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Acute Emotional Impact of Peer Suicide and Student-Related Factors

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Objective This study explored the negative emotional impact of peer suicide on adolescent students during the early stages of becoming aware of suicide and examined the adverse effects of related environmental and mental health factors.

Methods This study was conducted from March 1, 2020 to December 31, 2021, targeting students enrolled in middle and high schools where student suicide occurred. Emotional impact was assessed using the Korean version of the Impact of Event Scale-Revised (IES-R-K), State-Trait Anxiety Inventory-X, Center for Epidemiologic Studies-Depression Scale (CES-D), and Beck's Scale for Suicide Ideation (SSI). χ^2 test and Pearson's correlation analysis were performed to analyze subgroup differences and explore relationships between scale scores, respectively.

Results Of the 2,382 participants, 25.1% belonged to the post-traumatic stress disorder (PTSD) or PTSD tendency group on the IES-R-K, and 22.2% showed abnormalities in the State-Trait Anxiety Inventory-State. Students in the same class as the deceased student and those in the same grade but in different classes had higher risk rates than those in different grades. Boarding school students had 1.9 times higher odds of experiencing emotional impacts than non-boarding students. On the CES-D, 10.4% of the students showed potential depression, with 3.7 times higher odds of experiencing emotional impact than those with normal scores. Moreover, 4.5% of the students reported suicidal ideation on the SSI, with those experiencing mild suicidal ideation having 1.9 times higher odds of experiencing emotional impact than those with normal scores.

Conclusion A significant proportion of students experienced negative impacts of peer suicide. Students in close-knit environments, such as the same class, grade, and boarding school as the deceased, or those with depression or anxiety experienced a more pronounced negative impact. **Psychiatry Investig**

Keywords Emotional adjustment; Suicide; Post-traumatic stress disorder; Crisis intervention.

INTRODUCTION

Youth suicide is a significant mental health and social issue in South Korea. Since 2015, suicide has been the leading cause of death among Korean adolescents. As of 2021, the suicide rate per 100,000 youths was 7.1.[1] Adolescence is a transitional period from childhood to adulthood marked by rapid physical and psychological changes. Adolescents are cognitively immature, emotionally unstable, and highly susceptible to peer and environmental influences.[2,3] Mental health issues, including excessive academic stress, maladaptation in peer relationships, bullying, depression, and anxiety, can manifest as extreme behaviors such as self-harm or suicide if not properly addressed and treated.[4]

In a study that investigated student suicide, students reported mental health problems, conflict with parents, poor grades and low academic performance, and the burden of education and their future career one year prior to their death.[5] Moreover, compared with adults, adolescents are more sensitive to the effects of imitation; therefore, media coverage of celebrity suicide influences adolescent suicidal behavior, as such reports may inspire adolescents to end their own lives in a similar manner.[6]

Over the past decade, the Ministry of Education of South Korea has implemented nationwide countermeasures to promote students' mental health and prevent suicide. Emotional and behavioral characteristics were assessed at least once every three years for all elementary, middle, and high school stu-

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dents to identify students with emotional and behavioral vulnerabilities and provide them with appropriate mental health care services. Additionally, the "Mental Health Expert School Visit Project" was promoted, wherein psychiatrists and mental health experts visited schools to evaluate and provide advice regarding serious emotional and behavioral problems among students.[7]

Death by suicide among young students has negative emotional effects on parents and bereaved family members, friends, fellow students, and faculty members attending the same school, as well as students in other schools in the same area.[8] Individuals who have experienced the suicide of someone close to them are at an increased risk of attempting suicide themselves, and a heightened need for hospitalization often exists.[9]

Students who have experienced a friend's suicide are at an increased risk of developing post-traumatic stress disorder (PTSD) and major depressive disorder (MDD) and have an elevated likelihood of experiencing suicidal thoughts.[10-12] Furthermore, among students with preexisting emotional issues, such as depression and anxiety, the risk of developing PTSD, MDD, and alcohol dependence increases when they experience a friend's suicide.[13]

In schools where a student dies by suicide, it is critical to promptly assess the emotional impact on other students and provide appropriate therapeutic interventions to ensure the stability of students and schools. Unfortunately, domestic and international research on the emotional impacts and trauma experienced by these students is scarce.

To bridge this research gap, this study aimed to explore the negative emotional impact of peer suicide on students and investigate the factors related to the emotional shock of peer suicide.

METHODS

Participants

This study was conducted from March 1, 2020 to December 31, 2021, targeting all students enrolled in 17 middle and high schools in Gyeongsangbuk-do, South Korea. Each school had experienced a suicide incident and requested a crisis intervention from the Metropolitan Office of Education. Excluding five students who declined to participate, 2,382 students from 17 schools were included in the study.

Participants were categorized based on factors such as middle school/high school, boarding school/non-boarding school, sharing the same class as the deceased student, belonging to a different class in the same grade, or belonging to a different grade.

Methods

Surveys were conducted at 17 schools, where one student suicide incident occurred from March 1, 2020 to December 31, 2021. The evaluation of the enrolled students was conducted within 7 days of the student's suicide. Immediately following a student's death, a "School Crisis Management Committee to Respond to Student Deaths" was convened, involving key participants such as public officials in charge of student mental health at the Regional and Metropolitan Office of Education, a psychiatrist and clinical psychologists affiliated with the "Students Life Love Center," and teachers from the school where the student died by suicide. During the meeting, information regarding the time and method of the student's suicide, the student's school life, emotional issues, interpersonal relationships, and potential impact on other students was discussed. Strategies to address the impact and methods of notifying students about the death were also discussed. Subsequently, information about the student's death was communicated to the other students, a memorial ceremony was conducted, and an assessment of the students' current emotional state and the emotional impact on them was conducted on a designated date. We collected and analyzed the participants' personal information, such as grade, class, and dormitory or non-dormitory status, and following scales.

Assessment

Korean version of the Impact of Event Scale-Revised

The Korean version of the Impact of Event Scale-Revised (IES-R-K) is a self-report scale used to assess PTSD symptoms in trauma-related clinical research.[14] The IES-R has been translated into Korean and standardized.[15] The IES-R-K comprises 22 items, including symptoms of intrusion (8), avoidance (8), and hyperarousal (6). Symptoms experienced over the past week were assessed on a 5-point Likert scale ranging from 0 (not at all) to 4 (extremely). The suggested PTSD cutoff is either 24 or 25 points, and the cutoff for PTSD tendency is proposed to be either 17 or 18 points.[15]

State-Trait Anxiety Inventory-X

The State-Trait Anxiety Inventory-X (STAI-X) is a self-report anxiety scale comprising 40 items, divided into state anxiety (STAI-S), representing anxiety reactions to situational stressors, and trait anxiety (STAI-T), which reflects relatively stable and enduring individual dispositions or acquired behavioral tendencies that manifest as anxiety.[16] The STAI-X was developed by Spielberger and translated into Korean.[17] It comprises 20 items for both state and trait anxiety, each rated on a scale from 1 to 4 based on the degree of symptoms, with a score range of 20 to 80. For the STAI-S, scores below 52 are

classified as normal, 52−56 as mild, 57−61 as moderate, and 62 or above as severe anxiety. For the STAI-T, scores below 54 are considered normal, 54−58 as mild, 59−63 as moderate, and 64 or above as severe anxiety.

Center for Epidemiological Studies-Depression Scale

The Center for Epidemiological Studies-Depression Scale (CES-D) is a self-report depression scale known for its concise items and measurement of the severity of depression based on the duration of symptom presence, making it a suitable tool for epidemiological research.[18] It has been validated for validity and reliability in the domestic context by Lee et al.[19] Comprising a total of 20 items, it assesses symptom frequency over the past week on a 4-point scale ranging from 0 to 3, with a total score range of 0 to 60. In this study, a commonly used cutoff point in epidemiological research, defined as 16 or higher, was considered indicative of potential depression requiring psychiatric intervention.[20,21]

Beck's Scale for Suicidal Ideation

Beck developed Beck's Scale for Suicidal Ideation (SSI) to assess suicidal thoughts and behaviors, and it was originally designed as an interview assessment tool. However, it has been translated and adapted into a self-report form for use in Korea.[22] The SSI comprises 19 items, each rated on a 3-point scale from 0 to 2. A higher total score indicated a higher level of suicidal thoughts than an individual's age group. In this study, a cutoff point for high school students was used, classifying scores below 16 as normal, 16−19 as mild, 20−23 as moderate, and 24 or above as severe.[22]

Ethical approval

This study was approved by the Institutional Review Board (IRB) of Yeungnam University Hospital (IRB No. YUMC 2022-06-024-001). The requirement for informed consent was waived by the Ethics Committee of Yeungnam University Hospital because of the retrospective nature of the study. Participants' personal information, such as grade, class, dormitory or non-dormitory status, and assessment of acute emotional state, was kept confidential throughout the research process, including data collection and analysis.

Statistical analysis

Frequency analysis was performed to gather participants' demographic information and determine the severity of each scale score. The chi-square test (χ^2 test) was conducted to examine differences in the scores among subgroups such as middle school and high school; boarding and non-boarding; and students in the same class as the deceased, different classes in the same grade, and students in different grades. Pearson's correlation analysis was performed to explore the relationships between the scores on each scale.

A multinomial logistic regression analysis was conducted to identify the factors contributing to the likelihood of being in the PTSD group based on IES-R-K scores. The statistical significance level was set at $p<0.05$, and IBM SPSS ver. 27.0 (IBM Corp., Armonk, NY, USA) was used for statistical analysis.

RESULTS

Students' demographic characteristics and scores of impact, depression, anxiety, and suicidal ideation

A total of 2,382 students from schools, in which one student died by suicide, participated in this study. Among them, 767 (32.3%) were in middle school, and 1,615 (67.8%) were in high school. A total of 509 students (21.4%) lived in boarding school dormitories on weekdays, and 1,873 students (78.6%) commuted to school. Among the students, 165 (6.9%) belonged to the same class as the deceased students, 1,117 (46.9%) were in the same grade but different classes, and 1,100 (46.2%) were in different grades (Table 1).

According to the IES-R-K, 598 students (25.1%) belonged to the PTSD or PTSD tendency group. The PTSD-tendency group comprised 234 individuals, accounting for 9.8% of the total participants, whereas the PTSD group comprised 364 individuals, accounting for 15.3% of participants. Regarding the STAI-S, 22.1% of the students (n=528) obtained scores

Table 1. Participants' demographic data (N=2,382)

Variable	Value
Grade level	
Middle school	767 (32.3)
7th	203 (8.5)
8th	182 (7.6)
9th	382 (16.0)
High school	1,615 (67.8)
10th	384 (16.1)
11th	468 (19.6)
12th	763 (32.0)
School type	
Non-boarding	1,873 (78.6)
Boarding	509 (21.4)
Class and grade classification in relation to the deceased student	
Same class in the same grade	165 (6.9)
Different classes in the same grade	1,117 (46.9)
Different grades	1,100 (46.2)

Data are presented as number (%).

indicating abnormalities. Mild, moderate, and severe abnormalities were observed in 226 (9.5%), 146 (6.1%), and 156 (6.5%) students, respectively. For the STAI-T, 265 students (11.1%) showed abnormalities, with 129 (5.4%) categorized as mildly abnormal, 66 (2.8%) as moderately abnormal, and 70 (2.9%) as severely abnormal. In the CES-D, 247 participants (10.4%) exhibited abnormal levels. Finally, on the SSI, abnormalities were observed in 108 students (4.5%), with 69 (2.9%) classified as mild, 24 (1.0%) as moderate, and 15 (0.6%) as severe (Table 2).

Differences in the frequency of PTSD/PTSD tendency groups on the IES-R-K according to demographic subgroups

Participants were divided into subgroups based on school level (middle school vs. high school), dormitory residence (non-residential vs. residential), grade/class (same class vs. same grade, different classes vs. different grades), and IES-R-K scores.

Table 2. Assessment of acute emotional state after notification of a student's death (N=2,382)

Variable	Value
IES-R-K	
Normal	1,784 (74.9)
PTSD tendency group	234 (9.8)
PTSD group	364 (15.3)
STAI-S	
Normal	1,854 (77.8)
Mild	226 (9.5)
Moderate	146 (6.1)
Severe	156 (6.5)
STAI-T	
Normal	2,117 (88.9)
Mild	129 (5.4)
Moderate	66 (2.8)
Severe	70 (2.9)
CES-D	
Normal	2,135 (89.6)
Probable depression	247 (10.4)
SSI	
Normal	2,265 (95.1)
Mild	69 (2.9)
Moderate	24 (1.0)
Severe	15 (0.6)
Missing	9 (0.4)

Data are presented as number (%). IES-R-K, Korean version of the Impact of Event Scale-Revised ; STAI-S, State-Trait Anxiety Inventory-State; STAI-T, State-Trait Anxiety Inventory-Trait; CES-D, Center for Epidemiologic Studies-Depression Scale; SSI, Scale for Suicide Ideation

In the comparison of IES-R-K scores by school level, 74.4% of middle school students and 75.1% of high school students scored within the normal range, and there was no significant difference in the PTSD/PTSD tendency ratios between the two groups. Next, the IES-R-K scores were compared between students in boarding schools and those in non-boarding schools. While 22.9% of non-dormitory school students (n=428) belonged to the PTSD tendency group or the PTSD group, 33.4% of students from dormitory schools (n=170 out of 509) were in the PTSD tendency group or the PTSD group. There was a significant difference in the distribution between the two groups (χ^2=23.694, p<0.001).

Finally, students in the same class and same grade but different classes had significantly higher rates of PTSD tendency (same class, 16.4%; different class−same grade, 10.3%; different grade, 8.4%) and PTSD groups (same class, 29.7%; different class−same grade, 17.1%; different grade, 11.3%) compared with students in different grades (χ^2=61.094, p<0.001) (Table 3).

Correlation analysis between the degree of event impact, anxiety, depression, and suicidal ideation

Pearson's correlation analysis was conducted to examine the correlations between IES-R-K, STAI-S, STAI-T, CES-D, and SSI scores. The IES-R-K scores showed significant positive correlations with STAI-S (r=0.588), STAI-T (r=0.521), CES-D (r=0.603), and SSI (r=0.391) scores, all at a significance level of p<0.01. The STAI-S scores exhibited significant positive correlations with the STAI-T (r=0.732), CES-D (r=0.599), and SSI (r=0.395) scores at a significance level of p<0.01. The STAI-T scores demonstrated significant positive correlations with the CES-D (r=0.736) and SSI (r=0.541) scores at a significance level of p<0.01. In summary, the scores on all five scales showed significant positive correlations (Table 4).

Analysis of risk factors for the likelihood of PTSD

Logistic regression analysis was conducted to identify the factors contributing to the risk of PTSD. There was no significant difference in the likelihood of developing PTSD due to student death between middle and high school students. However, students attending boarding schools had an odds ratio (OR) of 1.9 times higher for being in the PTSD/PTSD tendency group than students attending non-boarding schools (OR 1.916, p<0.001). Comparing the risk of PTSD/PTSD tendency group among students, students in the same class as the suicide victim had 2.2 times higher risk (OR, 2.172, p<0.001), while students in different classes in the same grade as the suicide victim were at approximately 1.5 times higher risk

Table 3. Differences in the distribution of PTSD/ PTSD tendency groups by school level, school type, and class and grade (N=2,382)

Variable	IES-R-K				
	Normal (N=1,784)	PTSD tendency group (N=234)	PTSD group (N=364)	χ^2	p
School levels				0.124	0.940
Middle school (N=767)	571 (74.4)*	77 (10.0)	119 (15.5)		
High school (N=1,615)	1,213 (75.1)	157 (9.7)	245 (15.2)		
School types				23.694	<0.001
Non-boarding (N=1,873)	1,445 (77.1)	168 (9.0)	260 (13.9)		
Boarding (N=509)	339 (66.6)	66 (13.0)	104 (20.4)		
Class and grade classification in relation to the deceased student				61.094	<0.001
Same class in the same grade (N=165)	89 (53.9)	27 (16.4)	49 (29.7)		
Different classes in the same grade (N=1,117)	811 (72.6)	115 (10.3)	191 (17.1)		
Different grades (N=1,100)	884 (80.4)	92 (8.4)	124 (11.3)		

*frequency (%). PTSD, post-traumatic stress disorder; IES-R-K, Korean version of the Impact of Event Scale-Revised

Table 4. Correlation analysis between event-related impact, anxiety, depression, and suicide ideation (N=2,382)

Variable	IES-R-K	STAI-S	STAI-T	CES-D	SSI
IES-R-K	1				
STAI-S	0.558**	1			
STAI-T	0.521**	0.732**	1		
CES-D	0.603**	0.599**	0.736**	1	
SSI	0.391**	0.395**	0.541**	0.614**	1

**p<0.01, Pearson's correlation was conducted. IES-R-K, Korean version of the Impact of Event Scale-Revised; STAI-S, State-Trait Anxiety Inventory-State; STAI-T, State-Trait Anxiety Inventory-Trait; CES-D, Center for Epidemiologic Studies-Depression Scale; SSI, Scale for Suicide Ideation

(OR, 1.462, p<0.01), with students from a different grade as the reference.

Compared with students scoring within the normal range on the STAI-S, those with mild abnormalities had a 2.4 times higher risk of being in the PTSD/PTSD tendency group (OR, 2.350, p<0.001). Additionally, the risk was 5.5 times higher for students with moderate abnormalities (OR, 5.473, p<0.001) and 11.1 times higher for those with severe abnormalities (OR, 11.070, p<0.001). Meanwhile, compared with students scoring within the normal range on the STAI-T, those with mild abnormalities had a 1.7 times higher risk (OR, 1.658, p< 0.05), and those with moderate abnormalities had a 2.2 times higher risk (OR, 2.196, p<0.05) of being in the PTSD/PTSD tendency group.

Compared with students scoring within the normal range on the CES-D, those with abnormalities had 3.7 times higher odds of being in the PTSD/PTSD tendency group (OR 3.729, p<0.001). Finally, compared with students scoring within the normal range of SSI, those with mild abnormalities had 1.9 times higher odds (OR, 1.897, p<0.05) (Table 5).

DISCUSSION

This study aimed to assess the immediate emotional impact and emotional states, such as anxiety and depression, experienced by students who became aware of a peer's death by suicide and to identify groups of students at a higher risk of emotional impact due to peer suicide. The significance of this study lies in its potential to provide a foundation for post-suicide crisis intervention among students in schools where suicides have occurred.

The key findings of this study are as follows. First, a significant number of students experienced negative emotional effects in the early stages of becoming aware of peer suicide. According to the IES-R-K, 25.1% of the students were classified in the PTSD or PTSD tendency groups for emotional shock. While there has been few studies employing the IES-R-K in the general population, it is worth noting that one-quarter of students experienced emotional distress. This result is consistent with those of previous studies. Kang et al.[23] measured the risk of PTSD among middle school students who had experienced peer suicide. In their study, 21.6% of the 37

Table 5. Multiple logistic regression analysis of factors associated with PTSD/PTSD tendency in all respondents (N=2,382)

Variable	Reference		OR	95% CI	p
School level	Middle-school	High-school	0.917	0.721−1.166	0.481
School type	Non-boarding	Boarding	1.916	0.318−0.648	<0.001
Class and grade classification in relation to the deceased student	Different grades	Same class in the same grade	2.172	1.435−3.288	<0.001
		Different classes in the same grade	1.462	1.144−1.868	0.002
STAI-S	Normal	Mild	2.350	1.705−3.240	<0.001
		Moderate	5.473	3.684−8.132	<0.001
		Severe	11.070	6.556−18.695	<0.001
STAI-T	Normal	Mild	1.658	1.045−2.631	0.032
		Moderate	2.196	1.094−4.406	0.027
		Severe	0.925	0.404−2.117	0.853
CES-D	Normal	Probable depression	3.729	2.464−5.643	<0.001
SSI	Normal	Mild	1.894	1.019−3.522	0.044
		Moderate	0.742	0.246−2.237	0.596
		Severe	3.115	0.368−26.394	0.297

PTSD, post-traumatic stress disorder; OR, odds ratio; CI, confidence interval; STAI-S, State-Trait Anxiety Inventory-State; STAI-T, State-Trait Anxiety Inventory-Trait; CES-D, Center for Epidemiologic Studies-Depression Scale; SSI, Scale for Suicide Ideation

students were in the risk group, and a majority of them remained in the risk group when evaluated 8 months later. Many adolescent students are negatively emotionally affected by a peer's death by suicide. Active early post-suicide crises and long-term therapeutic interventions are needed for students in schools where student suicide occurs. Providing early and proactive treatment to students exposed to trauma may lead to a reduction in the severity of PTSD symptoms.[24,25] According to the STAI-S results, 22.2% of students reported anxiety. While studies employing the STAI-S in the general population are rare, research conducted in Chile found that over 90% of the adolescent participants fell within the normal score range.[26] In this study, 10.4% of the adolescents obtained abnormal scores on the CES-D. Likewise, in a study targeting general adolescents in France, 9.9% of males and 24.2% of females exhibited abnormal findings on the CES-D.[27] Without previous psychological test results for the participants in this study, it is unclear whether peer suicide exacerbates students' depression, anxiety, and suicidal ideation. However, based on research on the general population, peer suicide may temporarily amplify students' anxiety, with less association with the acute worsening of depression.

Second, the emotional impact varies depending on the relationship with the deceased peer. A larger proportion of students in boarding schools in the same class and grade as the suicide victims experienced negative emotional impacts. These students may experience greater emotional intimacy with each other, have a significant influence on each other, and be more likely to form stronger emotional connections. Students in boarding schools were more likely to have directly witnessed peer suicide. Direct exposure to trauma and spatial proximity are factors that increase the risk of PTSD following trauma.[28] Moreover, students in boarding schools may experience higher levels of stress and emotional exhaustion owing to factors such as a relatively isolated environment, homesickness, and a lack of personal space compared with non-boarding students.[29] Students who share the same class or grade with the deceased student are likely to form and maintain closer relationships with the deceased student compared with students from other grades. They spend a significant amount of time living in the same space, influencing each other through modeling and reinforcement.[30] Additionally, the experience of learning in the same space as a student who died by suicide may increase the likelihood of a negative emotional impact.

Finally, when the enrolled students had high levels of depression, state anxiety, mild-to-moderate trait anxiety, and mild suicidal ideation, they were at high risk of experiencing emotional trauma due to a suicide event. While the cross-sectional nature of this study precludes causal inferences, depression, anxiety, and suicidal ideation are highly likely to coexist with an increased risk of PTSD occurrence. This suggests that depression and anxiety play a crucial role as risk factors for PTSD in adolescents.[31]

This study has certain limitations. First, we did not obtain sufficient information on socioeconomic status, psychiatric diagnoses, or treatments during the post-suicide crisis intervention process for peer suicide deaths. Owing to the limitations of the collected data, there was insufficient confirmation of the factors related to the emotional impact of a peer's death by suicide. It is necessary to include sufficient demo-

graphic variables to identify risk factors for students. Additionally, the results of the emotional and behavioral characteristics assessment conducted by the Ministry of Education were not disclosed. Consequently, there were limitations in determining whether students with issues identified in the emotional and behavioral characteristics assessment were more vulnerable to the shock of a peer's suicide. Second, as a cross-sectional study, the causality between emotional characteristics and emotional shock caused by peer suicide is unclear. Based on the current data, further analysis of the relationship between student factors and emotional distress may be challenging. In future studies, using pre-incident emotional assessment results or conducting follow-up studies with at-risk students could help confirm causality.

Despite these limitations, this study is significant, as it is the first attempt to promptly identify emotionally at-risk groups within one week of suicide incidents among over 2,300 students who experienced the shock of peer suicide. When a student dies by suicide, the emotional impact may be evident in many students at the same school. We suggest the need for group-level interventions, such as classes or schools, rather than individual student interventions, especially in cases where students share common living arrangements in dormitories or belong to the same grade level as the student who died by suicide. The STAI-S can be useful for refining the prioritization of emotional risk groups in early emotional assessment. Additionally, considering that suicide incidents can manifest as impulsive imitative behaviors, separate evaluations apart from emotional distress appeals may be necessary. Further research is needed to explore additional risk factors and evaluate the initial and long-term emotional impacts of fellow students' suicide.

Availability of Data and Material

The datasets generated or analyzed during the study are available from the corresponding author upon reasonable request.

Conflicts of Interest

The authors have no potential conflicts of interest to disclose.

Author Contributions

Conceptualization: Min Ho Lee, Hee Jin Kim, Wan Seok Seo. Data curation: Han Gil Lee, Hee Jin Kim. Formal analysis: Yoo Jeong Lee. Funding Acquisition: Min Ho Lee, Wan Seok Seo. Investigation: Min Ho Lee. Methodology: Wan Seok Seo. Project administration: Min Ho Lee, Wan Seok Seo. Resources: Min Ho Lee, Wan Seok Seo. Software: Min Ho Lee, Hee Jin Kim, Wan Seok Seo. Supervision: Wan Seok Seo. Validation: Min Ho Lee. Visualization: Min Ho Lee. Writing—original draft: Min Ho Lee. Writing—review & editing: Wan Seok Seo.

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