Physical activity in physical education: a dynamic approach to earthquake disaster mitigation in schools

Integración de la actividad física en la educación física: un enfoque dinámico para la mitigación de desastres sísmicos en las escuelas

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Abstract

Introduction: Physical education is essential in promoting physical activity, which improves students' health and acts as a creative strategy for disaster mitigation, such as during earthquakes. Including physical exercises in disaster preparedness education within schools can enhance motor skills, promote swift reaction capabilities, and boost students' preparedness to manage emergency scenarios effectively.
Objective: To carry out earthquake disaster risk reduction simulations through physical activities for students via physical education in schools situated in disaster-sensitive regions.
Methodology: The study was conducted in three schools in Gresik, Lumajang, and Malang, involving 446 students in disaster readiness activities. A design using pre-test and post-test groups was applied. The execution was conducted between July and August 2024 in three phases: (1) evaluating earthquake risk using the InaRisk Personal app, which indicated a moderate level of danger; (2) validating 10 disaster prevention drills designed with input from 90 PESH instructors across different regions, achieving an 82% feasibility score; and (3) integrating the drills into PESH courses, carrying out surveys before and after the classes. Data analysis was conducted using SPSS.
Results: The tool was valid and dependable for assessing earthquake mitigation simulations in PESH classes. Nonetheless, the t-test outcomes (Sig. = 0.022) revealed a significant difference between the pre-and post-test scores, implying an impact from the simulations.
Conclusions: Simulations focused on disaster mitigation through physical education can significantly influence and enhance preparedness in schools susceptible to disasters.

Keywords

Mitigation; education; earthquake.

Resumen

Introducción: La educación física es esencial para promover la actividad física, lo que mejora la salud de los estudiantes y actúa como una estrategia creativa para la mitigación de desastres, como durante los terremotos. Incluir ejercicios físicos en la educación de preparación para desastres dentro de las escuelas puede mejorar las habilidades motoras, promover capacidades de reacción rápida y aumentar la preparación de los estudiantes para manejar escenarios de emergencia de manera efectiva.
Objetivo: Realizar simulacros de reducción del riesgo de desastres por terremotos a través de actividades físicas para estudiantes mediante educación física en escuelas ubicadas en regiones sensibles a desastres.
Metodología: El estudio se realizó en tres escuelas ubicadas en Gresik, Lumajang y Malang, involucrando a 446 estudiantes en actividades de preparación para desastres. Se aplicó un diseño que utiliza grupos de prueba previa y posterior. La ejecución se llevó a cabo entre julio y agosto de 2024, en tres fases: (1) evaluación del riesgo de terremoto utilizando la aplicación InaRisk Personal, que indicó un nivel moderado de peligro; (2) validación de 10 simulacros de prevención de desastres diseñados con el aporte de 90 instructores de PESH en diferentes regiones, logrando una puntuación de viabilidad del 82%; y (3) la integración de los simulacros en los cursos de PESH, realizando encuestas antes y después de las clases. El análisis de datos se realizó utilizando SPSS.
Resultados: se determinó que la herramienta era válida y confiable para evaluar simulaciones de mitigación de terremotos en clases de PESH. No obstante, los resultados de la prueba t (Sig. = 0,022) revelaron una diferencia significativa entre las puntuaciones de la prueba previa y posterior, lo que implica un impacto de las simulaciones.
Conclusiones: Las simulaciones centradas en la mitigación de desastres a través de la educación física pueden influir en gran medida y mejorar la preparación en las escuelas susceptibles a desastres.

Palabras clave

Mitigación; educación; terremoto.

Introduction

Indonesia recognized for its stunning landscapes, is also among the most globally vulnerable nations to disasters (Winarni & Purwandari, 2018). Recent statistics indicate that the countries facing the most significant disaster risks are the Philippines (WRI 46.86), Indonesia (WRI 43.50), and India (WRI 41.52) (Bündnis Entwicklung Hilft / IFHV, 2023). Holding the second position, Indonesia often faces natural calamities like earthquakes, tsunamis, volcanic eruptions, floods, and landslides (Badan Nasional Penanggulangan Bencana, 2023). Readiness and alertness are crucial since these occurrences can happen unexpectedly, impacting anyone, anytime. Mitigation approaches are divided into structural and non-structural measures, with this study highlighting the educational component (Pambudi, 2018; Pranoto et al., 2023). According to the 2023 Indonesian Disaster Risk Index (IRBI), East Java Province holds a moderate risk level, with a risk index of 118.61. This indicates the need for vigilance regarding potential natural hazards such as earthquakes, volcanic eruptions, floods, landslides, droughts, extreme waves or abrasion, forest and land fires, extreme weather conditions, and tsunamis. The moderate risk highlights the importance of preparedness and mitigation efforts across the region to minimize the impact of these disasters (Badan Nasional Penanggulangan Bencana, 2023). Nonetheless, an initial survey showed that while evacuation assembly locations are identified, most students do not know where they are, and evacuation drills are infrequently held. Efficient disaster prevention needs more than mere signs and pathways; it necessitates awareness, comprehension, and ongoing training. Studies indicate that non-structural earthquake mitigation measures in schools remain limited and are not yet fully optimized (Hadi, 2023).

Different mitigation measures have been implemented in Indonesian schools, both in structural and non-structural ways. This research emphasizes non-structural methods, including the application of interactive multimedia (Clarita et al., 2021) and educational comics (Sujinah et al., 2023). Although these strategies address crucial concepts, they frequently omit practical skills and active involvement from students. Providing students with the knowledge and skills to identify, comprehend, and apply disaster mitigation methods to improve their readiness is essential. Moreover, research emphasizes the necessity for improved assessment of disaster preparedness initiatives in educational institutions (Nopembri et al., 2020). Recent natural disasters have underscored that ensuring the continuity of education after these events remains a significant challenge worldwide (Opabola & Galasso, 2024).

Previous studies found that age, gender, and marital status are significant factors that shape different elements of students' and teachers' views on disaster risk reduction in schools. These components encompass disaster awareness, engagement in disaster education initiatives, disaster risk reduction education perspectives, and enhanced access to disaster-related information (Cvetković et al., 2024). Multiple research studies have shown that disaster mitigation education policies in early childhood education have been successfully implemented. This involves consistently integrating disaster readiness into curricular activities and offering adequate training and assistance for teachers (Samad et al., 2024). As an important educational environment in primary schools, there is often a lack of awareness and understanding of disaster preparedness among students, educators, and the local community. A significant obstacle in preparing these schools for disasters is the lack of effective teaching methods, especially in integrating local expertise and traditional insights (Lestari, 2024). One area that has yet to be fully explored is disaster prevention through physical activity.

This disparity is particularly concerning given that Physical Education, Sports, and Health (PESH) is an essential subject in the Indonesian curriculum, aiming to provide knowledge, attitudes, and skills vital for efficient disaster preparedness and response. PESH lessons utilize physical activities to engage students in introducing, comprehending, and applying natural disaster mitigation (Pambudi, 2018; Wardhani et al., 2024). The approach of PESH centered on physical activity, can successfully help reduce natural disasters and diminish risks when these situations arise (Pascapurnama et al., 2018). Nevertheless, research findings show that the participation of PESH teachers in dealing with natural disasters caused by earthquakes is presently inadequate (Clarita et al., 2021). This was validated in the initial survey when PESH teachers were directly questioned regarding the subject. They conveyed that, although mitigation via PESH is an intriguing idea, they had not centered their teaching around it before since their primary objective has been encouraging physical fitness. The study results suggest that students with a higher degree of physical fitness are more equipped for emergencies (Nopembri et al.,

2020). Consequently, incorporating natural disaster preparedness into physical education classes is crucial for students to identify, comprehend, and proficiently apply these ideas. This integration is essential for improving student readiness in educational environments.

Engaging in physical activity influences health (Miller et al., 2016), while physical fitness (Guijarro-Romero et al., 2020) is linked positively to cognitive function in students (Amin et al., 2023), with research findings indicating an enhancement in academic performance (Li & Zhang, 2022). Exercise positively impacts brain health, enhancing learning (Citra et al., 2024; Malm et al., 2019). Participating in physical exercise offers numerous benefits, making it crucial to prioritize these activities for enhancing safety in Indonesia, a nation that often faces natural calamities (Lisetyaningrum & Pujasari, 2021; Saunders & Lutan, 2020). Engaging in physical activities allows students to understand disaster prevention, beginning with subjects such as fire safety (Nopembri & Sugiyama, 2015; Pascapurnama et al., 2018; Widowati et al., 2023). Subsequently, individuals can cultivate a proactive attitude and refine essential skills, such as quickly navigating designated escape routes, navigating risky zones by leaping, ducking under furniture for protection, and promptly moving to the evacuation area carefully to avoid injuries from falling debris.

The deficiency in the research arises from the insufficient exploration of integrating physical exercise into PESH classes aimed explicitly at earthquake prevention, even though disaster preparedness is covered in various fields. Numerous schools emphasize theoretical concepts and structural preparations, while little research is on how physical activities in physical education, health, and safety (PESH) can enhance disaster readiness. The novelty of this approach lies in utilizing the physical skills acquired in PESH to improve overall health and prepare students for disasters, particularly in Indonesia, a country frequently affected by earthquakes. The connection between PESH and disaster readiness provides a new perspective on the role of physical education in ensuring student safety.

Therefore, this study seeks to carry out simulations for mitigating natural disasters, starting with educating, comprehending, and applying natural disaster mitigation via physical activities during physical education classes in schools.

Method

Study Design

This study employs a quantitative approach using a quasi-experimental method. The objective is to assess the effectiveness of incorporating physical activity into physical education as a dynamic strategy for earthquake disaster mitigation in schools. The research follows the pretest-posttest design, where data is collected both before and after the implementation of the physical education program, which integrates earthquake disaster mitigation activities. This design aims to evaluate changes in students' preparedness for disaster mitigation and improvements in their physical abilities.

Table 1. Sample Characteristics

School	Gender		Class					
	Male	Female	7	8	9	10	11	12
Junior High School in Gresik	40	43	27	32	24	-	-	-
Senior High School in Gresik	35	28	-	-	-	16	21	26
Junior High School in Lumajang	54	37	26	30	35	-	-	-
Senior High School in Lumajang	27	39	-	-	-	21	15	30
Junior High School in Malang	45	32	30	20	27	-	-	-
Senior High School in Malang	41	25	-	-	-	22	21	23
Sum	242	204	83	82	86	59	57	79
Total	446		446					
Percentage	100%		100%					

Participants

The participants of this study were students in junior and senior high school from three disaster-prone areas in East Java: Gresik, Lumajang, and Malang districts involved in natural disaster mitigation activities. A total of 446 samples were collected from students aged 12-18 years from class 7-9 for junior

high school and class 10-12 for senior high school, in good physical condition, actively involved in physical education, and with permission from both parents and the school, meeting the inclusion criteria. Sampling with simple random sampling, the research design used a single-group pre-test-treatment-post-test design (Mertler, 2022).

Study organization

Following a structured three-phase approach, the implementation occurred between July and August 2024. The first stage involved assessing the needs using the InaRisk Personal application, which indicated a moderate earthquake risk in the area. Ten physical activity models were developed for disaster mitigation simulations in the second stage. This involved collaboration with 90 PESH teachers from three districts through Focus Group Discussions (FGDs) conducted under the MGMP PESH program. The FGDs generated several innovative ideas, refined using relevant literature to ensure they aligned with physical education principles. The final stage resulted in ten physical activity variations designed to simulate earthquake or disaster conditions. These activities, practiced in safe gathering areas, included jumping over cones, running to assembly points, dodging obstacles, and performing safe jumps (Muhyi & Hakim, 2024). In physical education lessons, students practice earthquake disaster mitigation by focusing on knowledge, attitudes, and skills. The knowledge component provides an understanding of what constitutes an earthquake disaster. The attitude aspect fosters values such as independence, discipline, and perseverance. The skills aspect involves hands-on practice of physical activity-based mitigation techniques. These activities were validated by experts and received a feasibility score of 82%, indicating they are well-suited for research purposes.

Table 2. Simulation of Earthquake Natural Disaster Mitigation through Physical Activity in PESH Learning

Knowledge	Skills	Attitude
1. Explanation of Earthquake Natural Disaster Mitigation	1. Follow the evacuation route from Cones 1 to 2. Continue walking quickly to Cones 3 and 4 with short steps. Turn right to walk quickly to Cone 5. Walk quickly to Cone 6 and the safe assembly point, cone 7.	1. Able to perform independently, i.e., follow the route without mistakes, not scramble, and get to the assembly point safely. 2. Able to perform with discipline to follow each route properly, not cut the road, and get to the safe gathering point. 3. Able to perform persistently or unyieldingly to pass the route to a safe assembly point.
	2. Follow the evacuation route fast walking cones 1 to 2, turn left fast, zigzagging through cones 3, 4, 5, and 6, turn right fast walking while protecting your head with both hands to cone 7, and follow the route to safe gathering point cone 8.	
	3. Walk briskly, protecting the head with both hands, from the starting position to a safe assembly point at cones 1, 2, and 3, then assume a crouching position.	
	4. Follow the evacuation route from cones 1 to 2, then jump through cones 4, 5, and 6 to cone 7. End with a quick walk to cone 7, a safe gathering point.	
	5. Quickly follow the evacuation route from Cone 1, jump at Cone 2, turn left, slow walk to Cone 3, turn right fast, walk to Cone 4, jump at Cone 5, and fast walk to Cone 6, safe assembly point.	
	6. fast walk follow the evacuation route from Cone 1 to Cone 2, run zigzag at cones 3,4,5,6, turn left, jump at cones 7,8,9, fast walk to Cone 10, fast run to Cone 11, safe gathering point.	
	7. Walk quickly and slowly in a free direction on the field. There is a long whistle sound. All move quickly to the safe place of the evacuation gathering point at cones 1-7 scattered on the field, then squat to protect the head with both hands.	
	8. Quickly follow the evacuation route from Cone 1, jump at Cones 2,3,4,5, turn right to Cone 6, walk quickly to Cone 7, and run to the safe assembly point at Cone 8.	
	9. Two groups of equal numbers stand upright back to back. One group is a tree, and one group is a person. There is a long whistle sound. The group that is a tree raises both hands upright and then turns over like a tree falling. The group that is a person tries to avoid quickly.	
	10. Walk quickly, slowly, through the evacuation route; while walking from the starting cone to the final cone, protect the head with both hands; there is a falling object from above with a small plastic ball media, and it must be avoided; walk quickly follow the evacuation route to a safe gathering point.	

The execution occurs within PESH classes, starting with students finishing a pre-implementation questionnaire. After this, they receive a demonstration of techniques for mitigating earthquake disasters, which they subsequently implement in a designated field measuring 30 x 20 meters. The activity occurs

thrice throughout PESH lessons, which are held weekly, ending with a final test after the third session. The questionnaire employs a five-point Likert scale, from "strongly agree" (5) to "strongly disagree" (1), to assess students' levels of agreement with statements derived from the framework (Thomas et al., 2015). The questionnaire comprises ten items, featuring statements like: "Physical education promotes engaging disaster prevention," "I must be independent in the event of disasters," and "PESH classes improve my readiness for emergencies."

Validity assesses how effectively the survey measures what it is designed to evaluate, with the relationship of each item to the total score being crucial. The SPSS software is suggested for testing validity, enabling thorough quantitative analysis. In this research, the validity of responses from 118 participants was examined. As demonstrated in Table 2, for each of the ten items, the Pearson correlation coefficient (r) exceeded 0.098 (N = 446), with a p-value lower than 0.05, suggesting that all assertions are legitimate.

Table 3. Validity Test

Number	Quetions	r-count	p-value	Information
1	A1	0.737	0.000	Valid
2	A2	0.811	0.000	Valid
3	A3	0.781	0.000	Valid
4	A4	0.844	0.000	Valid
5	A5	0.817	0.000	Valid
6	A6	0.746	0.000	Valid
7	A7	0.847	0.000	Valid
8	A8	0.869	0.000	Valid
9	A9	0.869	0.000	Valid
10	A10	0.892	0.000	Valid

A reliability assessment was carried out on the 10 statement items following the validity test to verify their consistency. A variable is deemed reliable if it consistently produces the same outcomes over time. The reliability coefficient of the tool was determined to evaluate the consistency of the participants' answers. The split-half technique was employed to examine the data by correlating scores from odd and even items, with a reliability assessment performed using SPSS. Moreover, Cronbach's Alpha was used to assess the internal consistency of the tool. The reliability analysis results based on the pre-test data are as follows.

Table 4. Reliability Test

Quetions	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
A1	36.06	42.791	0.671	0.944
A2	35.74	42.623	0.767	0.940
A3	36.19	41.999	0.723	0.942
A4	35.98	41.983	0.805	0.938
A5	35.72	41.793	0.769	0.939
A6	36,12	41.849	0.674	0.945
A7	35.78	41.336	0.806	0.938
A8	35.81	41.919	0.837	0.937
A9	36.01	41.769	0.835	0.937
A10	35.92	41.275	0.863	0.935

Table 4 of the reliability test results above shows that all questions obtained a Cronbach's Alpha value > 0.60. Therefore, the measurements in this study are declared reliable.

Data analysis based on studies obtained from pre-and post-test data was also conducted using SPSS.

Results

Integrating earthquake disaster prevention simulations for students requires ten hands-on activities designed to assist them in identifying, comprehending, and applying successful prevention methods. The outcomes of this execution can be statistically examined, starting with descriptive statistics, testing for normality, and then conducting a t-test.

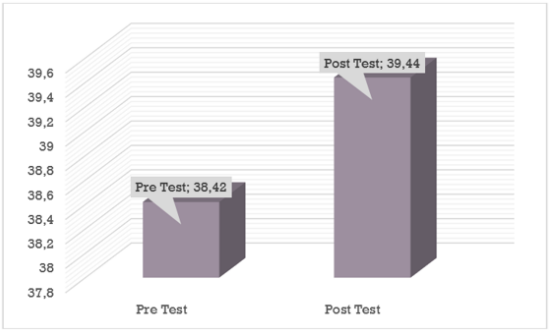
Descriptive statistics were used in Table 5 to analyze pre-test and post-test data from a sample of 446 participants. The pre-test recorded an average score of 38.42±1.45, while the post-test showed a mean of 39.44±1.26. The chart below will demonstrate the distinction between the pre-test and post-test outcomes.

Table 5. Descriptive Statistics

	N	Minimum	Maximum	Mean±SD
Pre Test	446	10	50	38.42±1.45
Post Test	446	15	50	39.44±1.26

Figure 1 illustrates a variation between the pre-test and post-test outcomes, with the pre-test score at 38.42 and the post-test score at 39.44, indicating a rise of 1.02. Next, the prerequisite and normality tests using the Kolmogorov-Smirnov Test will be displayed.

Figure 1. Distinction between the pre-test and post-test



The p-value in Table 6 from the Kolmogorov-Smirnov Test for the pre-test and post-test was 0.000, indicating a non-normal data distribution, necessitating the non-parametric Wilcoxon Signed Ranks Test.

Table 6. Normality Test

Group	Total Sample	Kolmogorov-Smirnov Test
Pre Test	446	0.000
Post Test	446	0.000

Table 7 displays the Asymp results from the Wilcoxon Signed Ranks Test. Signature: The 0.022 p-value indicates a significant difference between the pre-test and post-test, as it is less than 0.05. This indicates a significant difference in the average results between the pre-test and post-test. Therefore, the earthquake natural disaster mitigation simulation practices through physical activity in PESH lessons have a measurable effect.

Table 7. Wilcoxon Signed Ranks Test

	PostTest - PreTest
Z	-2.285[b]
Asymp. Sig. (2-tailed)	0.022

Discussion

The study results corroborated the research hypothesis, showing a significant difference between pre-test and post-test results. This indicates that incorporating earthquake disaster mitigation methods into physical education (PESH) classes via physical activities greatly influenced outcomes (Nurfalah et al., 2022). These results are consistent with earlier studies showing that integrating physical activities in educational settings can improve students' knowledge and skills in disaster prevention (Ayub et al., 2021). Involving students in physical simulations like disaster drills offers hands-on experience that enhances their comprehension of how to react in the event of an earthquake (Surbakti & Sunarno, 2015).

Moreover, engaging in physical activities has been proven to enhance self-esteem, an important element in efficient disaster readiness (Nopembri et al., 2020).

Indonesia often faces natural disasters on land, in water, and at sea. Although the government has put considerable effort into advancing disaster mitigation education in different sectors of society, the results have still not met the expected goals (Rachman et al., 2024). Therefore, the results of this study are essential.

Improving personal and community readiness can result in more effective disaster responses, reduced casualties, lower economic losses, increased community resilience, better resource distribution, and enhanced long-term recovery efforts (Fazeli et al., 2024). The study's findings indicated that certain teachers taught disaster mitigation to students, aiding them in comprehending how to act in a disaster. The classroom instructor stressed that disaster preparedness drills are important for students as they teach them to remain composed and prevent panic during a disaster (Rachman et al., 2024). Grasping disaster mitigation can influence students' mindsets and actions when encountering disasters. By furnishing them with thorough and contextually appropriate information regarding disaster mitigation, they gain important life skills that enhance their ability to make better decisions in urgent circumstances (Lestari, 2024).

The results emphasize implementing a flexible strategy in physical education (Meniyarti et al., 2022), integrating theoretical knowledge with hands-on disaster readiness activities. This blend enables students to obtain a comprehensive grasp of disaster mitigation, both academically and practically (Clarita et al., 2021). Consequently, learners are increasingly inspired to participate in disaster mitigation initiatives (Nurfalah et al., 2022). Nonetheless, instruction about disaster mitigation should not be confined only to PESH classes. Other disciplines, including geography (Zavar & Nelan, 2020), science (Pambudi, 2018), mathematics (Syarifuddin et al., 2023), and even conventional games (Setiono et al., 2021), may also contribute considerably to this endeavor (Nopembri & Sugiyama, 2015; Widowati et al., 2023). Numerous studies have shown the benefits of incorporating disaster preparedness instruction into various subjects (Mahmudah & Fauzia, 2022; Widiastuti et al., 2019).

Even though disaster mitigation simulations typically occur outside of PESH classes, physical education is essential for preparing students with the necessary fitness and skills for disaster readiness (Surbakti & Sunarno, 2015). Studies indicate that PESH lessons greatly enhance students' physical preparedness and capacity to solve emergency problems (Ayub et al., 2021; Nopembri et al., 2020). Furthermore, these lessons assist students in cultivating the agility needed for efficient reactions as members of school emergency response teams (Acebo & Alfarero, 2019) (Acebo & Alfarero, 2019). The national assessment report regarding the Disaster Safe School initiative suggests integrating disaster simulations into extracurricular activities and physical education classes to enhance their effectiveness (Amri et al., 2020).

To ensure thorough disaster preparedness, disaster mitigation drills should be carried out consistently across different subjects, such as science and geography, in partnership with PESH instructors. Regular simulations enhance students' preparedness and guarantee that disaster readiness integrates into their continuous education (Takenouchi et al., 2023). Additionally, PESH classes can promote discipline, a crucial quality for successful disaster management (Aliberti & Manzo, 2023).

Although PESH lessons frequently address health subjects, they do not consistently encompass disaster mitigation material. Integrating natural disaster readiness with health education into PESH would result in a more comprehensive curriculum (Pascapurnama et al., 2018). While different subjects address disaster mitigation, consistent simulations in PESH are essential for strengthening preparedness. This research lays the groundwork for creating a more cohesive physical education curriculum that improves physical fitness and boosts students' readiness for disasters. Implementing comparable programs in regions susceptible to earthquakes is strongly advised to enhance students' resilience and preparedness for upcoming natural disasters.

According to the results of this research, integrating physical activity into physical education is an effective strategy for preparing students with the skills and knowledge required for responding to earthquake disasters. This method integrates theoretical teaching with practical experience, enabling students to enhance their physical fitness while cultivating the resilience essential for disaster prepared-

ness, particularly in high-risk educational environments. Nevertheless, the research's coverage was confined to specific areas in Indonesia, resulting in findings that were not as thorough. To overcome this limitation, upcoming studies should involve additional disaster-prone regions for greater applicability.

Conclusions

Simulations for disaster mitigation that focus on physical education can significantly influence and enhance readiness in schools vulnerable to disasters, as these simulations can be used within PE classes to introduce, comprehend, and rehearse. Simulations for disaster mitigation included in physical education can significantly improve readiness in schools vulnerable to disasters, as they offer a tangible setting for presenting, comprehending, and applying mitigation techniques. Research indicates that following their involvement in these simulations during the learning phase, students' comprehension and use of disaster mitigation strategies through physical activities in PE classes enhanced, resulting in greater preparedness.

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