Center for Disease Control and Prevention, and Health Bureau of Macao.^{2,3,13} The instrument consisted of 17 items: 3 regarding social distance, 5 related to prevention skills, 4 concerning the environment, and 5 about health monitoring and promotion.^{2,3,13} Each item was rated using a Likert-type 5-point scale (from none to always). As a result, the total score of the COVID-19 PBQ was 85. Six public health experts were asked to evaluate the content validity of this self-made questionnaire. The universal agreement of the scale was 0.9. The item-level content validity index ranged from 0.83 to 1.00, and the average CVI (Content Validity Index) of the scale was 0.98. A pretest was used to test the face validity of the questionnaire, and 1 item was reworded to clarify its meaning. During the pilot study in 131 participants, the overall internal consistency reliability was sufficient,¹⁴ with a Cronbach's α coefficient of 0.898, and subscale Cronbach's coefficients ranged from 0.656 to 0.823.

Predicting Factor Questionnaire. The predictors of IDSHL and COVID-19 preventive behaviors were measured using a self-made questionnaire based on the concept model of health literacy created by Sørensen et al⁷ and literature review. The distal factors in this study were related to government responses to the pandemic.^{7,15,16} We asked participants to choose the 3 (out of 8) most important policies made by the Macao government, including providing masks, regulations about wearing masks in public, information about prevention, and so forth. A number rated scale (NRS) 0 to 10 was applied to determine the helpfulness of these policies: 0 = totally unhelpful to 10 = extremely helpful.

The proximal predicting factors in the questionnaire included demographic information (age, gender, marriage, education, living area, identification in Macao, occupation,

and working experience) and situational predictors (media use, resource accessibility, and organizational training adequacy).¹⁵⁻¹⁸ Media use included categories of the most important health information related to COVID-19 prevention and the helpfulness of this information (using NRS 0-10). Three reverse questions regarding resource accessibility (with a Cronbach's coefficient of 0.821) were asked: difficulty in buying resources (masks, disinfection supplies, and living resources) with a 5-point Likert-type scale (0 = none at all, 5 = completely difficult). Organizational training adequacy was rated on a 5-point Likert-type scale (0 = none, 5 = completely enough).

Statistical Analysis

Data were exported from the online questionnaire platform and imported into IBM SPSS statistics 22. Descriptive statistics were applied to demonstrate the demographic characteristics, COVID-19 preventive behaviors, and IDSHL. One-way ANOVA (analysis of variance) was adopted to compare the differences among demographic groups, and the Student-Newman-Keuls method was applied to compare the differences among subgroups if a significant difference was found. The Pearson correlation coefficient was used to examine the relationships among IDSHL, COVID-19 preventive behaviors, and their predictors, which are continuous variables.

Path analysis was implemented by IBM SPSS Amos 26 Graphics. Maximum likelihood estimation was conducted to evaluate the parameters with the covariance matrix. The path model was modified according to the P regression weight, modification indicators, and goodness-of-fit indexes (GFIs). Only variables with significant P values (less than .05) remained in the model. A comparative fit index ≥ 0.90 and root mean square error of approximation < 0.06 means that the fit was acceptable.¹⁹

Results

Descriptive Analysis

A sample of 1513 casino workers responded to our study, 1459 of which (96.4%) were eligible for analysis. The average age of the participants was 37.85 ± 9.27 (range from 21 to 66) years, and 65.5% of them were female (Table 1). The greatest proportion of occupations was dealers (36.1%), followed by clerks (25.9%) and managers (19.1%).

The average IDSHL score was 22.87 ± 6.81 (ranging from 0 to 38.62), and 83.1% of participants were identified with adequate IDSHL. In terms of the COVID-19 PBQ, the average total score was 71.06 ± 9.64 (ranging from 21 to 85), and the mean item score was 4.18 ± 0.57 (4 = often, 5 = always).

The most important government responses and health information about COVID-19 were demonstrated in

Table 1. Differences of IDSHL and PBQ Among Different Demographic Groups.

Participant characteristics (n = 1459)		N (%)	IDSHL, mean ± SD	COVID-19 PBQ, mean ± SD
Gender				
	Male	504 (34.5)	23.65 ± 6.86	70.60 ± 10.41
	Female	955 (65.5)	22.46 ± 6.75	71.31 ± 9.21
	<i>F</i> value		10.13	1.804
	<i>P</i>		.001**	.179
Marriage				
	Single	467 (32.0)	23.57 ± 6.57	69.59 ± 9.70
	Unsingle	992 (68.0)	22.59 ± 6.81	71.76 ± 9.54
	<i>F</i> value		7.332	16.24
	<i>P</i>		.007**	<.001
Macau identity				
	Macau residents	1408 (96.5)	22.72 ± 6.76	70.92 ± 9.63
	Nonresident	51 (3.5)	26.88 ± 7.18	74.94 ± 9.21
	<i>F</i> value		18.52	8.59
	<i>P</i>		<.001***	.003**
Occupation				
	Manager	279 (19.1)	22.74 ± 7.24 [§]	70.60 ± 10.70
	Dealer	527 (36.1)	22.07 ± 6.67 [#]	71.52 ± 8.96
	Clerk	378 (25.9)	24.20 ± 6.29 [€]	70.48 ± 9.48
	Service and sales	145 (9.9)	23.35 ± 6.78 [§]	71.11 ± 10.01
	Others	130 (8.9)	21.98 ± 7.32 [#]	71.88 ± 9.96
	<i>F</i> value		6.26	1.04
	<i>P</i>		<.001***	.385

Abbreviations: IDSHL, infectious disease specific health literacy; PBQ, preventive behavior questionnaire.

****P* < .001, ***P* < .01, **P* < .05. The Student-Newman-Keuls method was applied to control the total α value. There were significant differences between [§], [#], and [€] groups, but no significant differences within each group.

Supplemental Tables 1 and 2, available online. Mask supply is the top-ranked government policy, followed by the enactment of policy to wear facemasks in public areas. COVID-19 prevention knowledge and skills were the most popular health information.

Univariate Analysis

Table 1 demonstrates the differences among different social demographic groups on the IDSHL scale and COVID-19 PBQ. Gender, marriage, and occupation were correlated with IDSHL but not with the COVID-19 PBQ. Age, the helpfulness of government policies, the helpfulness of health information, and organizational training adequacy were all significantly associated with IDSHL and the COVID-19 PBQ (*P* < .01; Supplemental Table 3, available online), while education was only related to IDSHL, not to preventive behaviors.

Pathway Analysis

A pathway analysis was performed according to the conceptual model proposed in Figure 1. The final path model was verified with satisfying fit indexes,¹⁵ as shown in Figure 2, with a CFI of 0.937 and root mean square error of

approximation of 0.058. Other fit indexes were also satisfying or acceptable¹⁵: the GFI = 0.971; GFI adjusted for degrees of freedom = 0.951; root mean square residual (RMR) = 0.386; chi-square = 230.565, *df* = 39, *P* < .001, chi-square minimum/*df* (CMIN/*df*) = 5.912; and standardized root mean square residual = 0.0496.

The relationships among the COVID-19 PBQ, IDSHL, and their determinants are demonstrated in Figure 2. The usefulness of government policies directly affects proximal situational predictors, with the largest loading factor on health information (0.85), followed by organizational training adequacy (0.23) and resource accessibility (0.15). These situational predictors are important determinants of the COVID-19 PBQ, as well as IDSHL. Demographic data (gender, marriage, education, identification in Macao, and years working in casinos) influenced COVID-19 PBQ with a mediating effect of IDSHL. A total of 20% of the variance in the COVID-19 PBQ was explained by the verified model.

Discussion

This study verified a conceptual model demonstrating the relationships among health literacy regarding infectious disease and preventive behaviors during the COVID-19 outbreak, as well as the distal and proximal predictors.

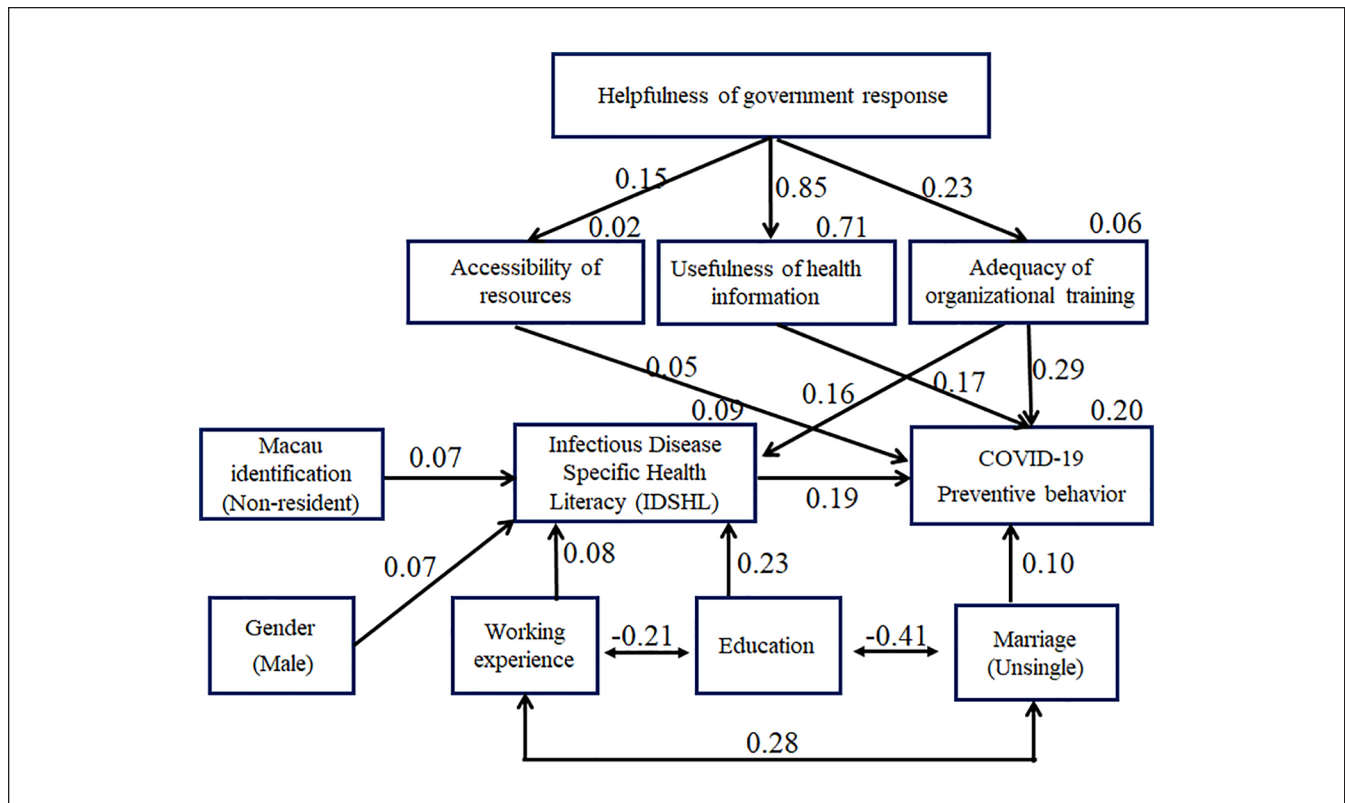


Figure 2. Verified conceptual model of health literacy and COVID-19 preventive behavior.

Demographic variables only affect the COVID-19 PBQ indirectly, with a mediating effect of IDSHL. Education is the most important determinant of IDSHL. The government response was acting as an indirect influencing factor on COVID-19 PBQ through situational social factors, including media usage or health information, organizational training, and prevention resource.

IDSHL was an important mediator in the relationship between background data and preventive behaviors, which should be considered seriously when composing public interventions. According to a study in Hong Kong during SARS (severe acute respiratory syndrome), the population's high preventive behaviors did not necessarily increase their IDSHL.²⁰ Even very basic skills such as wearing face masks and hand hygiene may require more interventions in the general population. According to a survey in Hong Kong during the non-epidemic period, none of the participants performed all the required steps when wearing a face mask, and hand hygiene was not taken seriously by the majority of the participants before putting on (91.5%), taking off (97.3%) or after disposing (91.5%) of face masks.²¹ Improving IDSHL is a very urgent task in the field of community public health management, especially in this society with the increasing presence of emerging infectious diseases.

The most prominent influence of government response on social factors was that on media usage or health information.

How to obtain accurate health information is part of health literacy and, thus, should be taken seriously. In our study, the most important health information included COVID-19-related knowledge and skills for prevention and governmental policies, and similar results were found in Greece.²² According to a study by Basch et al,²³ videos about practices to alleviate community transmission on YouTube were viewed by a tremendous portion of the population, but fewer than half of these videos contained any of the prevention behaviors recommended by the US Centers for Disease Control and Prevention. And educational information online was too difficult to understand for the public.⁸ Therefore, improving health literacy is not only an individual issue but also a governmental and professional issue. How to convey health information effectively and promptly will affect the population's health literacy and public health in society. In our study, the most important health information was identified as prevention-related knowledge and skills, and government-published policies. To avoid the irrational panic brought about by myths and misinformation, daily press conferences have been broadcast to provide the latest epidemic-related information and preventive measures.²⁴ Many videos, leaflets, and announcements were available in public areas. Additionally, the government uses many different languages to disseminate health information to accommodate the multi-language culture in Macao.²⁴ These types of dissemination is

believed to improve individual compliance with preventive behaviors by creating a supportive atmosphere.

The relationship between demographic variables and health literacy have been discussed in recent studies. For instance, education is the most important determinant of IDSHL in our study, which is consistent with a previous study,^{10,12,25} because education can not only affect health literacy directly but also demonstrate an indirect effect with a mediating effect of prior knowledge.¹⁰ In the present study, education only indirectly affected preventive behaviors by mediating the effect of IDSHL. Lower educational status was a social determinant of the spread of COVID-19 within the community,²⁶ due to the lower knowledge level and poorer preventive practices of such individuals.²⁷ During the H1N1 2009 pandemic, education was also positively associated with perception and compliance with preventive behaviors in the Chinese population, and knowledge about the disease also influenced risk perception and prevention,²⁸ which was consistent with another study showing that knowledge had a mediating effect on the relationship between education and health literacy.¹⁰

Organizational training adequacy and the helpfulness of health information were also found to be the 2 most significant factors influencing the COVID-19 PBQ, which were also prominently influenced by government response. Many industry-specific prevention recommendations were published by the Health Bureau in Macao, which supported organizational training. Information exchange may play an important role in organizational training, a type of targeted health information that is more appropriate and easier to apply during work and life. Nazir et al²⁹ indicated that social media exposure influenced preventive behavior through an indirect path with the mediators of awareness and information exchange rather than a direct effect. Similarly, the willingness to share information and sufficient knowledge on epidemic prevention can promote preventive behaviors during COVID-19 in Taiwan participants.³⁰

The accessibility of prevention-related resources and supplies directly influenced preventive behaviors and has been dramatically important during COVID-19, especially when there was a global lack of medical resources. Many people have had to find their alternatives, but Macao has succeeded in supplying masks to residents.²⁴ In our study, 90.7% of participants felt no difficulty or little difficulty in buying facemasks.

Limitations

We aimed to verify a theoretical model of health literacy related to infectious disease in the current COVID-19 pandemic, which is the first study, so we only measured those variables using self-made questionnaires. Additionally, only casino workers were recruited in the research; thus, the theory model needs to be examined in other populations. However, organizational training was highlighted in this

homogeneous sample, which provide very valuable for reference in other occupations.

Conclusions

In summary, the proposed conceptual model was well verified in our study. IDSHL could be a key target of intervention programs for COVID-19 and future pandemic prevention. This research also highlighted the function of government response on individual COVID-19 prevention behaviors by creating a supportive environment in the community or organization, which may have explained the secret of the success of pandemic prevention in Macao and China.⁶

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Author Contributions

HW composed the proposal, collected data, analyzed data, and was a major contributor in writing the manuscript. PLC helped the proposal design, data collection, and data interpretation. JW participated in the proposal design, data collection, and data analysis. IKV contributed to the proposal design, data collection, and data interpretation. All authors have read and approved the final manuscript.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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Supplemental Material

Supplemental material for this article is available online.

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