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The Effects of Air Quality on Mental Health, and A Comparative Study of Teenagers Aged 12-18 During January and February in Lampang, Phranakhon Si Ayutthaya, and Bangkok

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ABSTRACT: Nowadays, populations around the world are suffering from mental health issues, especially depression, and the number is estimated to increase every year. Not only depression issues but also air pollution that is surging. Air pollution has been shown to affect people's respiratory systems and may even have an impact on mental health, leading to various diseases, for instance depression and Alzheimer's disease. These disorders tend to occur in people of all age groups and in all countries and regions. Interestingly, each area has different air qualities, which raises concern of its impact on mental health. To investigate this issue, a cross-sectional survey was performed focusing on teenagers aged 12-18 in three different provinces in Thailand to compare the effect of air quality on mental health. This survey used a questionnaire consisting of 34 questions to collect data from 629 individuals participating in this research. The data analysis was performed using the statistical package for the social sciences (SPSS) program. Our results display the mean score of mental health and air quality as 2.62 and 3.02, respectively, which states that there is an average rate of these 2 variables. Furthermore, the one-way ANOVA test comparing mental health levels in 3 residents shows no significant difference (p-value = 0.225), however, one-way ANOVA comparing the air quality shows a significant difference between the 3 provinces (p-value less than 0.001). We also conducted a t-test to compare the 2 variables between pupils who have underlying medical conditions and pupils who don't have them. Unfortunately, we found no significant difference for mental health in pupils with and without medical conditions (p-value = 0.75) and for air quality in pupils with and without medical conditions (p-value = 0.52). Nevertheless, the correlation analysis obtained an r-value of 0.30, which indicates that the survey produced a weak positive correlation between mental health and air quality. This type of study is rarely conducted in Thailand, which means there will need to be more studies in this field. Regarding this research, it is apparent that air quality has an effect on mental health, so an open mind of caring for ourselves and others about this issue would be practical.

KEYWORDS: Air quality, Air pollution, Depression, Medical conditions, Mental health.

INTRODUCTION

Major depressive disorder (depression) is common in mental health and was ranked as the third cause worldwide in 2018 by the World Health Organization (WHO), which has projected that this disease will rank first by 2030 and has increased every year [1]. In 2019, approximately 280 million people, an increase of 5%, including all adults, adolescents, and children, experienced depression [2]. Additionally, Thailand has the number one cause of years of life; it is the main disease suffered by 1.5 million Thai people. Females have a higher prevalence compared to males, at 2.9% and 1.7%, respectively [3]. Mental health involves how individuals think, feel, and behave in various situations, as well as how they cope with stress, relate to others, and make decisions. The disease is caused by multiple factors, such as biological factors (e.g. physical health, genetics, and daily activities), psychological factors (e.g. imagination, thin thinking for overview, mental health diagnoses, and perception), and social factors (e.g. family,culture, and environment) [4]. Moreover, the environment is another cause of depression, which includes air pollution such as PM2.5 or PM10, where bad air quality is likely to be associated with bad mental health. Evidence seen by the research of The Impacts of Air Pollution on Mental Health: Evidence from Chinese University Students highlights the detrimental effects of poor air quality on mental well-being. In China, where air pollution levels are alarmingly high, PM2.5 was implicated in 40% of all premature deaths due to poor air quality in 2010. This underscores the profound impact of environmental factors on mental health, particularly in vulnerable populations like Chinese students [5].

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Air pollution is a significant health concern worldwide, with various adverse effects on human health. The respiratory system is particularly vulnerable, with pollutants like particulate matter (PM), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), and ozone (O_3) contributing to conditions such as asthma, chronic obstructive pulmonary disease (COPD), and respiratory infections [6]. Surprisingly, the report by IQAir, a Swiss air-quality technology company, revealed that in 2023, the air quality in Thailand ranked 36th globally and was among the top five worst in Southeast Asia, with a PM2.5 concentration of 106.4 µg/m³ [7]. Air pollution, be it the contamination of indoor or outdoor environments, is due to chemical, physical, or biological wastes that are released from household combustion, motor vehicles, industrial facilities, and forest fires. According to WHO data, 99% of the global population breathes poor-quality air, with low-income and middle-income countries suffering from the highest exposures [8]. Air pollution can have significant impacts on both physical (e.g. asthma, bronchitis, and other lung diseases) and mental health (e.g. depression, schizophrenia, bipolar disorder, and personality disorder). Numerous studies have demonstrated the correlation between poor air quality and various health problems. This is evidenced in a study where they showed long-term exposure has also been linked to cardiovascular problems, including heart attacks and strokes [9]. Moreover, air quality has been shown to be associated with the impact on the environment, changing the earth's climate and ecosystems globally [8].

Absolutely, air pollution's impact on mental health is high, with high levels of stress, psychological distress, and an increased risk of dementia, Alzheimer's disease, and depression. Research points out that air pollution specifically impacts the brains and mental health in children [10]. In addition, a study sampled a large population in the United States and Denmark, providing further support for the idea that air pollution is a significant environmental risk factor for mental health [11]. Thus, both children and adolescents should all be really careful on the impacts of poor air quality. Since there are limited studies done in Thailand. We conducted a survey to find out about the effects of air pollution on the mental health of teenagers ages 12-18 years in 3 different provinces of Thailand; Lampang, Phranakhon Si Ayutthaya, and Bangkok. Therefore, when comparing the effects of air quality on mental health across different areas, it's important to consider the specific context, including the local sources of pollution, surroundings, and shelter conditions.

METHOD

We conducted a cross-sectional survey to compare the effect of air quality on mental health in 3 provinces, including Lampang, Phra Nakhon Si Ayutthaya, and Bangkok. The survey was performed using a 3-part questionnaire consisting of 34 questions, which are categorized into 1) General information, 2) Depression assessment, consisting of 15 questions assessed using a 5-point Likert scale, and 3) Air quality using a 5-point Likert scale on 15 questions. These questions were assessed by 2 specialists to obtain Item-Objective Congruence (IOC) more than or equal to 0.5. The questionnaires were then tested by piloting on 30 participants to reveal the reliability test, and Cronbach's alpha score was approximately 0.805. The data was collected by sending it electronically via Google Forms to junior high schools and senior high schools in 3 different provinces of Thailand. The survey was conducted for 2 months (January and February) and obtained a total of 629 participants. The statistical package for the social sciences (SPSS) program version 29.0.2.0 (20) was used to compute all the data from the survey responses. We performed correlation tests by one-way ANOVA (F-test), Pearson correlations, and independent samples (t-test). The significant p-value in this study is less than 0.05.

INSTRUMENTS

General information

1. Please select your gender
2. Please select your age
3. Please select your province that you are currently living in
4. You have an underlying medical condition

Depression assessment

1. You generally feel unhappy.
2. You may notice a decreased interest in others compared to before.
3. You take a lot of effort to get yourself to start working on something new.
4. You may find that you no longer derive as much satisfaction from activities as you once did.
5. When you feel down, friends and family can't cheer you up.

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6. You easily get impatient, frustrated, or angry with people.
7. You feel that people aren't interested in you.
8. You feel like you have nothing to look forward to.
9. You experience episodes of crying that are difficult to control.
10. You have trouble getting to sleep.
11. You feel like your life has generally been a failure or disappointment.
12. You have trouble staying focused on what you are supposed to be doing.
13. You blame yourself for your faults and mistakes.
14. You think about death, or about people being better off without you.
15. Your appetite has changed; you are now eating much less or much more than usual. This change is affecting your weight.

Air quality assessment

1. You live in areas affected by dust or air pollution.
2. You wear a face mask in areas with dust or air pollution.You live in an area that burns garbage.
3. You don't have air purifiers both at home and school.
4. You live in an area that burns garbage.
5. You tend to stay at home when dust levels are high.
6. Your residence or school has high dust levels all the time.
7. You notice that the atmosphere isn't clear.
8. You often expose to smoke from cigarette.
9. You experience episodes of crying that are difficult to control.
10. You live or study in a home or school located near industrial plant.
11. You are often affected by fumes from vehicles.
12. You always check the dust level before leaving the house.
13. You experienced eye irritations.
14. You have a nose pain when exposed to dust.
15. You have difficulty breathing when exposed to dust.

RESULTS

Table 1. General information of participants (N=629)

General information	Frequency	Valid Percent
Gender		
Female	417	66.3
Male	190	30.2
Non-binary	22	3.5
Age		
16	136	21.6
12	41	6.5
Current living		
Lampang	261	41.5

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Phra Nakhon Si Ayutthaya	212	33.7
Bangkok	156	24.8
Medical condition		
Have	147	23.4
Do not have	482	76.6

Table 1 shows the personal information of the 629 participants collected. The majority of the participants are females, accounting for 417 people (66.3%). Followed by 190 males (30%) and 22 non-binary (3.5%). Most of the sample population are 16 years old, while age 12 has the lowest proportion during the period of sample collection, the participants currently living in Lampang, Phra Nakhon Si Ayutthaya, and Bangkok are 261 (41.5%), 21 (33.7%), and 16 (24.8%), respectively. Many of them do not contain any congenital diseases accounting for 482 people (76.6%), however, 147 participants (23.4%) contain medical conditions.

Table. 2. Descriptive statistics (mean and standard deviation)

	N	**Mean**	**Standard Deviation**
Mental health	629	2.62	0.77
Air quality	629	3.02	0.65

Table 2 illustrates the mean score and the standard deviation on mental health and air quality. The mean scores are between 1 and 5; 1 indicates the participants have the worst mental health, whereas 5 shows the participants do not have problems with mental health. The standard deviation is a measure of how dispersed the data is; a high number represents high dispersion, and a low number displays low dispersion. The mean score of mental health is 2.62, while the standard deviation is 0.77. Moreover, the mean score and the standard deviation of air quality are 3.02 and 0.65, respectively.

Table 3. One-way ANOVA test (F-test) comparing mental health levels between the three provinces of residence

		SS	**df**	**MS**	**F**	**p-value**
Mental health	**Between Groups**	1.76	2	0.88	1.49	0.225
	Within Groups	369.87	626	0.59		
	Total	371.64	628			

Table 3 displays that residents do not have a significant effect on mental health. The result from one-way ANOVA shows a p-value of 0.225, the number shows that the 3 residents do not have a significant difference in mental health as the p-value is more than 0.05.

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Table 4. One-way ANOVA test (F-test) comparing air quality between the 3 provinces of residence

		SS	df	MS	F	p-value
Air quality	**Between Groups**	7.89	2	3.94	9.7**	<0.001
	Within Groups	254.29	626	0.4		
	Total	262.18	628			

**. The difference is significant at 0.01 level (2-tailed).

Table 4 demonstrates that residents have a significant difference in air quality. The one-way ANOVA depicts that a p-value is less than 0.001, the number illustrates that the 3 residents have a significant difference in air quality as the p-value is less than 0.01.

Table 5. Pearson's correlation shows the relationship between mental health and air quality

		Mental health	Air quality
Mental health	**Pearson Correlation**	1	0.30**
	Sig. (2-tailed)		<0.001
	N	629	629
Air quality	**Pearson Correlation**	0.30**	1
	Sig. (2-tailed)	<0.001	
	N	629	629

**. Correlation is significant at 0.01 level (2-tailed)

Table 5 indicates the correlation between mental health and air quality. The result from Pearson's correlation shows the two variables have a significant correlation (r = 0.30), this indicates a weak positive correlation between mental health and air quality.

Table 6. Student's t-test comparing mental health between participants who have a medical condition and those who do not have a medical condition.

	Have medical condition	N	Mean	Standard Deviation	t	p
Mental Health	Yes	147	2.78	0.76	2.87	0.75
	No	482	2.57	0.77		

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Table 6 depicts that mental health is not significant between participants who have and do not have medical conditions. Having a medical condition shows a mean score of 2.78, while the standard deviation is 0.76. Moreover, those who do not have a medical condition have a mean score of 2.57, while the standard deviation is 0.77.

Table 7. Student's t-test comparing air quality between participants who have a medical condition and those who do not have a medical condition.

	Have medical condition	N	Mean	Standard Deviation	t	p
Air quality	Yes	147	3.15	0.66	2.85	0.52
	No	482	2.98	0.64		

The result in Table 7 indicates no significant difference in air quality between participants who have a medical condition and those who do not. Participants with medical conditions have a mean score of 3.15 and the standard deviation of 0.66. Additionally, those who do not have a medical condition have a mean score of 2.98 and the standard deviation of 0.64.

DISCUSSION

Nowadays, people in Thailand living in globalization and industrialization have produced diverse types of pollution that can affect individual health, especially children because they are a sensitive group [12]. Recently, there has still been an inequality between industrialization and environmental protection in Thailand [12]. According to China, they evidenced that air pollution is a risk factor for a wide range of potential mental health disorders [13]. In addition, long-term exposure to higher levels of air pollutants, namely particulate matter (PM2.5, PM10) and nitrogen dioxide (NO_2) has been found to affect teenagers's happiness at lower levels [13]. It is important to study and understand the relationship between air pollution and mental health among youngsters ages 12-18 in three provinces of Thailand, consisting of Lampang, Phranakhon Si Ayutthaya, and Bangkok.

From Table 3, provinces of residence have a significant effect on mental health caused by each location of residents having different environmental problems. Human beings spend most of their time indoors, living for more than 90%. Thus, environmental characteristics including housing, crowding, noise, indoor air quality, and light play a direct effect on mental health [14]. To begin with, Lampang, which is the northern region of Thailand, has petrochemical factories in coastal provinces, coal power plants, and agricultural burning activities [12]. Furthermore, from February to April, the highest daily average particulate matter (PM2.5) concentrations in Northern Thailand were as high as 200–300 μg/m^3, according to the Pollution Control Department (PCD) of Thailand [15]. In terms of Thailand's national ambient air quality standards (NAAQS), the average values over a 24-hour period shouldn't be more than 37.5 μg/m^3 [16]. Moreover, in the Bangpa-in Industrial Eatast area, there are 109 factories located in Phranakhon Si Ayutthaya province [17]. Over 30,000 industrial facilities located in the Chao Phraya River basin have contributed to river water contamination by toxic substances, including heavy metals from industrial effluents [10]. Heavy metals from industrial effluents are among the harmful elements that have contaminated river water in the Chao Phraya River basin, which is home to over 30,000 industrial facilities [18]. Ayutthaya Province's industrial complexes in Phra Nakhon Si Ayutthaya experienced catastrophic floods in 2011, which raised concerns about harmful chemical contamination coming from the wastewater treatment systems of these industrial estates. Current data on air pollution monitoring and recent evaluations of exposure six to ten million people live in Bangkok, the capital city of Thailand, and they are exposed to particulate matter (PM10), or particulate matter with an aerodynamic diameter ≤ 10 μm, at levels that are comparable to or higher than those found in cities in NAWE (North America and Western Europe) [19].

Table 4 depicts the correlation between provinces of residence that have a significant effect on air quality. That is caused by the 3 provinces having different geologies, types of pollutants, and concentrations of pollutants. The level of pollution in

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Lampang is the worst among the three provinces especially during the dry season in the northern part of Thailand including Lampang usually burns fields to prepare the land for cultivation; however, this releases harmful gasses from agricultural burning activities [16]. The particulate matter (PM2.5) in Northern Thailand is 60-70% contributed from forest burning, while farm burning, traffic, and others account for 30% [20]. That factor supports a high concentration of pollutants in Lampang province; the level of pollutants is so high that this level is far beyond the standard level (37.5 g/m^3) [21]. Phranakhon Si Ayutthaya is in the central region; particulate matter (P.M2.5) comes from farm burning at a proportion of 60-70%, while forest burning, traffic, and others are almost 30% [17]. From a study of air pollution emissions from industrial sources in Thailand, it was found that the central region had the highest emissions. Ayutthaya province is one of those central areas that is growing highly industrial. There are many industrial estates in the area. Dust particles no larger than 10 micrometers are the most problematic air pollution in this area [25]. The particulate matter (PM2.5) in Bangkok is mainly caused by traffic, with a proportion of approximately 60%, followed by farm burning 30%, forest burning, and other causes, roughly 10% [21]. The most significant local sources of particulate matter (PM2.5, PM10) in Bangkok include primary combustion, such as vehicle emissions, coal combustion, biomass burning, secondary aerosol formation, industrial emissions, and dust sources [22].

Table 5 compares the correlation between mental health and air quality. There is a weak correlation (r=0.3-0.5) which is a positive correlation between mental health and air quality. Numerous studies have shown that changes in the environment are linked to mental health issues. According to a self-assessed mental health survey, Xue et al. reported that an increase in air pollution is associated with a higher probability of self-assessed mental health problems [23]. Similarly, greater levels of inhalable fine and coarse particulate matter (PM2.5, PM10) were found to be significantly associated with an increase in mental health issues, according to Kioumourtzoglou et al. [24]. Even in cases of relatively low levels of particulate matter (PM10) air pollution, exposure to it has significant negative impacts on subjective life satisfaction and well-being [13]. Furthermore, it has been discovered that teenagers who are exposed to elevated amounts of nitrogen dioxide (NO_2) and particulate matter (PM2.5, PM10) for an extended period of time experience decreased levels of happiness [4].

Comparison between individuals who have medical conditions and those who do not were performed using t-test (Table 6 and Table 7). Table 6 demonstrates that mental health is not significantly different between those who have and those who do not have medical conditions. Black Americans with any medical condition were more likely than those with no medical condition to have at least one mental health disorder. The medical condition group, compared to those with no medical condition, had a higher prevalence of mood disorders, anxiety disorders, eating disorders, and childhood disorders [26]. Table 7 illustrates that air quality is not significantly different between these medical conditions as well. Having a medical condition has a higher mean score than not having a medical condition with poorer air quality. A possible reason for this is that the sample population has respiratory system diseases and others from poor air quality in this area. The respiratory system in children – due to a dynamic growth and development of the lungs, fast minute ventilation, the immaturity of the immune system, and spending long hours outdoors – is much more sensitive to harmful particles. According to Koranteng's analysis of the findings of thirteen studies evaluating the effects of ambient air pollution on children's health, higher air levels of sulfur dioxide (SO_2), carbon monoxide (CO), nitrogen dioxide (NO_2), and particulate matter (PM2.5, PM10) were linked to an increased incidence of asthma hospitalisations [27]. Particulate matter (PM2.5) exposure is a risk factor in the process of cardiovascular events and has a clear causal association with cardiovascular disease. Cardiovascular and respiratory health are impacted by poor air quality. Air quality warnings are used to inform the public about health dangers related to outdoor air quality. In 2017, multinomial and log binomial regression were used to examine the correlations between each health condition and air quality awareness [28].

CONCLUSION

In conclusion, this study investigates the effect of air pollution on mental health in 3 provinces in Thailand, focusing on two variables: air pollution and mental health. We did a correlation between these two variables, and the result shows that there is a weak positive correlation between air pollution and the effect on mental health. Moreover, we found that there was a significant difference in air quality between the three provinces of residence based on the one-way ANOVA test. On the contrary, it is shown that the provinces of residence and mental health have no effect on each other. In addition, we reveal that whether individuals undergo medical conditions or not, it does not affect the mental health of individuals. The result also indicates that air quality does

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correlate with mental health in a minor way according to our data analysis. Despite all our conducted tests and results, further research still has to be performed to better understand the link between air quality and mental health.

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