International Journal of Nursing and Midwifery Science (IJNMS)

http://ijnms.net/index.php/ijnms
ORIGINAL RESEARCH

e- ISSN: 2686-2123
p- ISSN: 2686-0538

ADOLESCENT ENGAGEMENT IN PHYSICAL ACTIVITY AMID PM2.5 POLLUTION IN SUPHAN BURI, THAILAND

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ABSTRACT

This study analyzes factors influencing physical activity (PA) among adolescents during periods of elevated ambient PM2.5 concentrations in Suphan Buri, Thailand. Utilizing a cross-sectional design, 227 adolescents completed an online questionnaire assessing their knowledge of safe physical activity during high PM2.5 periods and their engagement in such activities. Descriptive statistics and Chi-Square tests were used for analysis, with significance set at $p < .05$. Results indicated that academic faculty ($\chi^2 = 12.10$, $p = .033$) and Knowledge of PA during periods of elevated ambient PM2.5 concentrations ($\chi^2 = 13.91$, $p = .000$) significantly influenced engagement in physical activities during elevated PM2.5 periods. These findings suggest that adolescents with certain educational backgrounds and greater awareness of protective measures are more likely to remain active despite pollution risks. The study underscores the need for targeted educational interventions to promote safe physical activity among adolescents in polluted environments, contributing to public health strategies aimed at mitigating the adverse effects of air pollution on adolescent.

Keywords

Adolescent, air pollution, particulate matter 2.5, physical activity, Thailand

INTRODUCTION

Physical activity (PA) includes any movement that requires energy, encompassing leisure activities, travel, work, and household chores (World Health Organization, 2024). For adolescents, the Physical Activity Guidelines for Americans recommend at least 150 minutes of moderate-intensity activity or 75 minutes of vigorous activity weekly , supplemented by muscle-strengthening exercises twice a week. (Centers for Disease Control and Prevention, 2024). Regular PA enhances physical fitness, bone health, mental well-being, and cognitive function, forming a foundation for lifelong health (Qiu et al., 2023). Conversely, insufficient PA is a significant risk factor for noncommunicable diseases (NCDs) and increases pressure on healthcare systems (Dadras et al., 2024). Globally, the prevalence of insufficient physical activity has risen from 23.4% in 2000 to 31.3% in 2022, highlighting an escalating public health concern (Strain et al., 2024).

Environmental challenges, particularly air pollution, create new barriers to safe PA, especially in urban and industrialized areas with compromised air quality (Manisalidis et al., 2020). Particulate matter 2.5 (PM 2.5)—tiny particles that penetrate the lungs and enter the bloodstream—has been linked to respiratory and cardiovascular conditions (California Air Resources Board, 2024). In Suphan Buri Province, rural Thailand, agricultural practices, *burning* in *agricultural* areas, result in elevated PM 2.5 levels (Junpen et al., 2018), raising health risks for local adolescents engaged in outdoor activities and sports. While previous studies often focus either on promoting PA or examining air pollution impacts, few explore the intersection of these issues among adolescents (Imman et al., 2023; Fakmit & Wongwat, 2022; Malaicharoen et al., 2022).

This study applies the PRECEDE framework (Green & Kreuter, 2005) to analyze factors influencing physical activity (PA) among adolescents during periods of elevated ambient PM2.5 concentrations in Suphan Buri, Thailand. Understanding how PM2.5 pollution affects adolescent physical activity is crucial for developing effective health promotion strategies. This study addresses a significant public health issue by exploring the interplay between environmental hazards and health behaviors in a vulnerable population. Findings from this research may inform public health strategies and policies to create healthier, safer environments that encourage physical activity among adolescents, thereby mitigating the adverse effects of air pollution on this age group.

METHOD

This cross-sectional survey was conducted from November 2020 to February 2021 in Suphan Buri Province, Thailand, targeting first-year students aged 18 years or older enrolled during the 2020 academic year. The total population comprised 527 students. Using Taro Yamane's sample size formula (Yamane, 1973), a sample size of 227 participants was determined to achieve a 95% confidence level with a 5% margin of error. A multi-stage sampling method was employed to ensure balanced representation across different subgroups within the population.

Inclusion criteria required participants to be first-year students aged 18 years or older, engaged in physical activity, and proficient in Thai language skills, including speaking, reading, writing, and comprehension. Exclusion criteria included individuals without access to a smartphone, computer, or the internet, as the survey was administered online. Participants who

initially consented but later chose to withdraw were also excluded.

Data were collected using a 37-item online self-administered questionnaire, designed to be completed within 10 to 15 minutes. The questionnaire was structured into four sections:

1. **Predisposing Factors**: 18 items assessing knowledge, attitudes, and stress levels related to physical activity during elevated PM2.5 periods.
2. **Enabling Factors**: 3 items evaluating the availability of exercise facilities and policies.
3. **Reinforcing Factors**: 12 items exploring social and environmental influences, including support from peers, teachers, and family.
4. **Physical Activity During Elevated PM2.5 Periods**: 4 items assessing participants' activity levels and adaptations in response to air quality concerns.

The questionnaire underwent content and construct validity assessment by a panel of three experts in adolescent health. The Index of Item Objective Congruence (IOC) scores ranged from 0.67 to 1.00, indicating high item congruence. Reliability was evaluated through a pilot test with 30 first-year students from a similar population in Suphan Buri Province. Internal consistency was assessed using Cronbach's Alpha Coefficient, yielding satisfactory reliability across all sections:

- **Predisposing Factors**:
  - Knowledge: $\alpha = 0.705$
  - Attitudes: $\alpha = 0.811$
  - Stress Level: $\alpha = 0.899$
- **Enabling Factors**: $\alpha = 0.809$
- **Reinforcing Factors**:
  - Peer Support: $\alpha = 0.839$
  - Teacher Support: $\alpha = 0.949$
  - Family Support: $\alpha = 0.970$
- **Physical Activity During Elevated PM2.5 Periods**: $\alpha = 0.794$

These coefficients indicate acceptable to excellent internal consistency for the instrument's scales.

Data Analysis

Descriptive statistics, including mean, standard deviation, and percentage, were calculated to summarize sample characteristics such as gender, faculty, underlying health conditions, and age. Inferential analysis was conducted using Chi-square tests to assess relationships among predisposing, enabling, and reinforcing factors in relation to physical activity during elevated PM2.5 periods. This approach provided insights into how these factors influenced participants' physical activity under compromised air quality conditions.

Variables

- **Independent Variables**: Predisposing factors (knowledge, attitudes, stress levels), enabling factors (availability of exercise facilities and policies), and reinforcing factors (peer, teacher, and family support).
- **Dependent Variable**: Engagement in physical activity during periods of elevated ambient PM2.5 concentrations.

Justification of Methods and Study Area

- **Methodology**: A cross-sectional survey design was appropriate for assessing the prevalence and relationships between variables at a

single point in time. The use of an online self-administered questionnaire facilitated data collection during the COVID-19 pandemic, ensuring participant safety and compliance with social distancing measures.

- **Study Area**: Suphan Buri Province was selected due to its rural setting and prevalent agricultural practices, notably crop burning, leading to elevated PM2.5 levels. This context provided a relevant environment to study the impact of air pollution on adolescent physical activity.
- **Scope**: The study focused on first-year students in Suphan Buri Province, providing insights into a specific demographic within a defined geographical area.

Ethical Considerations

The study was approved by the College's Human Research Ethics Committee (Approval Document No. PHCSP-S2563/038). Written informed consent was obtained from all participants, adhering to the ethical guidelines of the World Medical Association Declaration of Helsinki for research involving human subjects. Participant information was kept confidential, with data anonymized and securely stored within the college's data system. Access to data was restricted to researchers with secure passwords. No financial incentives were provided to participants.

RESULTS

The demographic analysis of the sample, comprising 227 participants, revealed that 52 were male (22.9%) and 175 were female (77.1%). The majority were enrolled in the Faculty of Public Health and Allied Health Sciences, totaling 87 participants (38.7%), followed by the Faculty of Nursing with 62 participants (27.3%), and the Faculty of Sports and Health Sciences with 30 participants (13.2%). Most participants were 19 years old, accounting for 139 individuals (61.2%), with 20-year-olds comprising 42 participants (18.5%) and 18-year-olds representing 11.9%. Additionally, the majority of participants reported no underlying health conditions, totaling 205 individuals (90.3%).

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Table 1. Factors associated with physical activity amid ambient PM 2.5 air pollution among adolescents in Suphan Buri Province, Thailand (n=227)

Factors	df	x^2	p-value
Predisposing factors			
1. Gender	1	0.080	.777
2. Age (year)	1	2.673	.102
3. Academic faculty	5	12.106	.033
4. Underlying Health Conditions	1	0.249	.618
5. Knowledge of PA during periods of elevated ambient PM2.5 concentrations	1	13.910	.000
6. Attitudes Toward PA during the PM2.5 situation	1	7.512	.060
7. Stress	1	0.409	.522
Enabling Factors			
8. Access to PA facilities during periods of elevated ambient PM2.5 concentrations	1	0.517	.472

Factors	df	x^2	p-value
9. Access to PA equipment during periods of elevated ambient PM2.5 concentrations	1	0.310	.578
10. Institutional policy about PA the PM2.5 situation	1	0.081	.776
Reinforcing Factors			
11. Peer support	1	0.011	.915
12 Instructors support	1	0.001	.969
13. Family support	1	0.192	.662

Chi-square tests were conducted to examine associations between various factors and physical activity engagement during elevated PM2.5 periods. Two factors showed statistically significant associations:

1. **Academic Faculty Enrollment**: There was a significant association between the faculty in which participants were enrolled and their engagement in physical activity during high PM2.5 periods (χ^2 = 12.10, p = .033).
2. **Knowledge of Physical Activity During Elevated PM2.5 Periods**: Participants' knowledge levels were significantly associated with their physical activity engagement under high PM2.5 conditions (χ^2 = 13.91, p < .001).

These findings suggest that both the academic discipline of study and the level of knowledge regarding safe physical activity practices during periods of elevated PM2.5 concentrations are important factors influencing adolescents' engagement in physical activity under compromised air quality conditions. Detailed is showed in Table 1.

DISCUSSION

This study utilized the PRECEDE framework to analyze factors influencing physical activity (PA) among adolescents during periods of elevated ambient PM2.5 concentrations. The findings indicate that predisposing factors, such as knowledge and attitudes toward PA in polluted environments, were at moderate levels among participants. This finding according with previous research indicating that awareness and attitudes regarding health behaviors in polluted environments are often limited, with knowledge gaps significantly influencing engagement (Marín et al., 2024; Alzayani et al., 2022). Moderate levels of awareness may be insufficient to drive consistent PA participation during heightened health risks, such as PM2.5 exposure, where a deeper understanding of health implications could play a protective role by promoting safer PA practices (Siddique et al., 2024; Quintyne & Kelly, 2023).

Enabling factors, including access to PA facilities and equipment during high PM2.5 periods, were also moderate, highlighting potential logistical barriers to safe exercise. Additionally, while some participants reported the existence of institutional policies supporting PA during pollution episodes, the moderate engagement levels observed suggest these policies may lack the rigor necessary to effect meaningful behavioral changes (Wangsan et al., 2024).

Reinforcing factors, particularly social support, emerged as highly influential, with substantial encouragement from friends, instructors, and family reported by a significant portion of participants (Davis et

al., 2021). High social support is a significant motivator for PA engagement, particularly in challenging environments, and can reinforce persistence in maintaining healthy behaviors even in adverse conditions like high pollution levels (Guo et al., 2022).

Further analysis reveals that academic faculty is significantly associated with PA engagement (χ^2 = 12.10, p-value = .033). Students in health-related faculties display greater awareness of PM2.5 risks and are more likely to engage in PA safely, highlighting how academic background can influence health behaviors (Rendon-Marin et al., 2024). Tailoring PA interventions to academic disciplines may enhance their efficacy by aligning programs with specific knowledge levels and risk perceptions inherent in different fields of study. Knowledge of PA during periods of elevated ambient PM2.5 concentrations also showed a strong association with PA engagement (χ^2 = 13.91, p-value = .000), knowledge as a key predisposing factor. Participants with a deeper understanding of PA safety during amid ambient PM2.5 were more likely to safe PA, equipped with adaptive strategies such as exercising indoors or using protective equipment (Xiong et al., 2018). Marín et al. (2024) found that individuals well-informed about pollution risks tend to adjust their exercise routines to minimize exposure.

Neglecting to address these disparities may result in decreased physical activity among students during high pollution periods, increasing the risk of noncommunicable diseases and placing additional strain on healthcare systems. Furthermore, without proper guidance, students may continue to engage in unsafe physical activities during elevated PM2.5 periods, heightening their susceptibility to pollution-related health issues.

To mitigate these risks, it is imperative to implement targeted educational programs that raise awareness about the health implications of PM2.5 and promote safe physical activity practices. Enhancing access to indoor exercise facilities and fostering supportive social environments can further encourage students to maintain physical activity levels safely during periods of elevated air pollution. By addressing these factors, educational institutions can develop effective public health strategies that promote safe physical activity among students, even in challenging environmental conditions.

Limitations

Potential limitations include reliance on self-reported data, which may be subject to recall bias or social desirability bias. Additionally, the cross-sectional design limits the ability to infer causality between variables. Access to technology was a prerequisite for participation, potentially excluding individuals without internet access, which may affect the generalizability of the findings.

CONCLUSIONS

This study underscores the significant impact of academic affiliation and knowledge on students' physical activity (PA) during periods of elevated PM2.5 concentrations. Students from health-related faculties, who typically possess greater awareness of pollution risks, are more likely to adjust their exercise routines to maintain safe PA levels during such periods. Conversely, students from non-health-related faculties may lack this critical knowledge, potentially leading to reduced PA or engagement in unsafe practices during high pollution episodes. These findings highlight the need for targeted educational interventions across all academic disciplines

to enhance students' understanding of safe PA practices amid poor air quality, thereby promoting health-conscious behaviors and mitigating the adverse effects of air pollution on student health.

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