

DESIGNING RESILIENT SCHOOL BUILDINGS: ENHANCING INDOOR AIR QUALITY AND MENTAL HEALTH IN THE POST-PANDEMIC ERA

The Institution of Engineers, Malaysia (IEM)

Edited by Ir. Dr. Bhuvendhraa Rudrusamy

Prepared by The Institution of Engineers, Malaysia (IEM)

With Contributions from IEM Working Committee

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Abstract

This position paper highlights guidelines for the design of school buildings with a focus on epidemic prevention. Resilient and flexible educational infrastructure is now crucial in light of the risks that infectious diseases represent to the world. The purpose of this position paper is to give architects, planners, and policymakers a framework for designing school settings that prioritise the health and safety of teachers, students, and staff, without affecting teaching and learning activities, even during difficult times.

The document begins with an introduction, which comprises lessons learned from the COVID-19 pandemic, the importance of school building design, and the new era of school buildings. The research objectives are to investigate the design of current school buildings in Malaysia, conduct stakeholder engagement for school building design, and compile guidelines on the design of school buildings for epidemic prevention.

The report focuses on two main sections: the mental health surveys conducted for teachers, students, and staff, and the investigation of indoor air quality (IAQ) in three schools in Putrajaya. The report discusses key findings on mental health trends and IAQ results from the investigation. A section on recommendations provides information on evidence-based design techniques, based on case studies and research results, to improve the design of school buildings for epidemic prevention.

The results highlight the importance of building design in reducing the spread of infectious illnesses inside educational settings. Adoption of the suggested measures can facilitate the establishment of safer, healthier, and uninterrupted learning environments, and improve students' mental health, contributing to more resilient learning environments during epidemic conditions.

Executive Summary

The COVID-19 pandemic exposed significant gaps in Malaysia's school infrastructure, particularly in indoor air quality (IAQ), ventilation performance, and the mental health impact of built environments on students, teachers, and staff. This Position Paper, developed through collaboration between IEM, DOSH, JKR, CIDB, MoE, MoH, the Ministry of Economy and supported by Heriot-Watt University Malaysia, presents evidence-based findings and engineering recommendations to strengthen the resilience, safety, and well-being of school communities across Malaysia.

Key Findings

1. Mental Health Burden Among Students and Staff is Substantial

Using Ministry of Health-standard instruments (Whooley, GAD-7, PHQ-9, DASS-21), surveys across three Putrajaya schools revealed:

- Female students consistently scored higher on anxiety and depression scales across all severity levels, mirroring national MoE mental health data for 2021–2023.
- Male students showed declining representation at higher severity levels, indicating gender-based psychological differences.
- Teachers and staff across all three schools reported stress, anxiety, and depression, highlighting a silent but significant occupational mental-health load.

These findings demonstrate that environmental design features, temperature, ventilation, lighting, noise, and layout directly influence emotional and cognitive well-being.

2. Indoor Air Quality and Ventilation Are Below Acceptable Standards

IAQ inspections conducted with DOSH at all three schools found:

- CO₂ levels exceeding 1000 ppm in meeting rooms, libraries, and computer labs, indicating inadequate ventilation.
- Temperature and humidity levels commonly surpassing ICOP IAQ 2010 recommended ranges (23–26°C, 40–70% RH).
- Classrooms relying almost entirely on natural ventilation, with no mechanical fresh air intake.
- Split-unit AC systems are operating without fresh air and exhaust fans remaining switched off in several spaces.

These conditions fall short of ICOP IAQ 2010, JKR/SIRIM IEQ 2021, ASHRAE 62.1 (2022), and ASHRAE 241 (2023) benchmarks, and negatively affect student concentration, comfort, and infection risk.

Major Recommendations

A. Strengthen IAQ & Ventilation Requirements Nationwide

- Enforce compliance with ICOP IAQ 2010, ASHRAE 62.1, ASHRAE 241, and JKR/SIRIM IEQ 2021 for all new and existing schools.

- Implement monthly IAQ monitoring (CO₂, temperature, humidity, VOCs, particulates).
- Retrofit schools with fresh air supply systems, upgraded filtration (MERV 13+ / HEPA), and functioning exhaust systems.

B. Integrate Mental-Health-Supportive Design Principles

- Provide counselling rooms, quiet zones, and designated well-being spaces.
- Improve thermal comfort, acoustics, daylighting, and access to greenery (biophilic design).
- Expand outdoor learning areas to reduce stress and provide alternative learning environments.

C. Implement Practical Upgrades for Existing Schools

- Activate and maintain existing exhaust fans to improve air change rates.
- Conduct routine maintenance of AC units with IAQ checks.
- Deploy portable HEPA air purifiers in high-risk or under-ventilated rooms.

Conclusion

This Position Paper emphasises that school design is fundamental to health, safety, and educational continuity. Poor IAQ, inadequate ventilation, thermal discomfort, and the absence of mental-health-supportive design features can significantly impair learning outcomes, emotional well-being, and resilience during epidemic conditions.

By adopting the recommendations outlined herein, Malaysia can transform its schools into safer, healthier, and more resilient environments, safeguarding students and staff while strengthening national preparedness for future public-health challenges.

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Sincerely,

Ir. Dr. Bhuvendhraa Rudrusamy

Chairman of Position Paper

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1.0 Introduction

1.1 Lessons Learned from COVID-19

The COVID-19 pandemic has been a transformative experience for schools, producing valuable lessons that will shape educational policy in the future. One critical lesson is the importance of incorporating technology into education. The abrupt shift to remote learning highlighted the need for schools to improve their digital infrastructure and provide teachers with the required training to use online platforms for teaching and learning effectively (Hodges et al., 2020). This includes utilising tools for video conferencing, learning management systems, and digital resources to ensure educational continuity during times of crisis. The COVID-19 pandemic has caused enormous changes in many areas of society, including schooling.

As schools throughout the world dealt with the virus issues, one of the most important lessons gained was the importance of indoor air quality (IAQ) in school buildings. It became clear that well-ventilated and adequately equipped rooms are critical to protecting the health and safety of students and staff. Properly planned and maintained ventilation and air quality systems can help to reduce the transmission of infectious illnesses such as COVID-19 within educational facilities.

Adequate ventilation aids in the dilution and dispersal of airborne pollutants such as viruses, lowering the danger of transmission. To perform properly, ventilation systems must fulfil prescribed criteria and be serviced regularly (Morawska et al., 2020). There are many new key components that could be implemented in schools to enhance the IAQ. These systems are excellent in trapping and removing virus-carrying particles, lowering the risk of infection. Schools should invest in current air filtration systems and follow the advice of organisations such as ASHRAE. It is critical to be able to change classroom layouts, include innovative ventilation technologies, and deploy effective monitoring systems. Schools must now adopt flexible design concepts that enable the quick deployment of health and safety measures, ensuring that the learning environment stays robust in the face of future issues.

Another important lesson from the pandemic is the importance of putting students' well-being and mental health first. The pandemic's disruptions had a significant impact on students' emotional and psychological well-being (Loades et al., 2020). Schools recognised the value of incorporating social-emotional learning and mental health support into the curriculum to assist students in coping with stress, building resilience, and developing emotional intelligence (Greenberg et al., 2017). This includes encouraging mindfulness practices, offering counselling services, and creating a welcoming and inclusive atmosphere for learning.

In addition, the COVID-19 pandemic highlighted the importance of collaboration and partnership among schools, families, and communities. During remote and hybrid learning

models, effective communication and engagement with parents and carers became critical in supporting students' learning and well-being (Wang et al., 2020). Collaborative efforts aided in addressing students' unique challenges, such as access to technological devices, internet connectivity, and learning resources. Another important lesson from the epidemic is the importance of flexibility in school building design. The shifting nature of public health emergencies necessitates places that can adapt to changing conditions, including IAQ issues.

In conclusion, the lessons learned from COVID-19 will continue to guide their efforts to create more inclusive, flexible, and resilient educational systems. The COVID-19 pandemic taught us the importance of proper guidelines needed to be implemented in the design of school buildings for epidemic prevention. Incorporating these lessons into the design and management of school facilities is critical to ensuring the well-being of students, teachers, and staff throughout the epidemic and beyond. With this guideline for the design of school buildings can develop safer and more resilient learning environments in the future by prioritising various recommendation that reduces the risk of virus transmission.

1.2 The Importance of Design of School Buildings

When it comes to providing students with an excellent learning environment, school building design is extremely important. The design of schools has a significant impact on how students learn and how they perform academically. There has been a rising realisation in recent years of the crucial necessity of proper indoor air quality (IAQ) in school buildings. Beyond merely being physical structures, well-designed school buildings have the potential to create the best possible learning environments that encourage academic success, guarantee safety and security, promote health and well-being, promote collaboration and social interaction, offer flexibility and adaptability, embrace sustainability, and encourage community engagement.

In addition to that, designing school buildings with safety and security in mind is essential, clear evacuation routes and emergency exits are essential disaster preparedness measures that aid in safeguarding students and staff (Barrett et al., 2019). A simple method of ensuring safety and security is by including security measures like access controls and monitoring cameras that improve safety on school grounds.

Proper ventilation systems and indoor air quality measures contribute to a healthy learning environment, reducing health risks and improving cognitive function (Sadrizadeh et al., 2022). Access to natural elements, such as green spaces and outdoor areas, supports physical activity, stress reduction, and overall well-being (Kuo, 2015).

One of the main importance is the lighting and acoustics, which are very critical considerations in school building design (Lewinski, 2015). This is because appropriate lighting and sound management can contribute to improved concentration, focus and productivity (Hamida et al., 2023). Moreover, properly engaging and inspiring designs help stimulate creativity and

motivation among students and teachers is another very important factor in the design of school buildings. This is said because the emotional health and involvement of students can be improved by carefully choosing colour schemes, and interior finishes, and incorporating student artwork. Furthermore, another importance of the design of school buildings is to help enhance and encourage collaboration and social interaction (Teo, 2019). The design of cafeterias, libraries, and outdoor areas should encourage student engagement, communication, interaction, and community-building. Moreover, certain larger common areas in the school such as multipurpose halls also help encourage collaborative activities and project-based learning.

In conclusion, the design of school buildings extends well beyond only aesthetic considerations. Education quality, student safety, wellbeing (physical and emotional), teamwork, adaptation, sustainability, and community involvement are all directly impacted. The creation of ideal learning environments should be a top priority for schools to ensure students succeed academically, socially, and emotionally. Academicians and Parent Teacher Associations are encouraged to collaborate with government agencies to create educational settings that inspire and empower the future generation by realising the importance of school building design.

1.3 New Era of School Buildings

It has recently become evident that in order to address the issues posed by epidemics, schools must be built in new and innovative ways. The design of school buildings has entered a new era, influenced by the need to create innovative and dynamic learning environments that align with 21st-century demands. The 'New Era,' defined as the post-pandemic era, has unlocked the door to more possibilities for transforming school design with the aim of establishing an improved functional, engaged democratic community based on social responsibility and reflected in multicultural, empowered school buildings. The new era of school building design emphasises a variety of new aspects that will have a significant positive impact on students and teachers by prioritising their health and safety. This also contributes to the development of a creative and student-centred learning environment. There are many ideal features for the design of new school buildings in terms of many different types of aspects.

Firstly, adequate ventilation systems are installed for health and safety. Proper ventilation contributes to good air quality and decreases the risk of disease transmission. Furthermore, proper ventilation aids in the prevention of airborne disease transmission and improves the quality of air indoors, resulting in a healthier educational environment for students and faculty. Sufficient sanitation facilities, such as sanitisation stations and handwashing stations, are provided throughout schools to encourage regular hygiene practices among students and faculty. Sustainable design standards such as BREEAM and LEED can be used to conceptualise excellent educational spaces for flexible uses, such as using natural daylight,

ventilation from the outdoors where possible, minimal energy use, reduced water use, good acoustics, along with sustainable building materials (Juan et al., 2010).

The MS1525:2019-Energy Efficiency and Use of Renewable Energy for Non-Residential Buildings can be used as guidelines and requirements that promote sustainable practise in the construction and operation of buildings, mainly focusing towards improving energy efficiency and incorporating renewable energy in buildings in Malaysia. The Malaysia Green Building Index (GBI) can also be used to assess and certify the environmental quality, sustainable site planning and innovation of buildings in the country. Proper cleaning procedures are also required. Enhanced cleaning procedures, such as the design of easy-to-clean surfaces and materials, facilitate frequent and thorough cleaning.

Next-generation technology integration is also crucial. High-speed internet access and consistent connectivity throughout the school facilitate online learning and remote collaboration for students using Zoom, Google Meet, and Teams (Rizvi & Nabi, 2021). Smart classrooms with whiteboards that are interactive, projectors and audio systems improve educational experiences by allowing for seamless transitions between in-person and remote learning. Furthermore, touchless technology is a feature that can be integrated. This enables automatic doors, sensor-activated faucets, voice-activated devices, and mobile apps for attendance and communication to reduce direct contact and the potential spread of infections. Energy-saving systems such as LED lighting, smart thermostats, and solar panels can also be used to decrease energy consumption and carbon footprint. Smart technology can assist in accomplishing educational goals with the minimum amount of technical equipment possible by redesigning academic content and teaching methods to accomplish the institution's objectives and educational goals (McCabe & Meuter, 2011).

Moving on implies adaptability. Flexible educational institutions and multipurpose areas can be easily reconfigured to meet a variety of educational and instructional requirements, such as the need for social distancing during epidemics. Movable walls, multi-purpose rooms, and open spaces that can be modified to allow for social distancing during epidemics or other circumstances that require physical distancing are examples of this. The ideal educational institution should be designed to be both sustainable and resilient. When designing the surroundings of the schools, the building should provide space, allowing children to integrate and promote all types of physical activities in the open air (Skowronek & Winnicka-Jasłowska, 2021).

In the context of recurring pandemics and environmental challenges, resilience and sustainability are critical. Energy-efficient equipment, renewable energy sources, and environmentally friendly materials should be used in the design of school buildings. Green roofs, rainwater harvesting, and passive design principles decrease environmental impact while also leading to a better indoor atmosphere. To reduce the negative environmental effects of the school building and promote sustainability, eco-friendly and recycled materials can be used.

The ideal educational institution should facilitate national school evaluations by offering a conducive environment for students to demonstrate their skills. A well-constructed building promotes the well-being of pupils, comfort, and concentration, allowing them to give their best performance during evaluations. According to the findings of a large research project led by (Freeth et al., 2008), involving school design initiatives in eleven countries around the world, effective designing can boost feelings of well-being and social interaction, which are related to improved evaluations of performance. Furthermore, technological integration and adaptable spaces may help online evaluations, allowing for precise and effective evaluation. The new school building era represents a paradigm shift in the infrastructure of education. As education evolves, school buildings must evolve to meet the evolving requirements of students, to make sure they have the greatest possible environment in which they can acquire knowledge, advance, and excel in the twenty-first century.

In addition, Public Works Department / Jabatan Kerja Raya (JKR) Malaysia in collaboration with SIRIM Berhad had developed a standard on an Indoor Environmental Quality (IEQ) for office buildings in 2021 that can be used as a reference for designing new school buildings. The Industry Code of Practice on Indoor Air Quality 2010 (ICOP IAQ 2010) published by DOSH can also be a reference to ensure good indoor air quality for buildings served by Mechanical Ventilation and Air Conditioning (MVAC), including air-cooled split units.

1.4 Aim/Scope of Work

The recent COVID-19 pandemic has brought to light how the design of school buildings can significantly disrupt teaching and learning activities tremendously. It has also taught us many new, valuable lessons that have changed our lives for a long period. During the COVID-19 outbreak, it has resulted in school closures across Malaysia. Moreover, certain institutions also resorted to classes being conducted on rotational periods and certain classes being conducted online to continue providing education and knowledge to the students, so there would not be a huge impact towards the students' educational journey. However, with all these measures implemented to avoid a major virus outbreak among students, there have been a significant number of drawbacks which resulted in delayed school semesters, delayed public exams, and disturbed learning patterns, which also had a considerable impact towards the student's mental health. As a result of the pandemic's difficulties, dropout rates rose as more students struggled to adjust to the sudden adjustments to their learning environment. This crisis has highlighted the necessity for adaptable educational institutions and a proper design of school buildings that can deal with unanticipated situations while putting the well-being of students and academic advancement first.

With all the information stated above, there have been a few research questions to focus on in this position paper, which are

- a) What are the conditions of the current school buildings in Malaysia with regard to the epidemic situation?
- b) Who are the stakeholders in the design of school buildings?
- c) What are the guidelines on the design of school buildings for epidemic prevention?

The three questions stated above are the three main research questions focussed on throughout the research of this project. Furthermore, with the research questions stated above there are a few research objectives aimed to achieve in this position paper which is:

- a) To investigate the design of current school buildings in Malaysia for epidemic prevention.
- b) To conduct stakeholder engagement for the design of the school building for epidemic prevention.
- c) To compile a position paper on Guidelines on the Design of School Buildings for Epidemic Prevention.

There are many elements of the new era of the design of school buildings, the scope of work for this position paper focuses on:

- a) Mental health.
- b) Indoor air quality.

The first section is the mental health survey compilation. The purpose of this section is to receive data from the various mental health surveys used to obtain the students, teachers and staff severity of psychological impact concerning the design of school buildings. To successfully conduct the mental health survey four main Ministry of Health standard questionnaire surveys were used which are the Whooley, Patient Health Questionnaire (PHQ-9), General Anxiety Disorder (GAD-7) and the Depression Anxiety and Stress Scale (DASS-21) survey questions. These various types of survey tools were mainly obtained from the Ministry of Health, Malaysia.

The second section of the investigation consists of information related towards the Indoor Air Quality (IAQ) of schools. For the school investigation section, a walkthrough inspection for IAQ in an enclosed space was conducted together with the Department of Occupational Safety and Health (DOSH) through the Chemical Management Division (BPKimia). There are also a few added objectives by DOSH that need to be achieved in conducting the measurements for ventilation and indoor air quality in schools which include the following:

- a) To assist researchers in conducting indoor air quality measurements in schools for the preparation of "The Position Paper on Safe @ Schools;"
- b) To measure the concentration of carbon dioxide (CO₂) as an indicator of ventilation adequacy.
- c) To assess the level of indoor air quality in schools.

d) To provide the following outcomes from the measurement results. (i) The management of the Ministry of Education Malaysia (MOE) can understand the level of ventilation and indoor air quality in schools, and (ii) The MOE management can improve ventilation and indoor air quality in schools.

2.0 Literature Review

This section focuses on the literature review within the scope of the work mentioned in Section 1.4 of this position paper.

2.1 Mental Health Surveys

MoH had four main mental health surveys for schools based on different age groups and categories as follows:

- a) Whooley Survey
- b) General Anxiety Disorder (GAD-7)
- c) Patient Health Questionnaire-9 (PHQ-9)
- d) Depression Anxiety and Stress Scale 21 (DASS-21)

Before carrying out the survey, a literature review was conducted to ensure the above instruments were well understood for this investigation.

2.1.1 Whooley Survey

Over the past ten years, there has been a growing emphasis on student mental health around the world. Moreover, in Malaysia, concerns about issues impacting primary school students are on the rise. The Whooley Survey has become known as a succinct and useful instrument for evaluating depressive symptoms especially among primary school students at standard 5 and standard 6 respectively obtained from the Ministry of Health Malaysia.

There has been substantial research on the reliability and validity of the Whooley Survey as a survey screening tool for depressed symptoms among students. However, the survey found that internal coherence and construct validity were good. The diagnostic accuracy of the Whooley questions demonstrates continuous high sensitivity and moderate specificity for the two questions across a variety of situations and groups (Bosanquet et al., 2015). Similar to this, based on the psychometric characteristics of the Whooley Survey and discovered that it was a trustworthy indicator of depressive symptoms. Moreover, a sample of primary school students revealed a substantial prevalence of positive Whooley Survey responses, indicating the existence of depressed symptoms. Hence, demonstrating the survey's continued relevance for detecting symptoms of depression among student populations. The use of the Whooley Survey to evaluate the mental health of students in primary schools has important implications for intervention and support.

Early detection of depression symptoms using the Whooley Survey can direct the introduction of focused treatment options in the educational environment (Zivin et al., 2009). There needs to be a huge importance school-based initiatives that offer counselling, psychoeducation, and mental health care to address the needs of Malaysian students in primary schools. The Whooley Survey is a useful screening tool for recognising depressive symptoms among primary school students. Educational institutions can improve their ability to recognise students who require support and carry out prompt interventions to foster mental well-being by utilising the Whooley Survey.

2.1.2 General Anxiety Disorder (Gad-7)

Over the years concerns about student mental health have drawn a lot of attention lately especially mental health issues among secondary school students in Malaysia. A useful instrument for evaluating anxiety symptoms in various demographics of students is the General Anxiety Disorder-7 (GAD-7) survey which has only seven questions and also has shown to be a valid and reliable measure of anxiety among secondary school students, Ministry of Health Malaysia. There has been substantial research on the reliability and validity of the General Anxiety Disorder-7 (GAD-7) Survey as a survey screening tool for anxiety symptoms among students. It has been demonstrated that the GAD-7 is a good and reliable indicator of anxiety among secondary school students which had a Cronbach's alpha of 0.91 in a sample of adolescents (Tiirikainen et al., 2019). The GAD-7 was able to distinguish between students with and without anxiety disorders. Across different studies conducted the prevalence of anxiety symptoms among secondary school students varies between urban and rural areas. Moreover, a study evaluated the GAD-7 survey's reliability and validity among a sizable sample of secondary school students within these areas. The findings supported the use of the GAD-7 survey in assessing anxiety symptoms in secondary school children and showed good internal consistency and concurrent validity (Ip et al., 2022). The GAD-7 survey has revealed how common anxiety symptoms are among Malaysian secondary school pupils. Using the GAD-7 survey, a study examined the high prevalence of anxiety and related factors among students surprisingly little attention has been given to the psychometric properties of the GAD-7 (Byrd-Bredbenner et al., 2021). Their results showed a significant prevalence of anxiety symptoms, underscoring the significance of addressing mental health issues among secondary school pupils (Beiter et al., 2015). Teachers and mental health professionals may use the right treatments and support systems by recognising the symptoms of anxiety. According to research, early intervention and support can lessen the negative effects of anxiety on students' academic performance and general well-being. In conclusion, the GAD-7 survey has many benefits and is a useful instrument for recognising and managing anxiety symptoms in Malaysian secondary school students.

2.1.3 Patient Health Questionnaire-9 (PHQ-9)

Concerns about secondary school students' mental health are becoming increasingly common, especially in Malaysia. The use of credible and trustworthy evaluation tools is essential for correctly identifying and addressing these problems. The Patient Health Questionnaire (PHQ-9) is one such instrument, and it is well-known for evaluating depressive symptoms, Ministry of Health Malaysia. Many studies have shown the reliability and validity of the Patient Health Questionnaire (PHQ-9) survey in various demographics. For instance, many research carried out among students discovered the PHQ-9's strong internal consistency and concurrent validity (Beard et al., 2016). Moreover, another study that looked at the PHQ-9's psychometric qualities among teenagers discovered good internal consistency and concurrent validity (Auerbach et al., 2016). These results indicate that among Malaysian secondary school students, PHQ-9 may be used and relied upon to evaluate depressive symptoms. Furthermore, depressive symptoms are significantly more common among secondary school students, according to research. There is an elevated prevalence of depressive symptoms among university students in Malaysia, according to research, and secondary school students may exhibit comparable trends. Depression was one of the often-mentioned disorders in research looking at mental health issues among Malaysian school students (Kaur et al., 2014). These findings highlight the critical need for interventions and assistance in mental health in educational settings and in terms of the design of school buildings. For intervention and support efforts, the probable high incidence of depression symptoms among secondary school children in Malaysia has significant consequences. Other than that, students who might need extra support can be found at an early stage of their depression by implementing school-based mental health programmes that involve routine screening utilising the PHQ-9 survey. Positive mental health outcomes for secondary school students can also be facilitated by fostering mental health knowledge and a friendly learning environment (Werner-Seidler et al., 2017). Furthermore, the PHQ-9 may miss other mental health disorders because it predominantly measures depression symptoms. To develop a more thorough knowledge of students' mental health, future studies should include the use of complementary evaluation instruments. The likelihood that students in secondary schools in Malaysia may have depression symptoms emphasises the value of early detection and focused interventions that can overcome this issue drastically.

2.1.4 Depression Anxiety and Stress Scale 21 (DASS-21)

In Malaysia, there is growing concern about the mental health and well-being of teachers and other staff members working in educational sector. Their level of general well-being and mental health may be significantly impacted by the demanding nature of their tasks and obligations (Othman & Sivasubramaniam, 2019). A popular instrument for evaluating mental health symptoms is the Depression Anxiety Stress Scales-21 (DASS-21) survey which evaluates the staff's mental health in terms of depression, anxiety and stress. Many studies have examined the DASS-21 survey's psychometric characteristics in the context of Malaysia,

proving its validity and reliability. The DASS-21 has good internal consistency and construct validity, according to research done with a sample of teachers and staff in the educational sectors (Musa & Mohammad Aidid, 2020). Moreover, in another study with a sizable sample of teachers and staff, the DASS-21 was shown to have high internal consistency and construct validity (Cao et al., 2023). These findings offer solid proof that the DASS-21 is a very viable and reliable tool for evaluating mental health symptoms among Malaysian school teachers and staff in the educational sector. According to research conducted in Malaysia, school employees, including teachers, have an elevated prevalence of mental health problems. A research employing the DASS-21 questionnaire found that a huge number of individuals of teachers and staff had signs of stress, anxiety, and depression (Yusoff et al., 2013). These results underline the necessity of attending to the mental health requirements of teachers and other staff members in Malaysian educational environments. The development of focused interventions and support systems benefits from an understanding of the prevalence of symptoms among schoolteachers and staff. The study demonstrated that early identification and targeted interventions improved mental health outcomes for teachers and staff because early intervention can help people at risk of mental disease alter their mental health trajectory (Fazel et al., 2014). These results highlight the DASS-21 survey's potential as a useful instrument for implementing research-based support and intervention systems for the Malaysian school teachers and staff. These results highlight the DASS-21 survey's potential as a useful instrument for implementing research-based support and intervention systems in Malaysian educational contexts. Teachers and employees in educational settings can experience improved mental health outcomes by putting into practise evidence-based interventions that make use of the DASS-21 survey which will also bring a huge positive impact towards the students' academic performance.

2.2 Indoor Air Quality (IAQ)

Indoor air quality (IAQ) is an essential component of the built environment that has a substantial influence on occupants' health, comfort, and productivity, particularly in educational facilities where students and teachers spend the majority of their time. The quality of the air that students and teachers breathe becomes an important factor in determining their educational experience since they spend a significant amount of their day in these enclosed spaces. IAQ refers to a complex interaction of variables that may affect respiratory health, comfort, academic performance and many more. Factors that influence IAQ include air movements, air temperature, humidity levels, the presence of biological contaminants, chemical contaminants, and other sources of indoor air pollution. This introductory exploration delves into the crucial role of IAQ in schools, shedding light on its various determinants, the potential health implications, existing guidelines, and regulations, as well as cutting-edge strategies that can be used to create welcoming learning environments for all occupants.

Furthermore, there is an abundance of factors that influence the indoor air quality of school buildings, such as building characteristics, environmental conditions, and human activities. Consequently, to establish a conducive learning environment that promotes both physical

health and academic performance, these complex factors must be taken into account while designing school structures. The architectural and structural features of school buildings play a crucial role in determining the ideal indoor air quality of schools. Indoor air quality is substantially influenced by elements including building age, materials, and ventilation systems. For instance, outmoded ventilation systems and construction materials in older buildings could eventually release dangerous chemicals over time. Only a few sources of indoor air pollution include the production of volatile organic compounds (VOCs) by construction materials, cleaning products, and furniture. Additionally, the choice of construction materials, such as paints, adhesives, and flooring, can release volatile organic compounds (VOCs) into the indoor environment, leading to health concerns (Johnson et al., 2018). To reduce contaminants and maintain ideal IAQ, proper ventilation design and air exchange rates are crucial (Sundell et al., 2011).

Other than that, environmental factors also impact the standards of indoor air quality. Proximity to sources of outdoor pollution, such as vehicular traffic or industrial sites, can introduce pollutants into the indoor environment (Daisey et al., 2003). Weather factors are also important; for instance, excessive humidity levels can promote the growth of mould and bacteria, which can cause respiratory issues (Wargocki, 2000). To overcome the entry of environmental contaminants and preserve a healthy atmosphere, proper filtering systems and air intake designs are essential.

Human activity has a big impact on indoor air quality in schools. Pollutants can enter the air through tasks like cleaning, the usage of classroom supplies, and inhabitant actions like smoking. IAQ can be negatively impacted by fumes released by cleaning products that include harsh chemicals (Shaughnessy & Sextro, 2006). IAQ in school buildings is impacted by several elements linked to the structure, the surrounding environment, and human activity. To maintain a safe and beneficial learning environment, these many-faceted variables must be considered in the design of educational buildings.

Moreover, the importance of IAQ in educational settings and its real impacts on occupants have been underlined in several research. According to the World Health Organisation (WHO), indoor air pollution can cause a variety of health issues, especially respiratory conditions, and can impede cognitive development, which also has an impact on academic achievement. Health issues commonly associated with poor IAQ include allergic reactions, respiratory problems, eye irritation, sinusitis, bronchitis, and pneumonia. IAQ problems can be closely related to the mechanical ventilation and air conditioning (MVAC) system in buildings, especially in enclosed spaces equipped with split-type air conditioning units. Improved ventilation and lower indoor pollutant concentrations were linked to considerably higher cognitive function scores in school children, according to a thorough investigation by the (Health, 2017). These results emphasise the close connection between indoor air quality and academic performance, which results in the requirement for comprehensive IAQ management methods in educational institutions. High CO₂ levels indicate a lack of ventilation and air movement in a room, which might lead to higher concentrations of a number of irritants (Health, 2017).

CO₂ levels in schools have consistently been shown to be higher than the ASHRAE threshold in IAQ studies (Muscatiello et al., 2015). According to research, faster ventilation rates and low CO₂ levels can improve cognitive performance (Mendell et al., 2016). For example, in a controlled exposure study of office employees, participants exhibited superior cognitive function ratings when ventilation rates were doubled from the "acceptable" minimum and CO₂ concentrations were reduced from 1400 to 950 or 550 ppm (Allen et al., 2016).

Other than that, Indoor air quality (IAQ) has become more prominent among the various elements influencing disease transmission because of its propensity to spread airborne illness. Schools are close-knit communities where staff and students often come into contact, rendering them vulnerable to the fast transmission of infectious illnesses. If the proper preventative precautions are not in place, airborne transmission of illnesses, including influenza, COVID-19 and many other airborne diseases, can occur within schools. According to research, respiratory viruses may survive and hang about in the air for long periods, increasing the risk of transmission in confined settings (Brankston et al., 2007).

As a result, the negative result of indoor air quality has a negative influence on respiratory, cardiovascular and neurological health, and is a major cause of disease worldwide (Kumar et al., 2023). Due to their maturing immune systems and increased vulnerability to environmental exposures, these impacts can be particularly noticeable in school settings, where children spend a significant amount of time. Indoor air quality can get contaminated with allergens, volatile organic compounds (VOCs), and respirable particulates, which can irritate and inflame the respiratory system and cause respiratory issues such as asthma exacerbation, allergies, and respiratory tract infections. Improved IAQ has been shown to reduce the prevalence of respiratory symptoms among students. IAQ can affect academic success and mental state in addition to physical health, which can lead to symptoms of depression and anxiety. An increase in ventilation in classrooms improved students' learning results and cognitive performance (Mendell & Heath, 2005).

In conclusion, the importance of indoor air quality in school buildings goes beyond a purely environmental issue to become a significant factor in academic attainment, comfort, and health. Indoor air quality (IAQ) is a significant element affecting occupants' health and well-being in school buildings. The negative impacts on health caused by inadequate IAQ highlight the need to apply effective IAQ measures in school design and management. Effective ventilation systems, temperature control, and adherence to set standards are all necessary due to the intricate interaction of elements affecting indoor air quality (IAQ). Educational institutions should proactively embrace creative solutions to produce healthier indoor spaces by realising the tremendous influence of IAQ on students' well-being and learning results. Researchers have also discovered a 5% decrease in "power of attention" in poorly ventilated classrooms, nearly similar to the effect of skipping breakfast (Coley et al., 2007). As this investigation progresses, it will dig more into the many IAQ variables, the possible health effects, current rules and regulations, and cutting-edge techniques that may be used to guarantee the best learning environments for all occupants.

3.0 Methodology

According to the Malaysian Public Works Department (JKR), there are three categories for the design of school buildings, which are “Reka Bentuk Piawai”, “Reka Bentuk Baru (one-off)” and “Reka Bentuk Pre-Approved Plan”. This Position Paper is only limited towards Reka Bentuk Baru (one-off) because the investigation was only conducted in three schools which fall under the Putrajaya district. **Figure 1:** Project flow chart of the process in which the position paper was carried throughout the Position Paper. The mental health survey and IAQ measurements were conducted at the following locations:

- a) School A
- b) School B
- c) School C

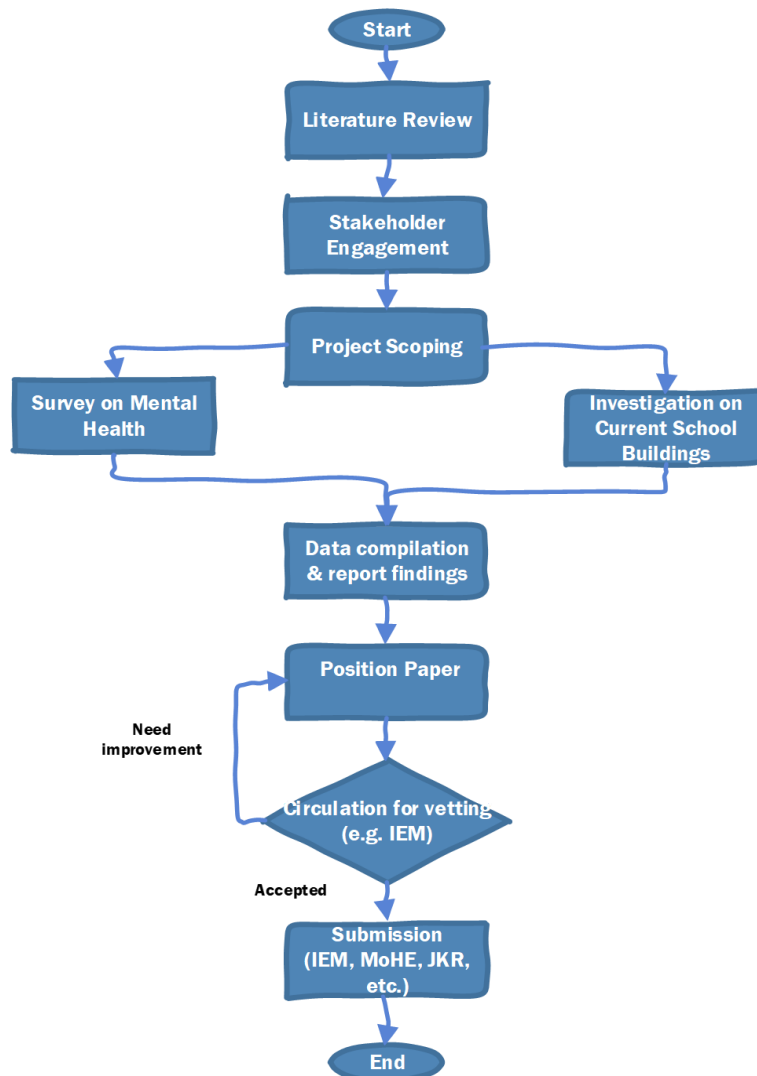


Figure 1: Project flow chart of the process in which the position paper was carried throughout the Position Paper

3.1 Mental Health Survey

There are four main important mental health surveys based on the Ministry of Health standard questionnaire survey was used for this investigation comprises of Whooley, PHQ-9, GAD-7, and DASS-21. This survey was used to determine the mental health of students towards the design of school buildings to support teaching and learning activities even during the pandemic, without interrupting the students' academic journey and learning experiences. It also plays a vital role in creating an environment that either supports or hinders their psychological well-being, emotional, and mental health, which indirectly impacts their academic performance. A thoughtfully designed school building can promote mental well-being, while poorly designed buildings can lead to discomfort, stress, and even exacerbate existing mental health conditions. A different set of surveys was used on different age groups and users, as shown from 3.1.1 to 3.1.3 of this report.

3.1.1 Primary Schools

The Whooley Survey was used for upper primary school students in Standard 5 and Standard 6. The first two questions of the survey were to differentiate the gender and the standard the student is currently studying. The Whooley survey had two main questions in which the students must answer yes or no. If "YES" is answered to one or both the questions, it is a positive test result for depression. If "NO" is answered to both questions, it is a negative test result for depression. A complete set of the Whooley survey is in Appendix A.

3.1.2 Secondary Schools

Secondary school students from form 1 to form 5, consisting of ages 13 to 17, had two different sets of surveys that were used, which are the General Anxiety Disorder-7 (GAD-7) and the Patient Health Questionnaire-9 (PHQ-9). The first two questions of the survey were to differentiate the gender and the form of the students are currently studying in. The general anxiety disorder (GAD-7) consists of seven questions, whereby each question the student rates from 0-3 on how often they have been bothered by any of the following problems over the last two weeks. It comprises a Likert scale of "0" (not at all) to "3" (nearly every day) applied to the 7 items in the measure. There are four different ranges of anxiety severity symptoms of the General Anxiety Disorder-7 (GAD-7) questionnaire. It ranges from 0-4, 5-9, 10-14 and 15-21, whereby 0-4 is the least severe and 15-21 is the most severe range as shown in **Table 1**.

Table 1: The ranges and the severity level of the GAD-7 survey.

Total Score	Anxiety Severity Level
0-4	Minimal Anxiety
5-9	Mild Anxiety
10-14	Moderate Anxiety
15-21	Severe Anxiety

Moreover, another type of questionnaire was also handed out to the secondary school students. The other survey used was the patient health questionnaire (PHQ-9), which consists of nine questions, whereby each question the student rates from 0-3 on how often they have been bothered by any of the following problems over the last two weeks. It comprises a Likert scale of “0” (not at all) to “3” (nearly every day) applied to the 9 items in the measure. There are five different ranges of depression severity symptoms of the Patient Health Questionnaire (PHQ-9) questionnaire. It ranges from 0-4, 5-9, 10-14, 15-19 and 20-27, whereby 0-4 is the least severe and 20-27 is the most severe range as shown in **Table 2**. A complete set of the PHQ-9 and GAD-7 surveys is in Appendix A.

Table 2: The ranges and the severity level of the PHQ-9 survey.

Total Score	Depression Severity Level
0-4	Minimal depression
5-9	Mild depression
10-14	Moderate depression
15-19	Moderately severe depression
20-27	Severe depression

3.1.3 Teachers and Staff

The Depression Anxiety and Stress Scale 21 (DASS-21) survey was tested on and responded to by all the teachers and staff of all three schools visited for the position paper. The first question of the survey is to differentiate the gender of the respondents. The Depression Anxiety and Stress Scale 21 (DASS-21) consists of 21 questions, whereby the teachers and the staff rate from 0-3 on how much the statement applied to them over the past week, based on the following

questions in the questionnaire. It comprises a Likert scale of “0” (Did not apply to me at all) to “3” (Applied to me very much, or most of the time) applied to the 21 items in the measure. From there, the survey responses are categorised and tabulated based on three different categories, which are stress, anxiety, and depression. The Depression Anxiety and Stress Scale 21 (DASS-21) questionnaire severity level and ranges of stress, anxiety and depression, respectively in **Table 3**. A complete set of Depression Anxiety and Stress Scale 21 (DASS-21) survey questions used for the position paper is in Appendix A.

Table 3: The ranges and the severity level of the DASS-21 survey.

	Depression	Anxiety	Stress
Minimal	0-4	0-4	0-4
Mild	5-9	5-9	5-9
Moderately	10-14	10-14	10-14
Moderately Severe	15-19	15-19	15-19
Severe	20-27	20-27	20-27

The details of Whooley, General Anxiety Disorder-7 (GAD-7), the Patient Health Questionnaire-9 (PHQ-9) and the Depression Anxiety and Stress Scale 21 (DASS-21) survey questions used for this position paper can be referred to Appendix A.

3.2 IAQ Inspection

The DOSH, through the Chemical Management Division (BPKimia), has collaborated with research committees from The Institution of Engineers, Malaysia (IEM) to conduct indoor air quality survey measurements in three (3) schools in the vicinity of Putrajaya. This collaboration stemmed from the appointment of three (3) JKKP officers to the IEM Working Group Committee to prepare this Position Paper. The measurement of indoor air quality in schools is a highly significant initiative that can provide real insight into the air quality conditions in these educational institutions. Overall, this initiative is a positive step in enhancing the quality of education and well-being in the educational community. It also demonstrates the authorities' commitment to the health and safety of students and school staff.

3.2.1 IAQ Measurement Strategy and Methodology

The measurement strategy carried out consists of several essential steps to ensure optimal indoor air quality in schools around Putrajaya. Here are further details for each step of the strategy:

- a) Initial discussion with representatives from IEM and school representatives to determine the locations where measurements will be conducted.
- b) Inspection of Split Air Conditioning Units/Fan Coil Units (FCUs):
 - i. Condition of Split Air Conditioning Units/FCUs (External cleanliness).
 - ii. Condition/Type of air filters used.
 - iii. If there is the use of fans/exhaust in the Split Air Conditioning Units/FCUs system.
 - iv. If there is fresh air intake from the outside in the Split Air Conditioning Units/FCUs system.
- c) Parameters measured - Acceptable limits refer to the Industry Code of Practice on Indoor Air Quality 2010 (ICOP IAQ 2010):
 - i. Carbon dioxide, CO₂ (C1000 ppm)
 - ii. Carbon monoxide, CO (10 ppm)
 - iii. Temperature (23-26°C)
 - iv. Relative humidity (40-70%)
 - v. Total volatile organic compounds, TVOC (3 ppm)
 - vi. Respirable Particulates (0.15 mg/m³)

The measurements conducted were as follows:

- a) Measurements were taken for five (5) minutes using sampling method only at each sampling point using four (4) types of equipment to measure carbon dioxide (CO₂), carbon monoxide (CO), temperature, relative humidity, total volatile organic compounds (TVOC), and respirable particulates.

3.2.2 IAQ Monitoring Equipment

The equipment used for indoor air quality (IAQ) measurements plays a crucial role in assessing and monitoring air quality inside buildings. The measurement equipment used in this investigation is as follows.

a) Multiparameter Indoor Air Quality Monitor

This is a versatile tool for measuring various parameters related to indoor air quality, including CO₂, CO, temperature, relative humidity, TVOC, and respirable particulates as shown in Figure 2.



Figure 2: Multiparameter Indoor Air Quality Monitor

b) Anemometer

This instrument is used to measure the speed and direction of air movement. In the context of indoor air quality measurements, an anemometer is useful for assessing the efficiency of ventilation systems and air circulation, as shown in Figure 3.



Figure 3: Anemometer

c) VOC Detector ppbRAE 3000+

This equipment is a very sensitive volatile organic compound (VOC) detector, capable of measuring at extremely low levels, typically in parts per billion (ppb). Its ability to detect VOCs allows accurately and precise identification and measurement of the presence of harmful chemicals that can affect indoor air quality, as shown in Figure 4.



Figure 4: VOC Detector ppbRAE 3000+

d) Dust Trak DRX Handheld

This instrument, shown in Figure 5, is used to measure the quantity of fine particles in indoor air. Studies have shown that exposure to fine particles can contribute to respiratory health problems.



Figure 5: Dust Trak DRX Handheld

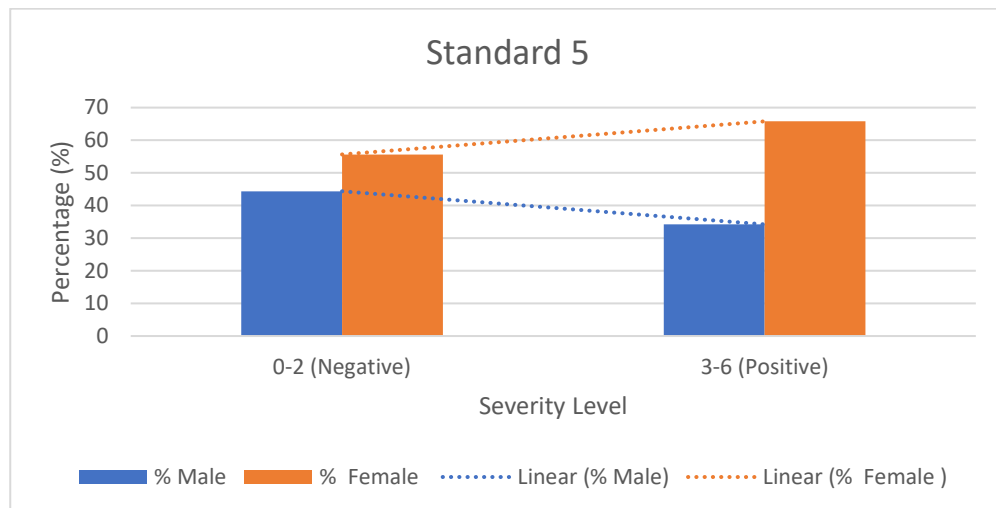
4.0 Results and Discussion

This section focuses on the results and discussion of the work carried out within the scope mentioned in Section 1.4 of this position paper.

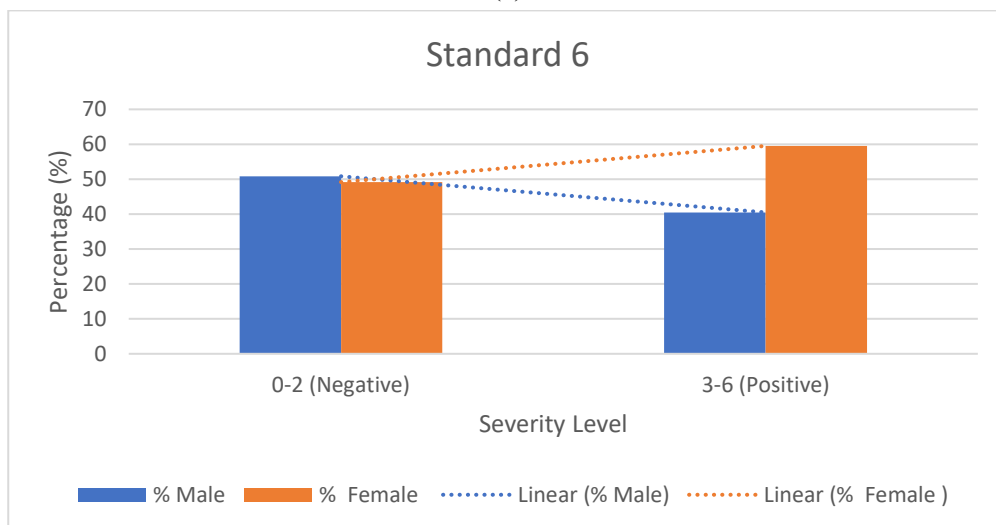
4.1 Mental Health Results and Discussion

Three schools were used as a medium to conduct the mental health survey. The schools involved in the mental health survey comprised two secondary schools, which were School A and School C. The primary school involved was School B.

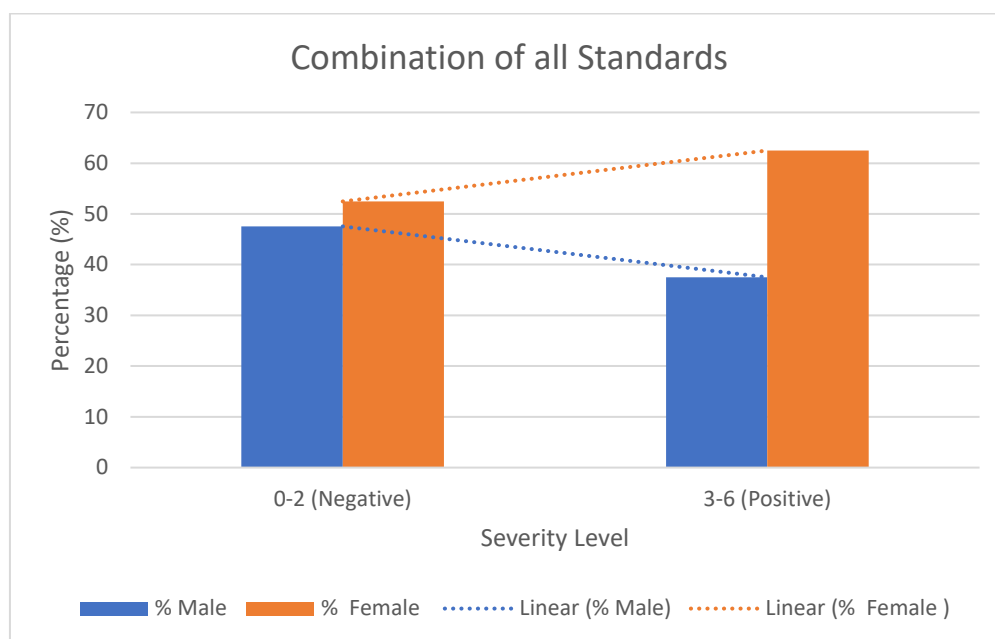
4.1.1 Primary School (School B)



(a)



(b)

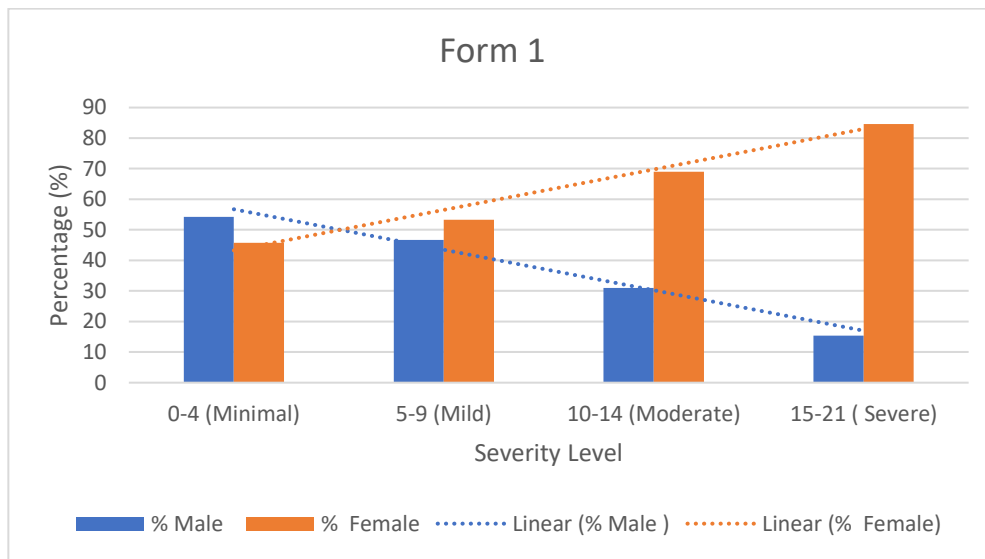


(c)

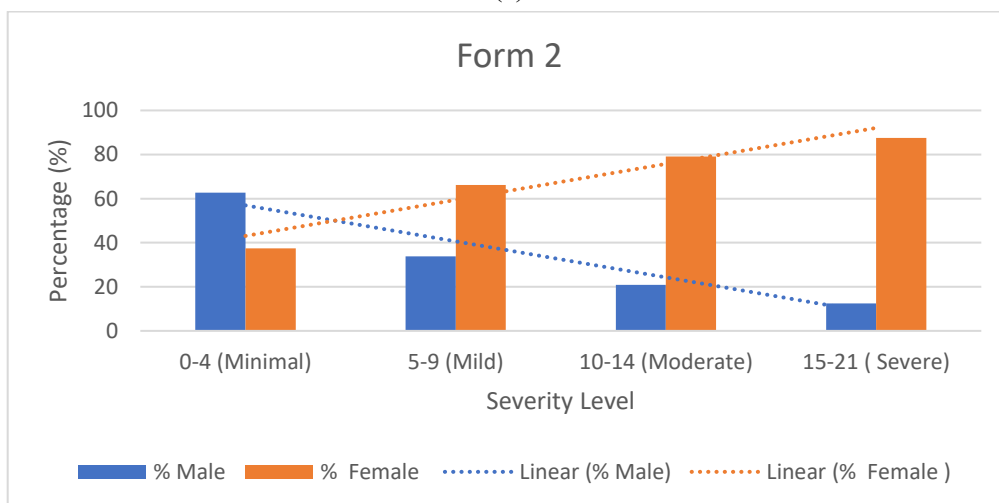
Figure 7: DASS-21 mental health results obtained from School B responded by teachers and staff, for 2023. (a) Depression, (b) Anxiety, and (c) Stress.

The Depression Anxiety and Stress Scale 21 (DASS-21) survey was investigated on and responded by all the teachers and staff of the school, and the details can be referred in **Appendix C**. The total sample number of teachers and staff that answered the survey were N=61 whereby 13 male teachers and staff (21.31%) and 48 female teachers and staff (78.69%) answered the survey, respectively. A total of 70.93% of all the teachers and staff of School B answered the DASS-21 questionnaire. The DASS-21 is divided into three main categories, which are depression, anxiety, and stress. A graph of percentage against the severity levels plotted. It can be analysed that the pattern of the graphs of the two categories, which are depression and stress, when the severity level of each category increases, the percentage of male and female in those from lowest to highest in severity levels decreases linearly for both the male and female teachers and staff. However, for anxiety graph, the percentages among male teachers and staff increases linearly when the severity level increases whereas the percentages among female teachers and staff decreases linearly when the severity level increases. This data and graphs regarding the DASS-21 surveys is at **Figure 7**.

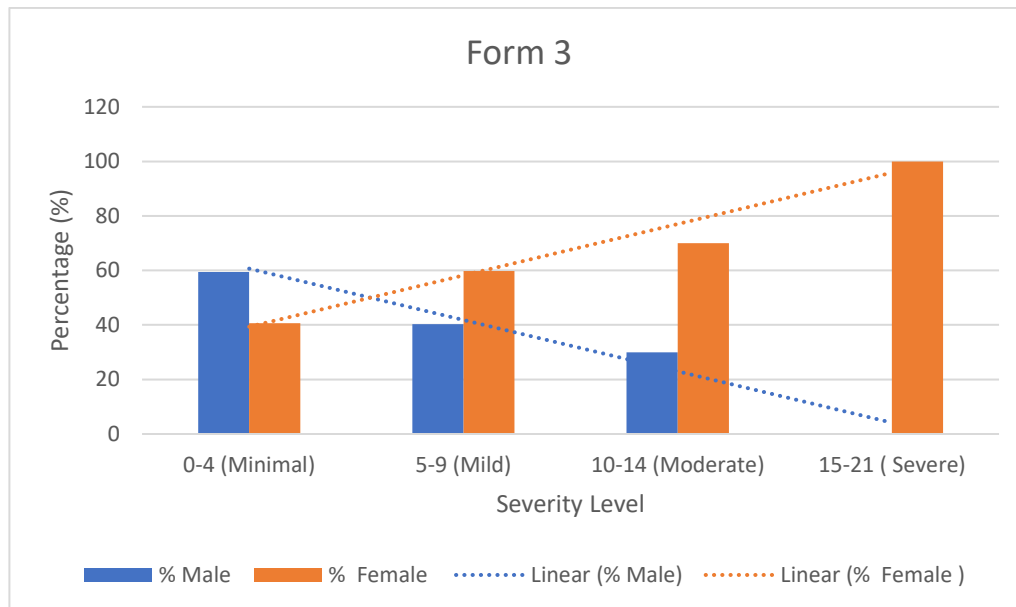
4.1.2 Secondary School 1 (School A)



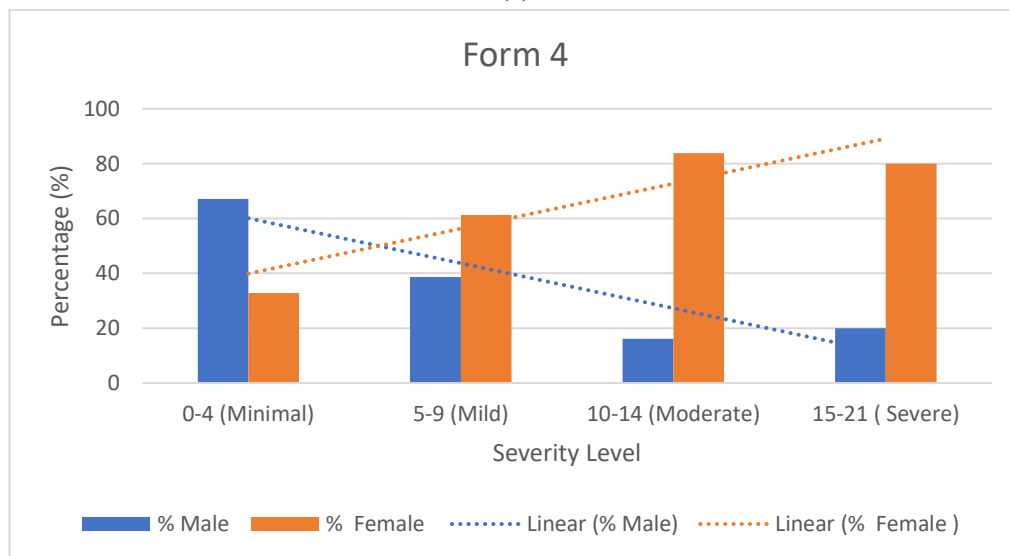
(a)



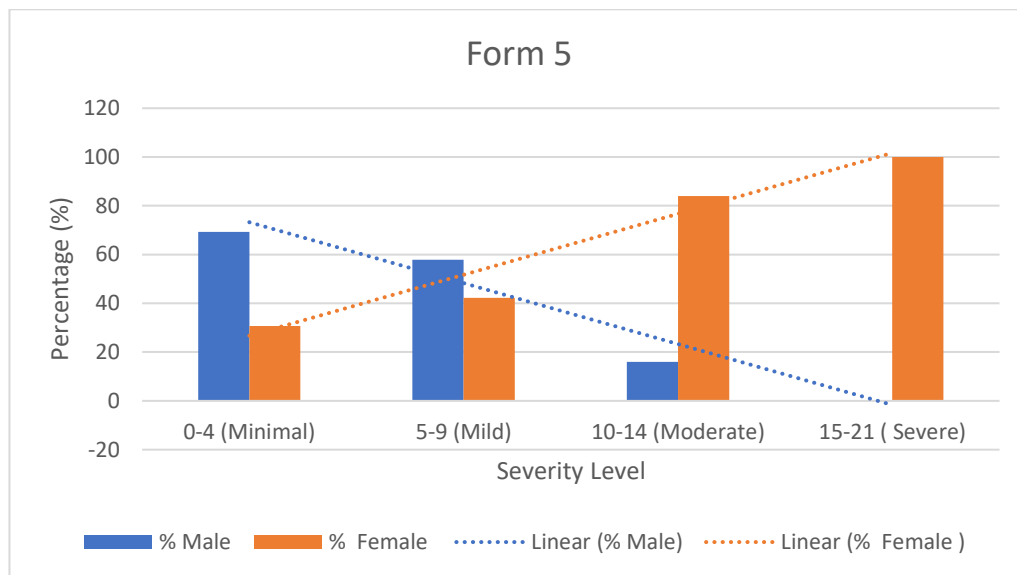
(b)



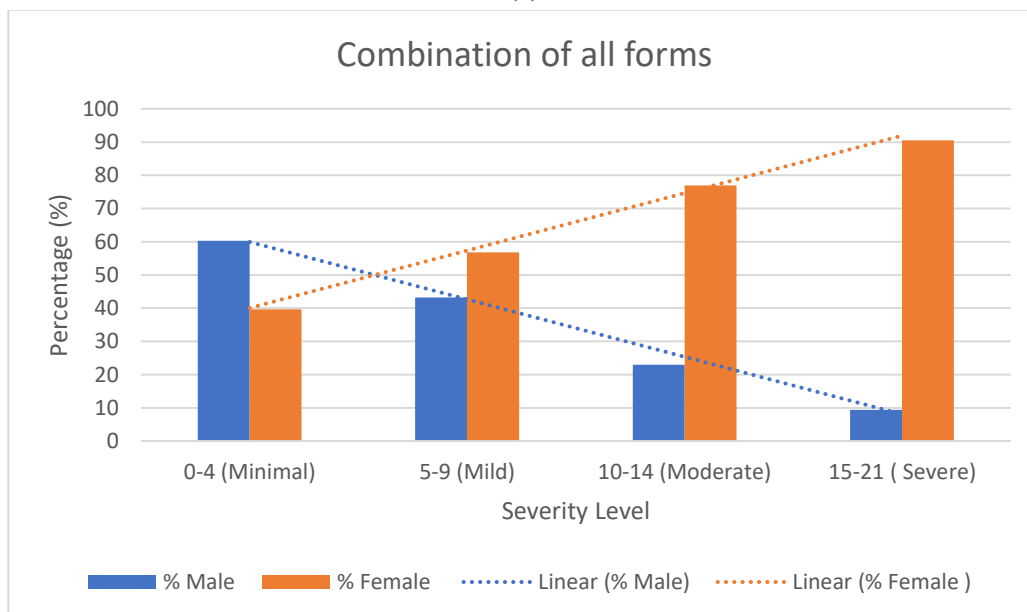
(c)



(d)



(e)

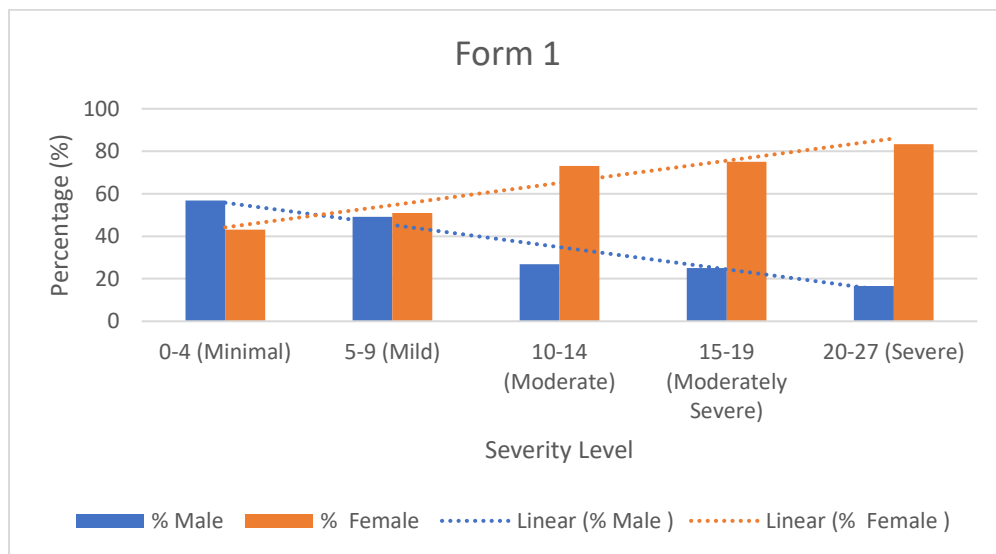


(f)

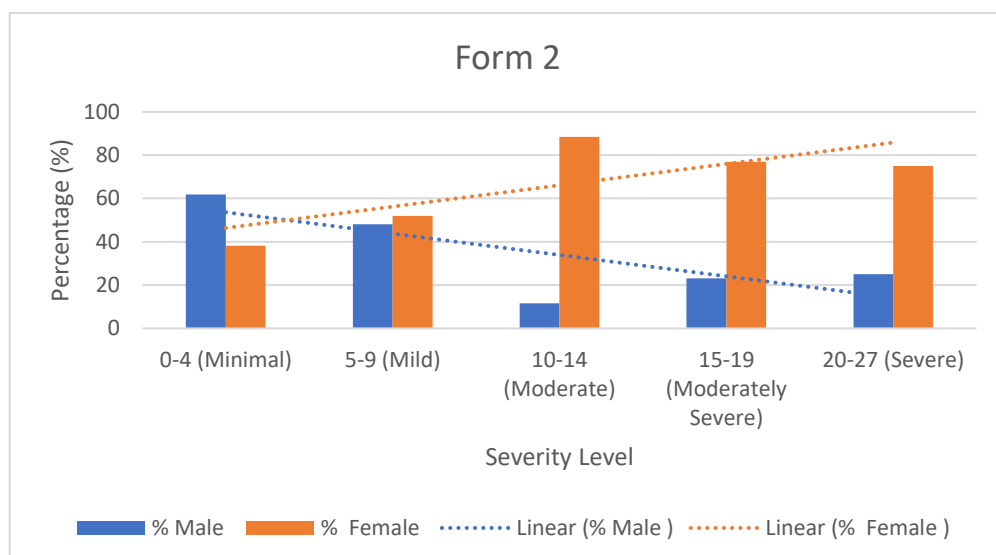
Figure 8: The GAD-7 mental health results obtained from School A. For 2023, (a) Form 1, (b) Form 2, (c) Form 3, (d) Form 4, (e) Form 5, and (f) Form 1 to 5.

The data was tabulated and analysed thoroughly using Excel, and the details can be found in **Appendix D**. A total of two different types of mental health questionnaires were given to the students of School A, which are the General Anxiety Disorder-7 (GAD-7) and the Patient Health Questionnaire-9 (PHQ-9). The characteristics of the final sample and quantitative analysis of GAD-7 and PHQ-9 total scores based on the severity of students

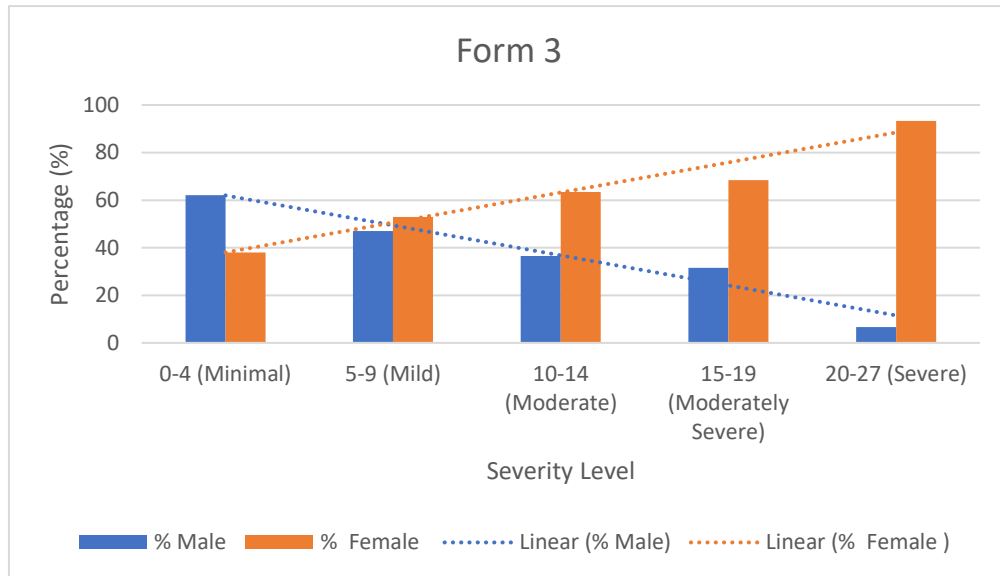
of various forms and a combined analysis of form 1 through form 5 students are shown in **Figure 1, Figure 8, and Figure 9**, respectively. The total sample number of students from form 1 until form 5 that answered both the questionnaires is N=1272, which comprises of 624 male students (49.05%) and 648 female students (50.94%). A total of 85.54% of the total students from School A answered both the GAD-7 and PHQ-9 questionnaires. A graph of percentage against the severity levels is plotted. It can be analysed that the pattern of the graphs for both GAD-7 and PHQ-9 are similar, whereby the percentage among female students increases linearly when the severity level increases, whereas the percentage among male students decreases linearly when the severity level increases.



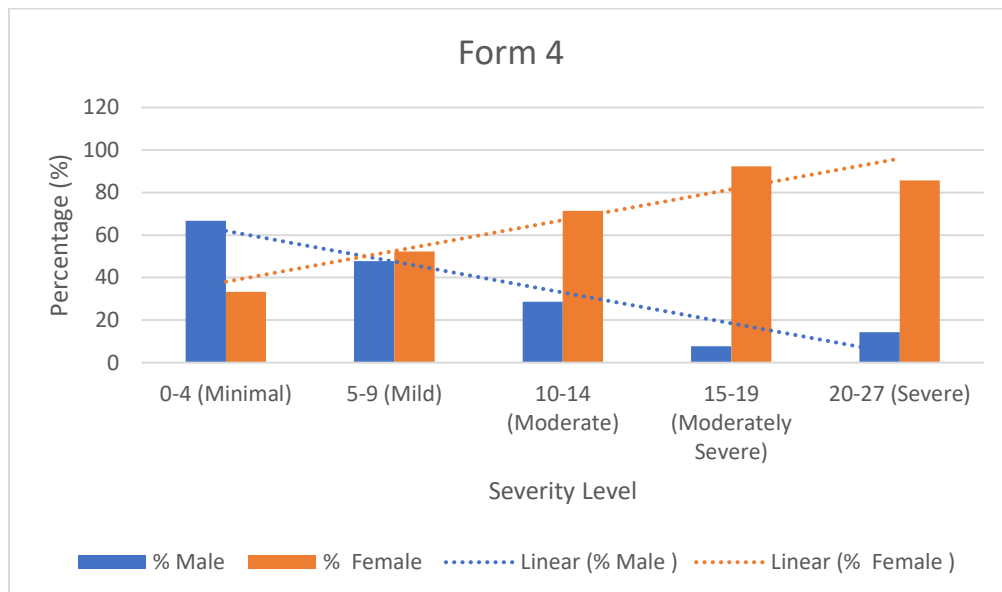
(a)



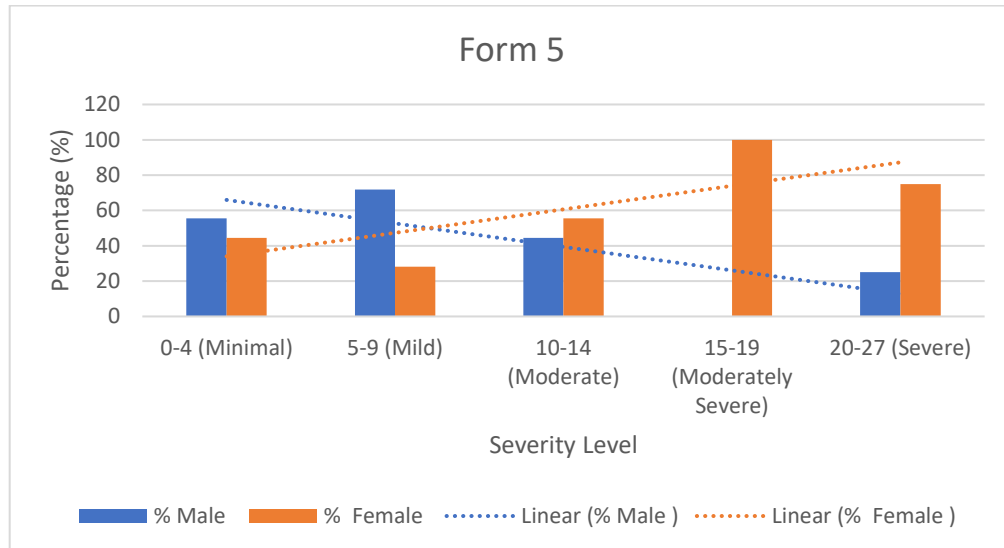
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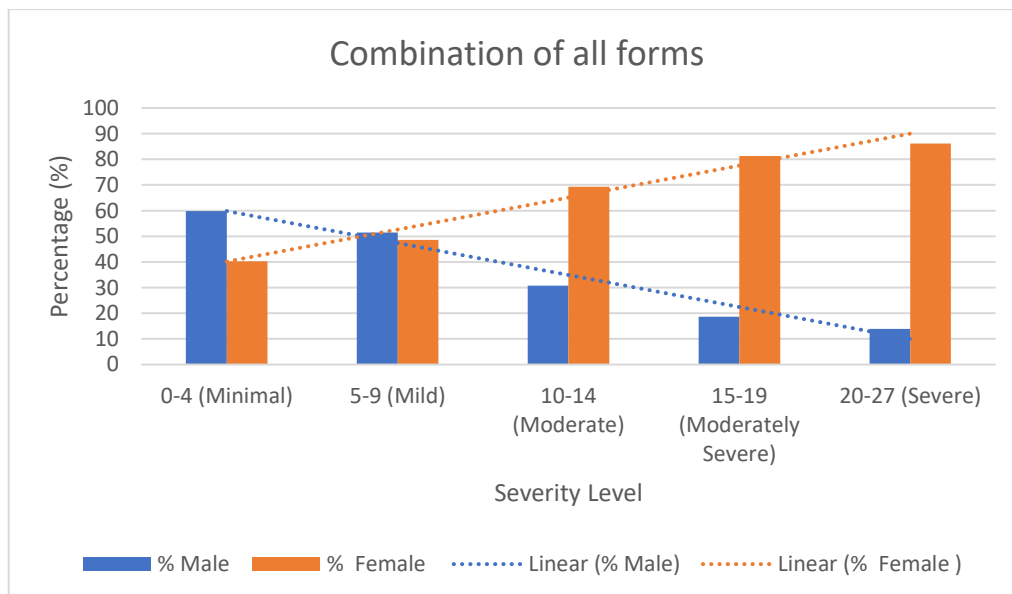
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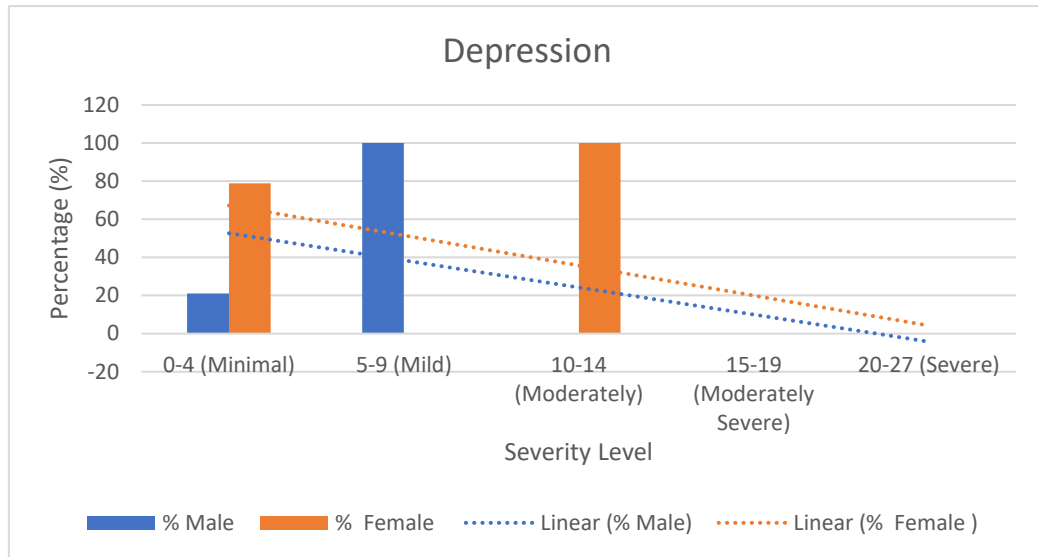


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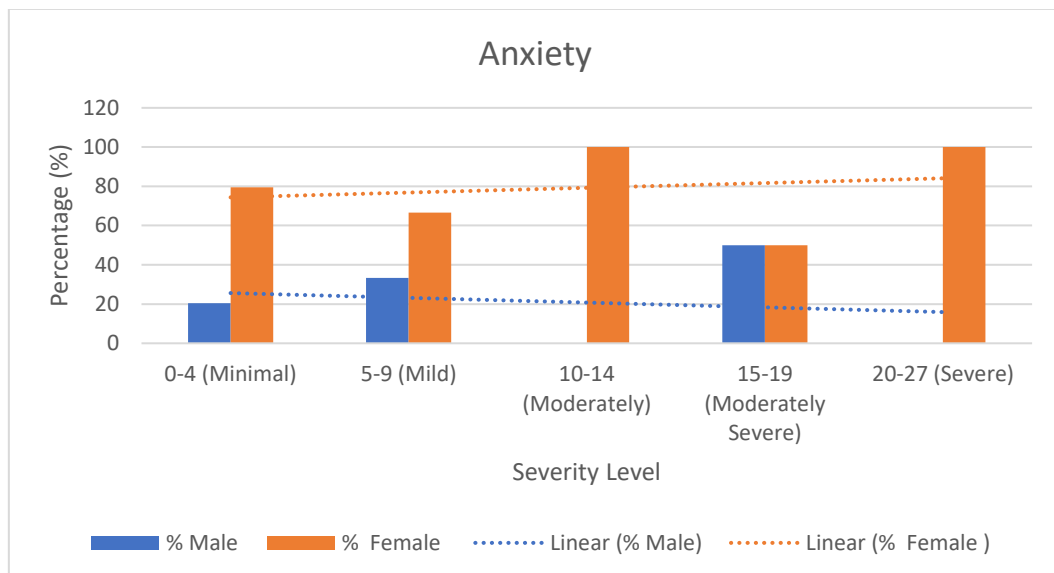


(f)

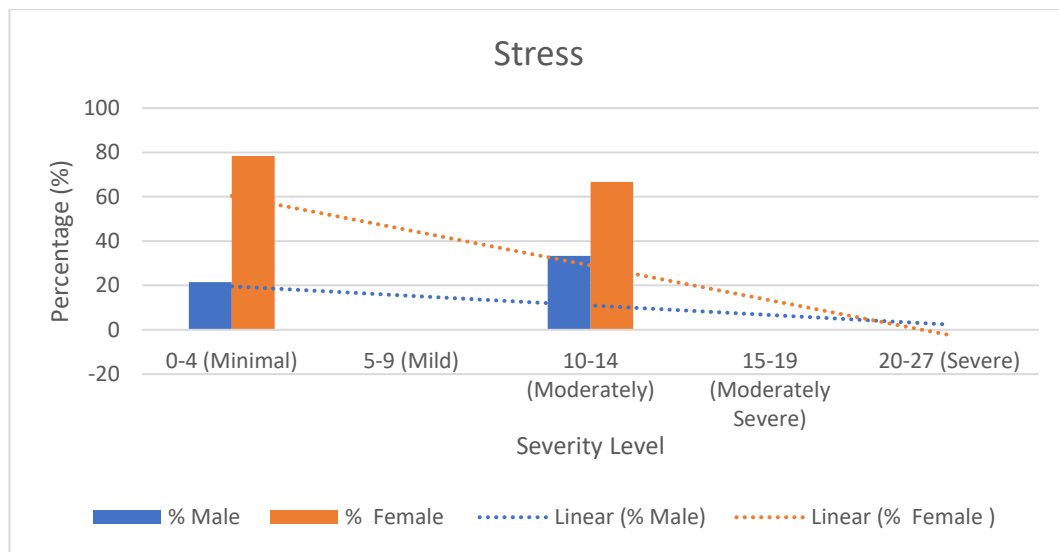
Figure 9: The PHQ-9 mental health results obtained from School A. Results for 2023.
 (a) Form 1, (b) Form 2, (c) Form 3, (d) Form 4, (e) Form 5, and (f) Form 1 to 5.



(a)



(b)

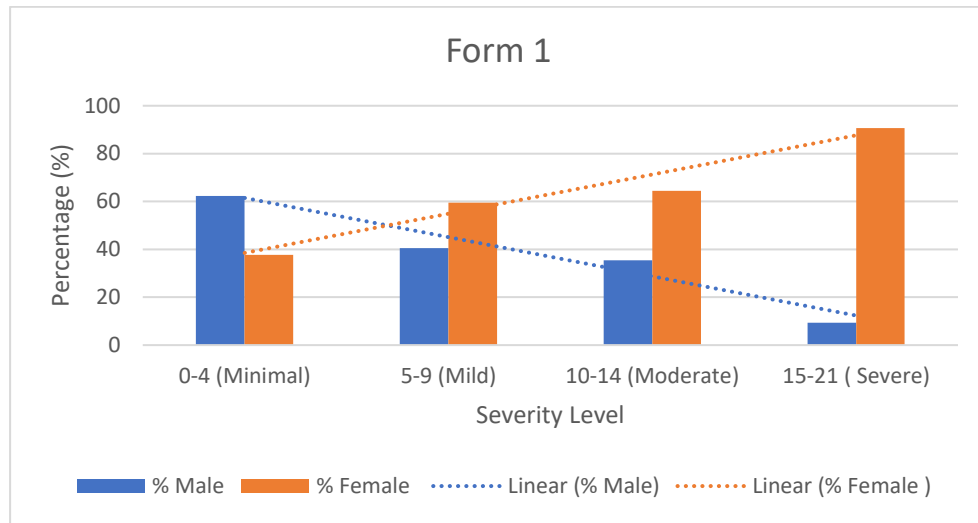


(c)

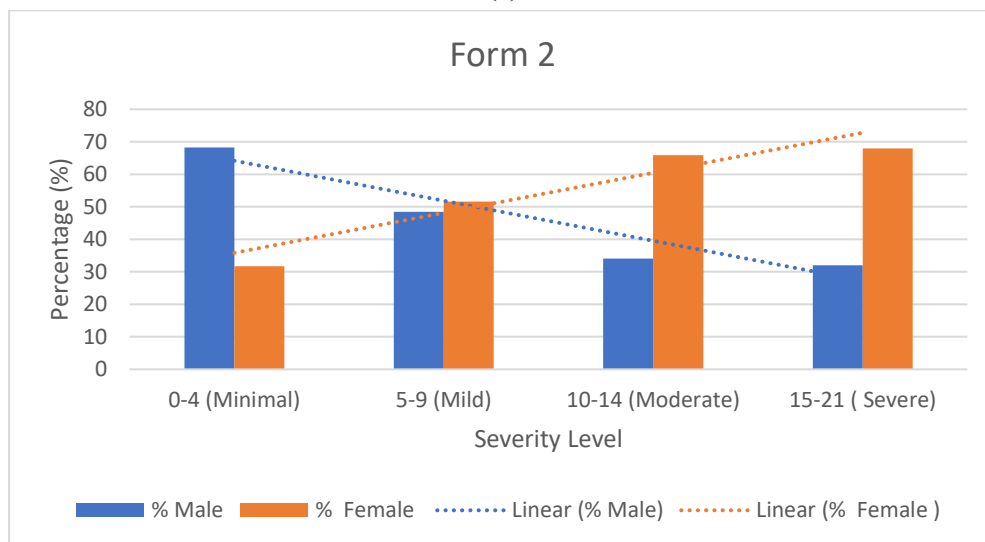
Figure 10: The DASS-21 mental health results obtained from School A for 2023. The results for (a) Depression, (b) Anxiety, and (c) DASS-21.

However, for the Depression Anxiety and Stress Scale 21 (DASS-21) survey was tested on and responded by all the teachers and staff of the school, and the details can be referred to **Appendix F**. The total sample number of teachers and staff who answered the survey were $N=54$, whereby 12 male teachers and staff (22.22%) and 42 female teachers and staff (77.78%) answered the survey, respectively. A total of 50.00% of all the teachers and staff of School A answered the DASS-21 questionnaire. The DASS-21 is divided into three main categories, which are depression, anxiety, and stress. A graph of percentage against the severity levels plotted as shown in **Figure 10**. It can be analysed that the pattern of the graphs of the two categories, which are depression and stress when the severity level of each category increases the percentage of male and female in those from lowest to highest in severity levels decreases linearly for both the male and female teachers and staff. However, for anxiety graph the percentages among female teachers and staff increases slightly when the severity level increases whereas the percentages among male teachers and staff decreases slightly when the severity level increases.

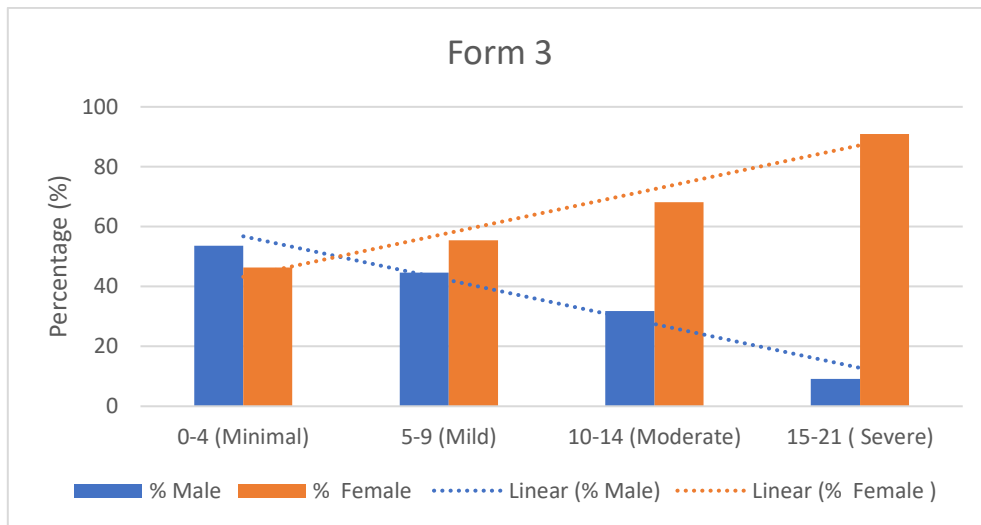
4.1.3 Secondary School 2 (School C)



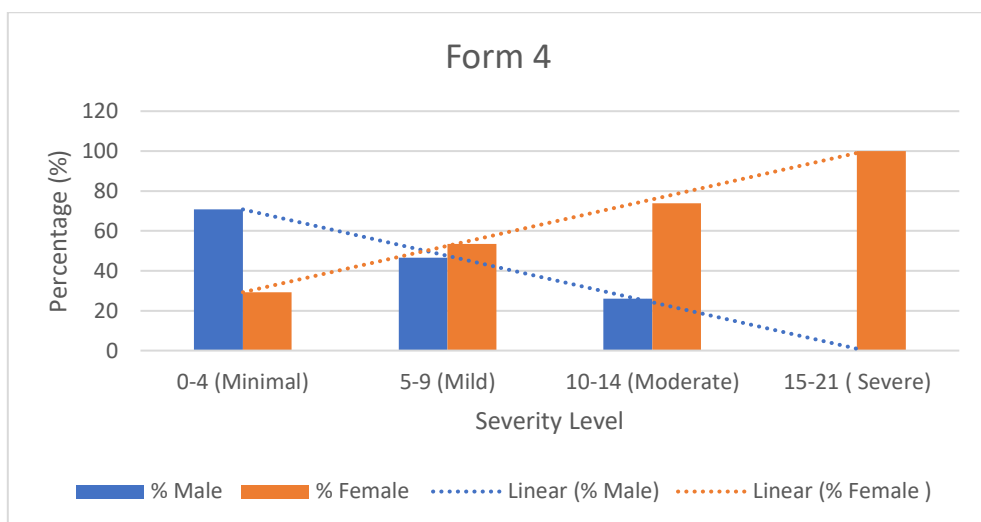
(a)



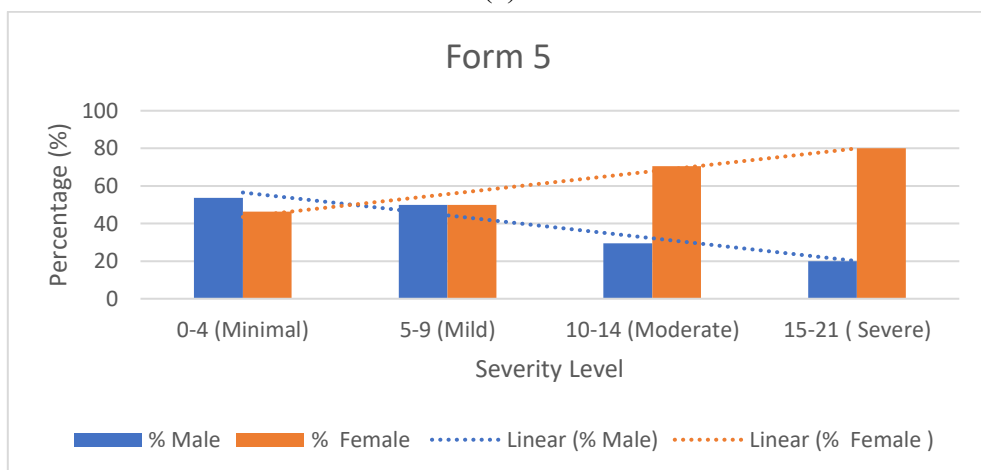
(b)



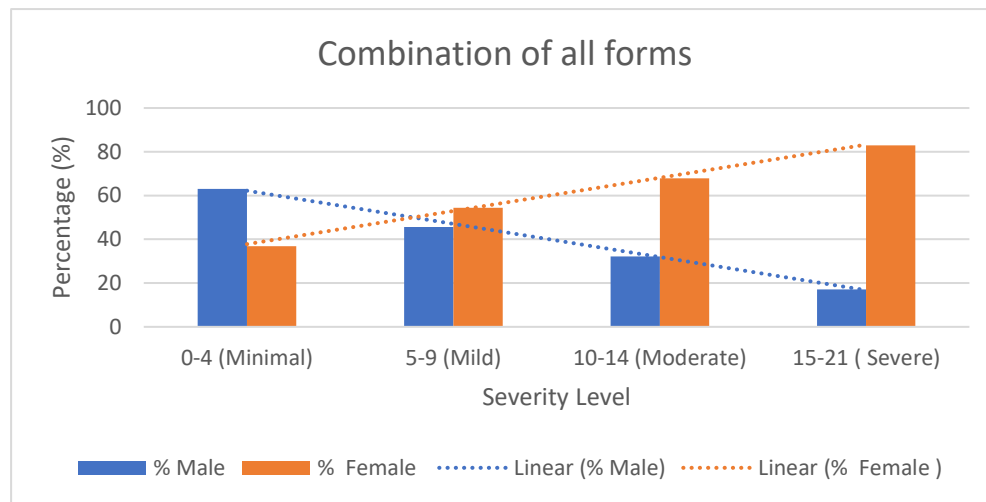
(c)



(d)



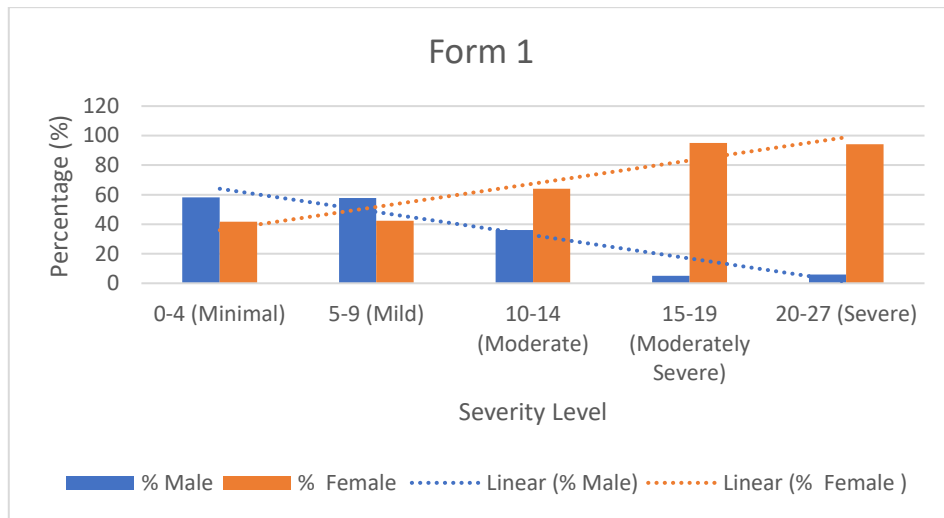
(e)



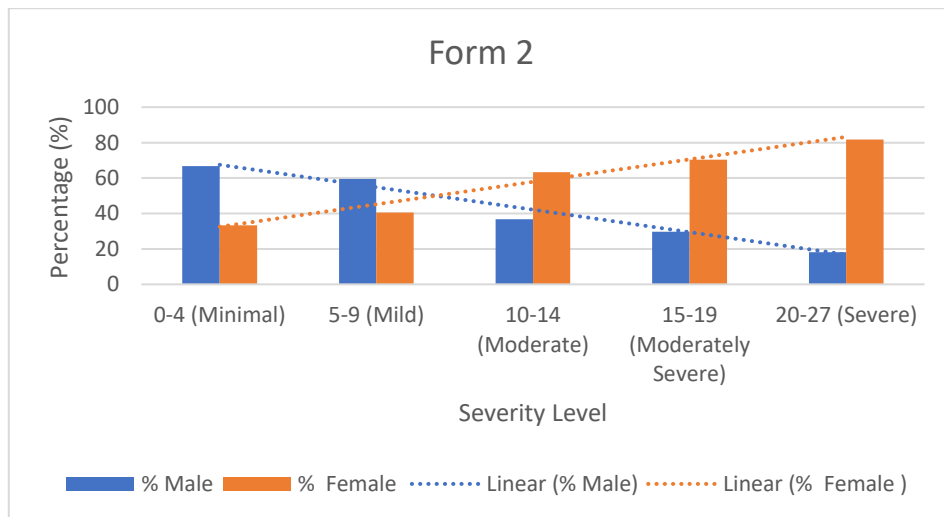
(f)

Figure 11: The GAD-7 mental health results obtained from School C for 2023. (a) Form 1, (b) Form 2, (c) Form 3, (d) Form 4, (e) Form 5, and (f) Form 1 to 5. The details can be referred at **Appendix G**.

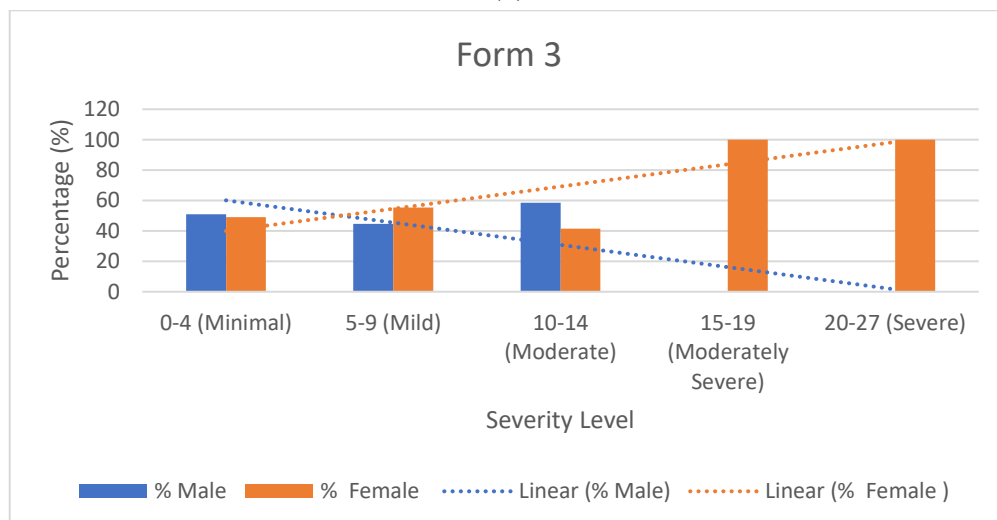
A total of two different types of mental health questionnaires were given to the students of School C, which are the General Anxiety Disorder-7 (GAD-7) and the Patient Health Questionnaire-9 (PHQ-9). The data was tabulated and analysed thoroughly using Excel, and the details can be referred to in **Appendix G**. The characteristics of the final sample and quantitative analysis of GAD-7 and PHQ-9 total scores based on the severity of students of various forms and a combined analysis of Form 1 until Form 5 students are shown in **Figure 11** and **Figure 12**, respectively. The total sample number of students from Form 1 until Form 5 that answered both questionnaires is N=1003, which comprises of 492 male students (49.05%) and 511 female students (50.95%). A total of 77.33% of students from School C answered both the PHQ-9 and GAD-7 questionnaires. A graph of percentage against the severity levels plotted. It can be analysed that the pattern of the graphs for both GAD-7 and PHQ-9 are similar, whereby the percentage among female students increases linearly when the severity level increases, whereas the percentage among male students decreases linearly when the severity level increases.



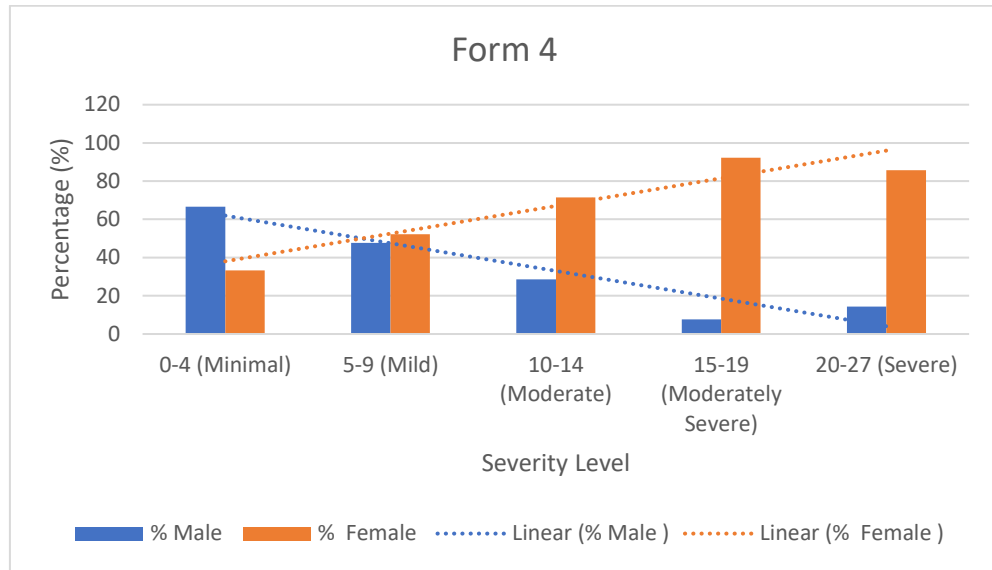
(a)



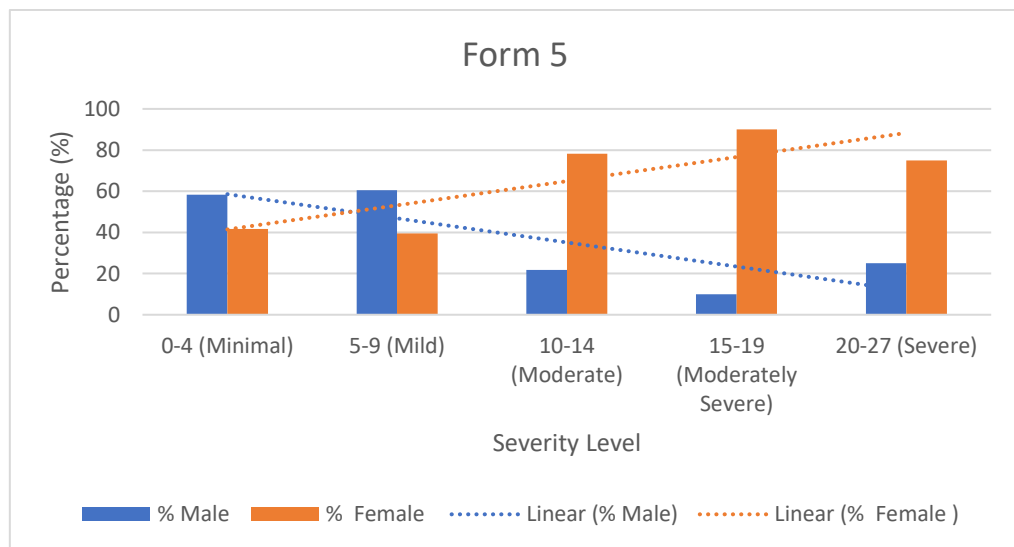
(b)



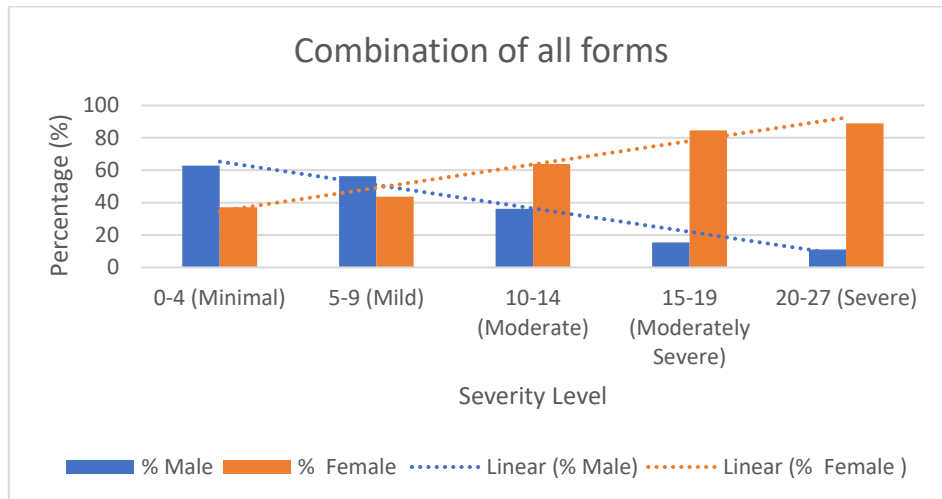
(c)



(d)

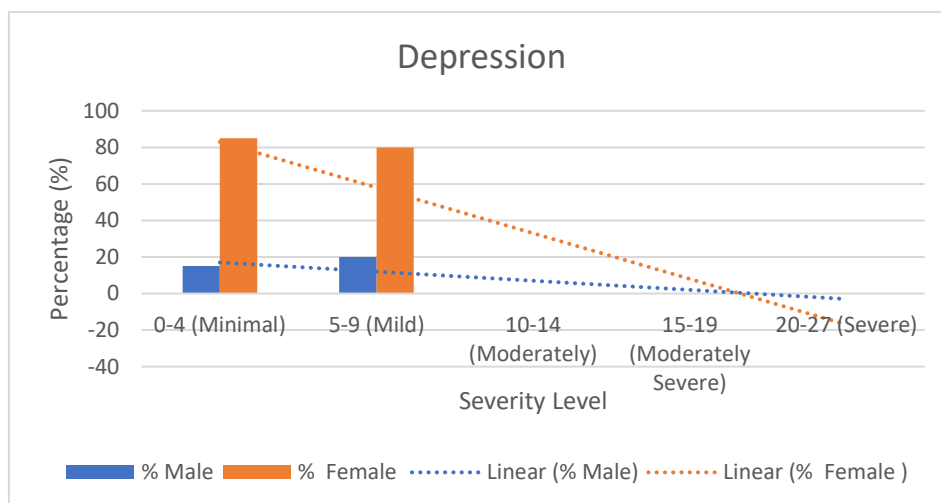


(e)

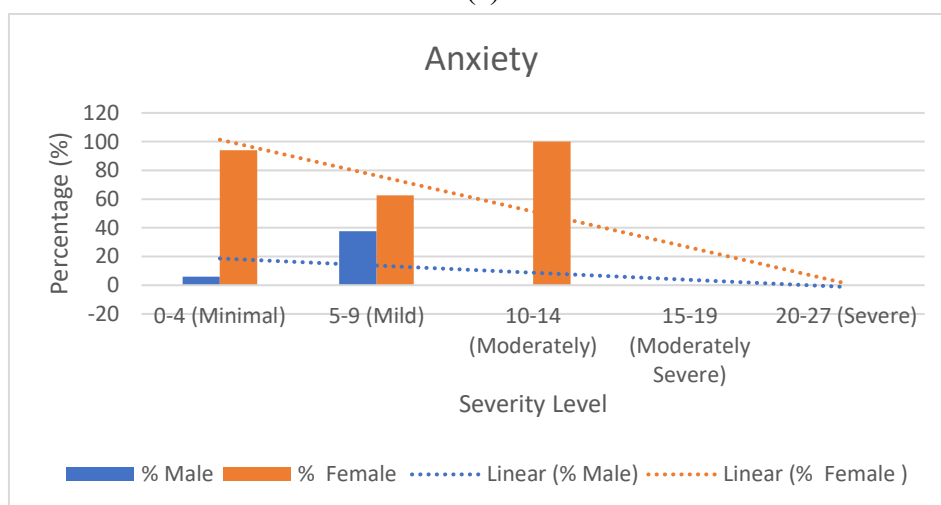


(f)

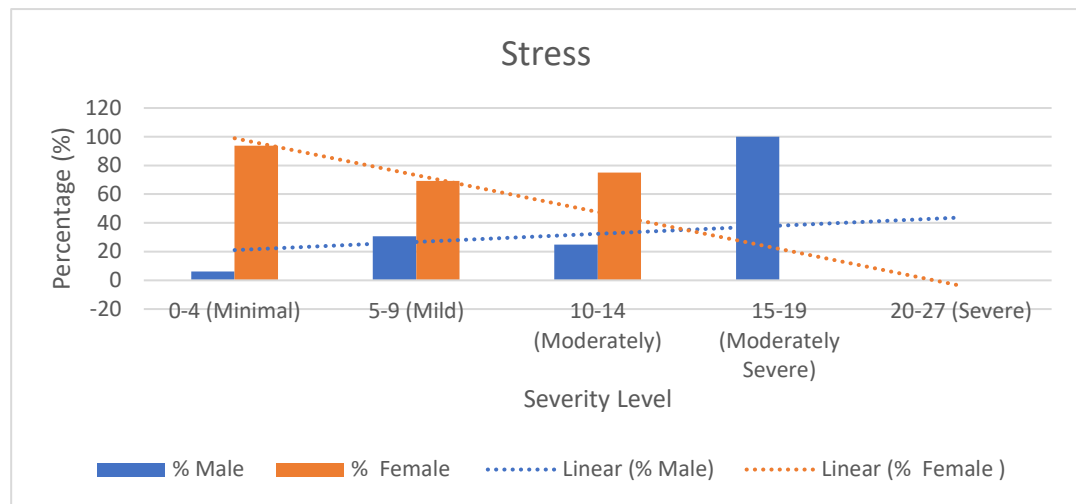
Figure 12: The PHQ-9 mental health results obtained from School C for 2023. (a) Form 1, (b) Form 2, (c) Form 3, (d) Form 4, (e) Form 5, and (f) Form 1 to 5.



(a)



(b)



(c)

Figure 13: The DASS-21 mental health results obtained from School C for 2023. (a) Depression, (b) Anxiety, and (c) Stress.

The Depression Anxiety and Stress Scale 21 (DASS-21) survey was tested on and responded by all the teachers and staff of the school, and the details can be referred in **Appendix I**. The total sample number of teachers and staff who answered the survey were $N=50$, whereby 8 male teachers and staff (16.00%) and 42 female teachers and staff (84.00%) answered the survey, respectively. A total of 45.05% of all the teachers and staff of School C answered the DASS-21 questionnaire. The DASS-21 is divided into three main categories, which are depression, anxiety, and stress. A graph of percentage against the severity levels plotted as shown in **Figure 13**. It can be analysed that the pattern of the graphs for two categories, which are depression and anxiety, when the severity level of each category increases the percentage of male and female in those categories from lowest to highest in severity levels decreases linearly for both the male and female teachers and staff. However, for stress graph the percentages among male teachers and staff increases linearly when the severity level increases whereas the percentages among female teachers and staff decreases linearly when the severity level increases.

4.1.4 Combination of Surveys for All Schools

The mental health survey from all schools were combined accordingly.

Figure 14 shows Whooley results that obtained from School B. **Figure 15** and **Figure 16** shows GAD-7 and PHQ-9 results for both School A and School C, and the details can be referred to in **Appendix J**, and **Appendix K**, respectively.

Figure 17 shows DASS-21 results from all three schools involved in this research, which are School A, School B and School C, and the details can be referred at **Appendix K**.

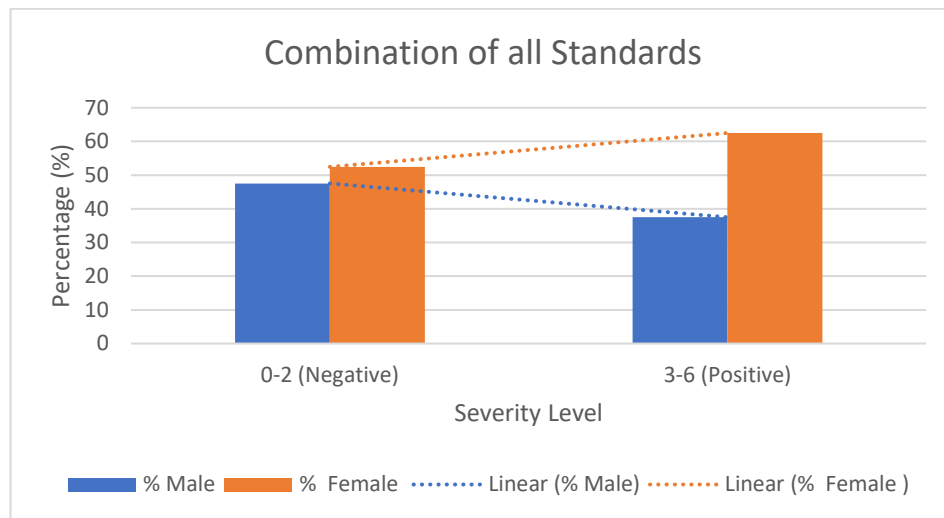


Figure 14: Is the Whooley mental health results obtained from School B, for 2023.

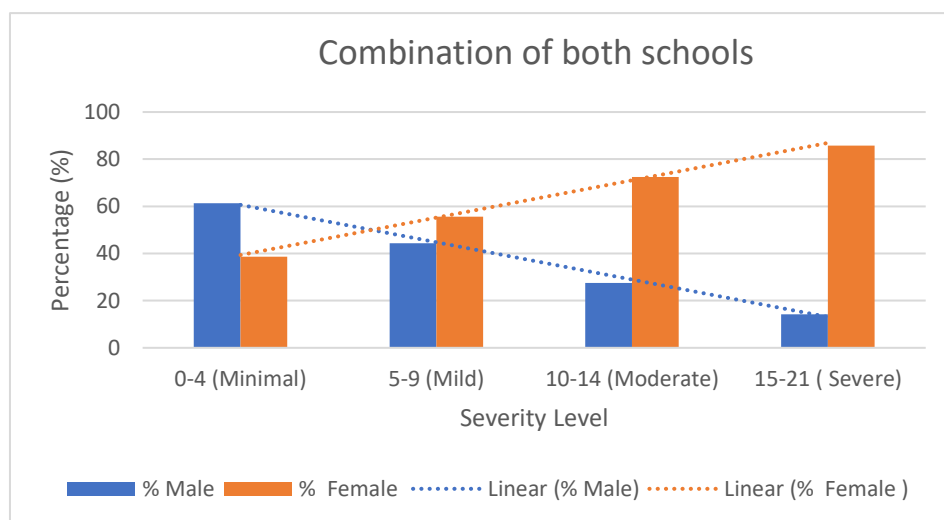


Figure 15: Comprises of the compiled GAD-7 data from both School A and School C for 2023.

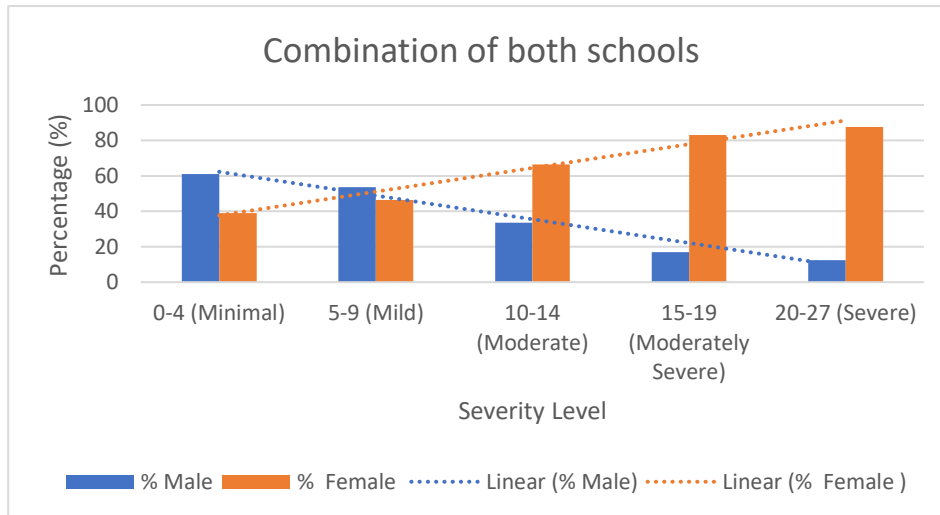
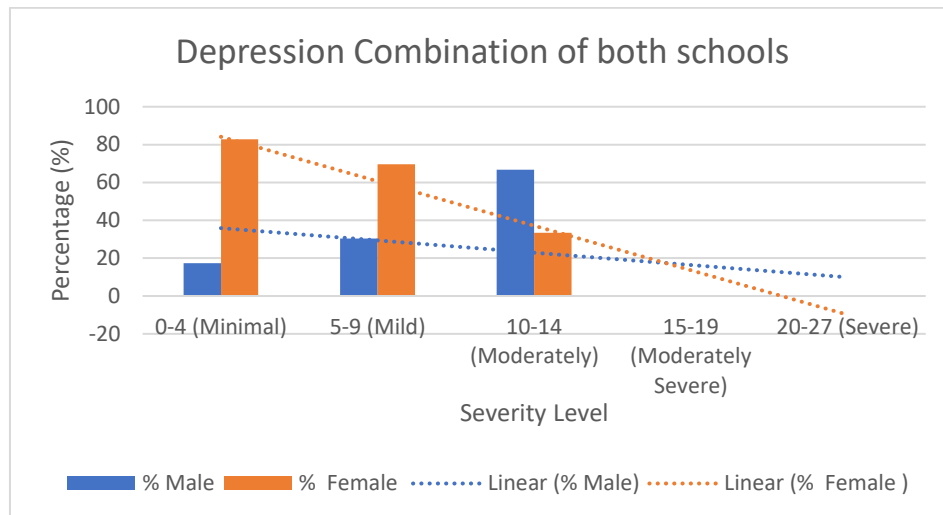
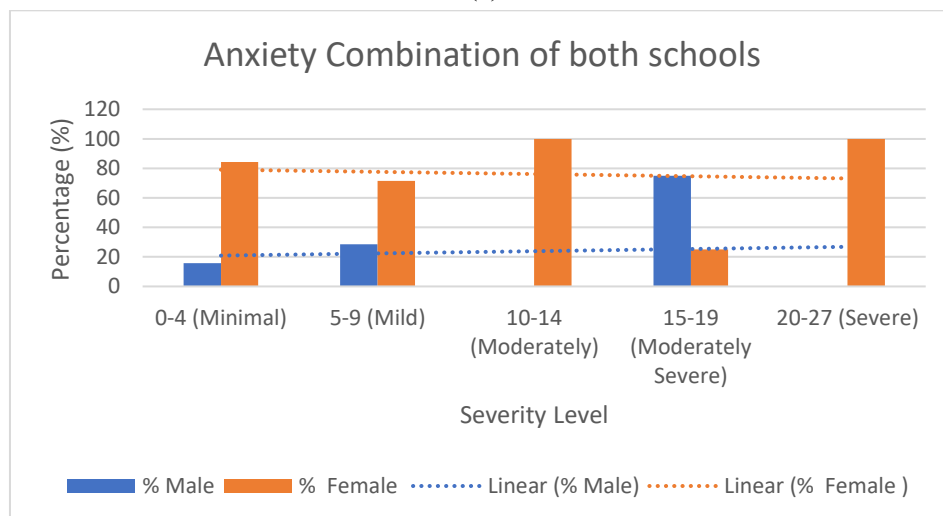


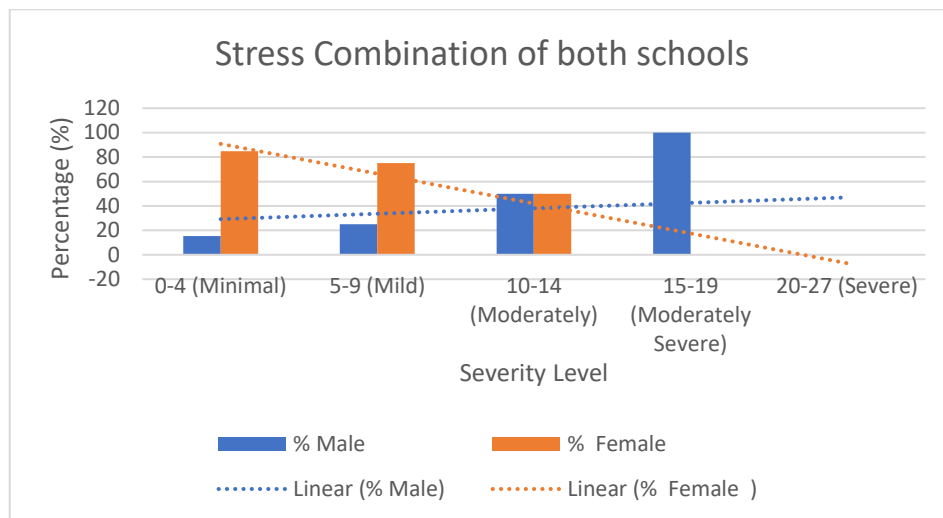
Figure 16: Comprises of the compiled PHQ-9 data from both School A and School C for 2023.



(a)



(b)

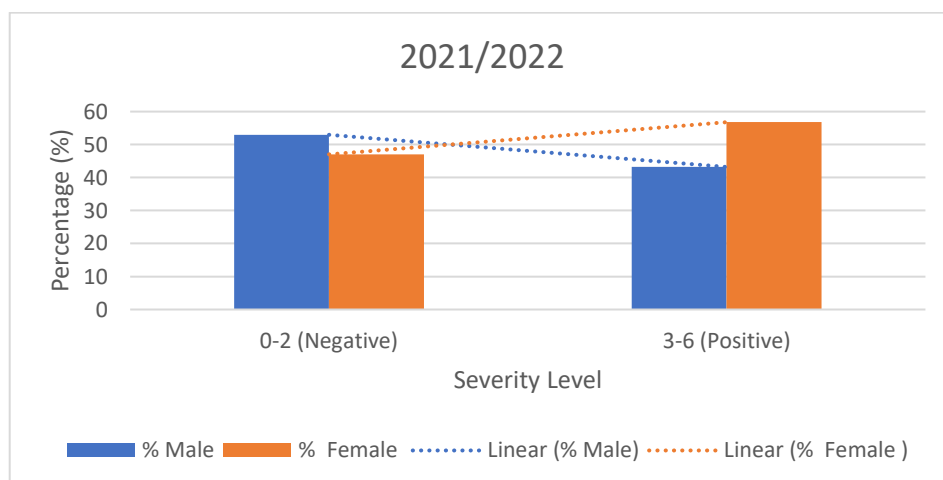


(c)

Figure 17: Compiled DASS-21 data from all three schools involved in this research, which are School A, School B, and School C for 2023. (a) Depression, (b) Anxiety, and (c) Stress.

4.2 Mental Health Government Data Comparison

Besides the collected data from school for the year 2023, general mental health data from the government between the years 2021/2022 and 2022/2023 was further analysed, and the mental health trends among students, teachers and staff from the three schools were compared. **Figure 18** shows a general Whooley mental health survey results obtained from the government of Malaysia for year 2021/2022 and 2022/2023, and the details can be referred in **Appendix L**.



(a)

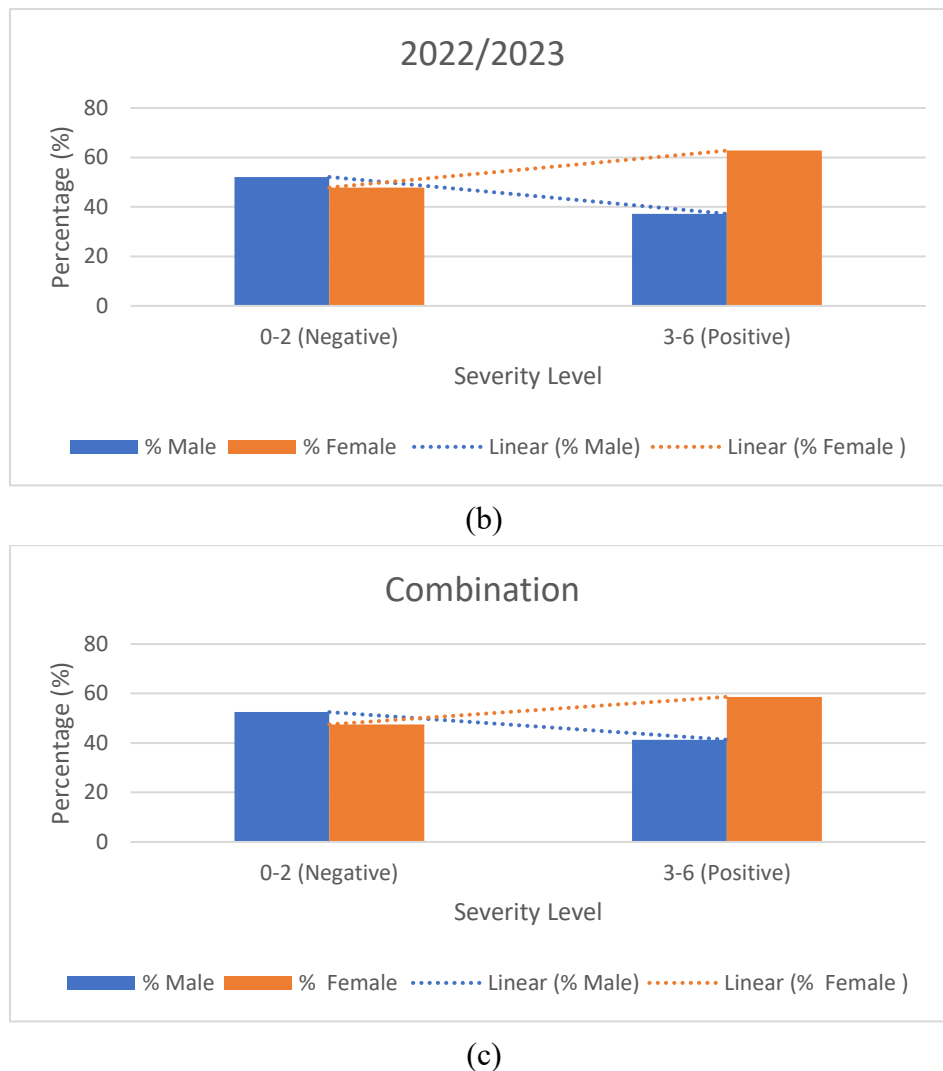
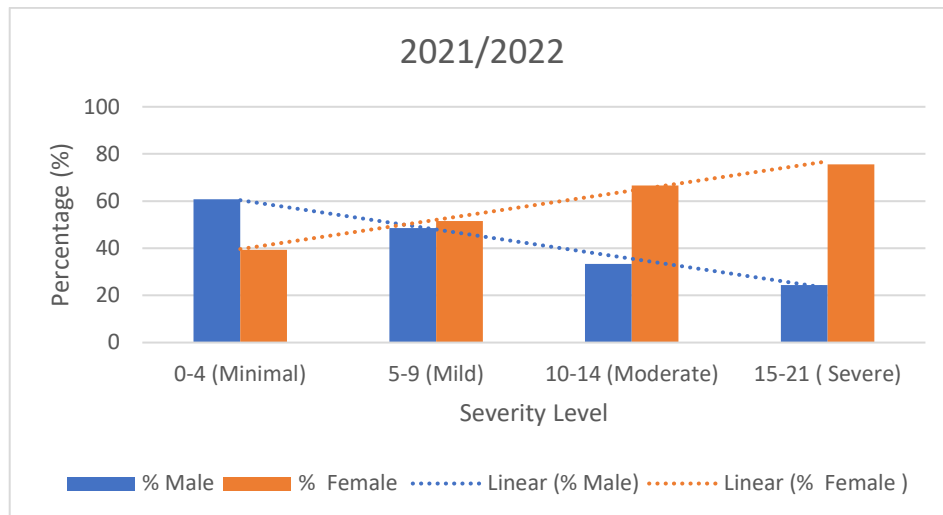


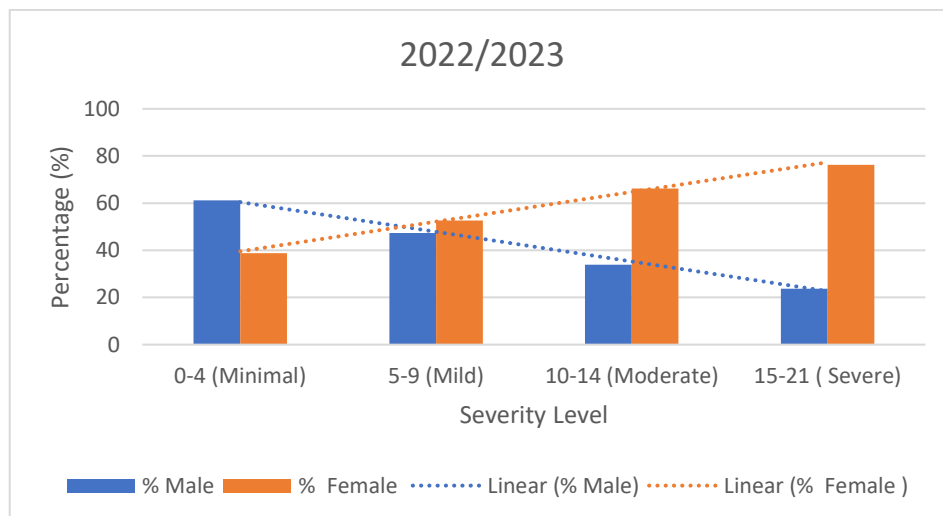
Figure 18: General Whooley mental health survey results that was obtained from the government of Malaysia. (a) Year 2021/2022, (b) 2022/2023, and (c) combined, 2021/2023.

Comparing the Whooley survey with the Government data, School B was used. There was no combination of data for the Whooley mental health survey as this was the only primary school throughout the investigation. As mentioned above in 4.1.1, the combined analysis of both standards of students are shown in **Figure 14**. For the mental health screening data for the primary school students in standard 5 and standard 6 survey results was also obtained from the government for schools in the Federal Territory Department of Education, Putrajaya for the academic sessions 2021/2022 and 2022/2023 as shown in **Figure 18**. The purpose of obtaining the data from the government was to compare the mental health results of the Whooley survey. The total sample number of students of standard 5 and standard 6 from the government data that answered the Whooley questionnaires is $N=13335$, which comprises of 6782 male students and 6553 female students. With the data obtained from the government, a graph of percentage against the severity levels plotted to compare the trends of both data obtained. It can be analysed that the pattern of the graph for both the Whooley mental health surveys from the investigation

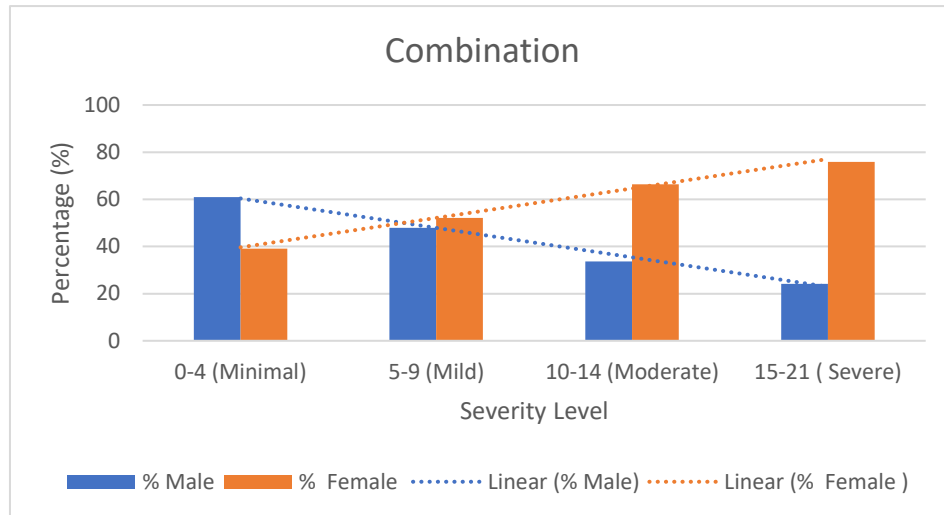
at School B and the government had similar trends of percentage against severity level. It can be observed that the percentage among female students increases linearly when the severity level increases, whereas the percentage among male students decreases linearly when the severity level increases.



(a)

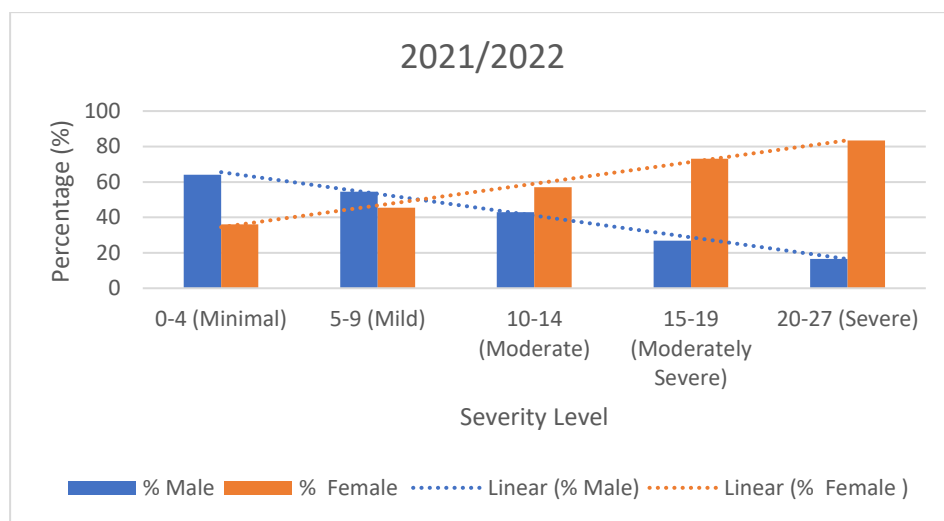


(b)

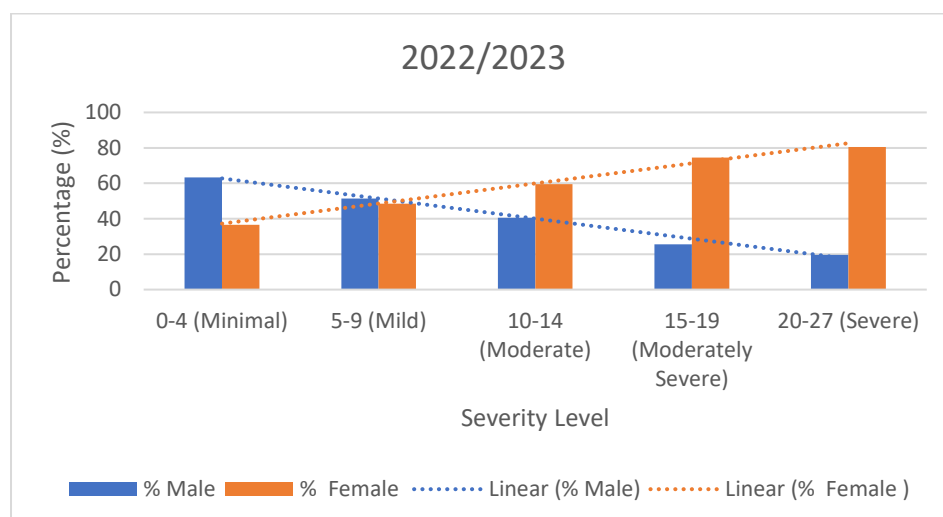


(c)

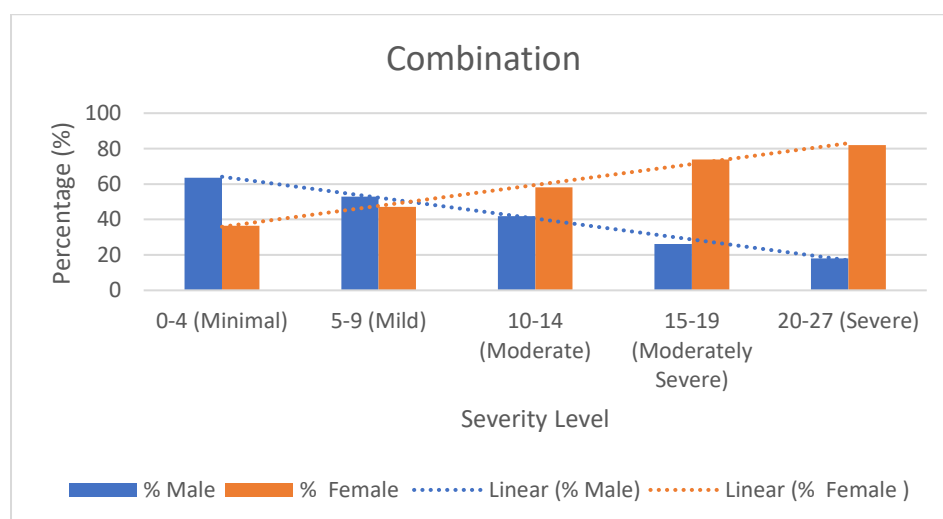
Figure 19: The GAD-7 mental health surveys results that was obtained from the government of Malaysia, (a) 2021/2022, (b) 2022/2023, and (c) combined - 2021/2023 the details can be referred at **Appendix M**.



(a)



(b)



(c)

Figure 20: The PHQ-9 mental health surveys results that was obtained from the government of Malaysia, (a) 2021/2022, (b) 2022/2023, and combined 2021/2023. The details can be referred at **Appendix N**.

Comparing GAD-7 and PHQ-9 of School A and School C with Government Data, two different types of mental health questionnaires were given to the students of School A and School C, which are the General Anxiety Disorder-7 (GAD-7) and the Patient Health Questionnaire-9 (PHQ-9). The data obtained from both the secondary schools were combined together as shown in **Figure 14** and **Figure 15** to compare it to the overall data obtained from the government for schools in the Federal Territory Department of Education, Putrajaya for the academic sessions 2021/2022 and 2022/2023 for the for the GAD-7 and PHQ-9 mental health survey as shown in **Figure 19** and **Figure 20**, respectively. The total sample number of students of the combined data from both School A and School C that answered both the questionnaires is N=2275, which comprises of

1116 male students (49.05%) and 1159 female students (50.95%). A total of 81.72% of students from the schools answered both the GAD-7 and PHQ-9 questionnaire, as shown in **Appendix J**.

For the mental health screening data for the secondary school students was also obtained from the government for schools in the Federal Territory Department of Education, Putrajaya for the academic sessions 2021/2022 and 2022/2023, as shown in **Figure 19** and **Figure 20**, respectively. The purpose of obtaining the data from the government was to compare the mental health results of the PHQ-9 and GAD-7 surveys. The total sample number of students from the government data that answered the PHQ-9 survey are N=21151, which comprises of 11083 male students and 10068 female students. However, the total sample number of students from the government data that answered the GAD-7 survey is N=21132, which comprises of 11066 male students and 10066 female student. With the data obtained from the government, a graph of percentage against the severity levels plotted to compare the trends of both data obtained. It can be analysed that the pattern of the graphs for both PHQ-9 and GAD-7 from the investigation at School A and School C, and the government had similar trends of percentage against severity level. It can be observed that the percentage among female students increases linearly when the severity level increases whereas the percentage among male students decreases linearly when the severity level increases.

For the Depression Anxiety and Stress Scale 21 (DASS-21) survey it was given to three schools, which are School A, School B and School C. The data obtained from all the schools the investigation was carried out were combined to obtain the overall results as shown in **Figure 17**. The total sample number of students of the combined data from both School A, School B and School C that answered both the questionnaires is N=165, which comprises of 33 male students (20.00%) and 132 female students (80.00%). A total of 54.10% of teachers and staff from all the schools answered the DASS-21 questionnaire. When the data from the three schools is combined, it can be analysed that for the depression graph the pattern of the graphs when the severity level of each category increases, the percentage of male and female in those from lowest to highest in severity levels decreases linearly for both the male and female teachers and staff. For the anxiety graph, it can be seen that the percentages among male teachers and staff slightly increases linearly when the severity level increases whereas the percentages among female teachers and staff slightly decreases linearly when the severity level increases. However, for stress graph, the percentages among male teachers and staff increases linearly when the severity level increases whereas the percentages among female teachers and staff decreases linearly when the severity level increases.

The data for the Depression Anxiety and Stress Scale 21 (DASS-21) mental health survey was not able to be obtained from the government for schools in the Federal Territory Department of Education, Putrajaya, for the academic sessions 2021/2022 and 2022/2023 to compare.

4.3 IAQ Results

Based on the observations during the site visit to the three schools, the majority of the classrooms in the schools follow the open-air design concept, where the classrooms are not installed with any purpose-designed mechanical ventilation and air conditioning system. The classrooms are designed with a large area of operable windows and are only equipped with either ceiling fans or standing fans. Only certain spaces in the schools are equipped with an air-conditioning system, i.e. principal and deputy principal's offices, meeting room, teacher's room, library, computer lab, etc.

It is also noted that the ICOP IAQ 2010 is only applicable to the buildings or spaces served by the mechanical ventilation and air-conditioning (MVAC) system, including air-cooled split units. Hence, not all the parameters stated in the ICOP IAQ 2010 can be achieved by the room/space which is not equipped with MVAC system. The parameter like the temperature and humidity may not be achieved without a proper air-conditioning system installed in these rooms/spaces. Under these circumstances, natural ventilation would play an important role in keeping the room/space well ventilated.

The following sections show the findings from the site visit to the three schools. Rooms/spaces equipped with an air-conditioning system are mentioned in the table.

4.3.1 Primary School – School B

The site inspection at School B was carried out on 9 August 2023, and the following are the results based on categorisation. Table 4 to Table 9 shows the inspection of Split Air Conditioning Unit/Fan Coil Unit (FCU) results.

Table 4: Inspection results of Split Air Conditioning Unit/FCU at the Principal's Office

No	Elements	Notes
1.	Condition of Split Air Conditioning Unit/FCU (External cleanliness)	Clean
2.	Condition/Type of air filters used	Clean
3.	The use of fans/exhaust in the Split Air Conditioning Unit/FCU system is present.	No exhaust fan
4.	Fresh air intake from the outside is present in the Split Air Conditioning Unit/FCU system.	Not applicable

Table 5: Inspection results of Split Air Conditioning Unit/FCU at the Deputy Principal 1's Office

No	Elements	Notes
1.	Condition of Split Air Conditioning Unit/FCU (External cleanliness)	Clean
2.	Condition/Type of air filters used	Clean
3.	The use of fans/exhaust in the Split Air Conditioning Unit/FCU system is present.	No exhaust fan
4.	Fresh air intake from the outside is present in the Split Air Conditioning Unit/FCU system.	Not applicable

Table 6: Inspection results of Split Air Conditioning Unit/FCU at the Meeting Room

No	Elements	Notes
1.	Condition of Split Air Conditioning Unit/FCU (External cleanliness)	Clean
2.	Condition/Type of air filters used	Clean
3.	The use of fans/exhaust in the Split Air Conditioning Unit/FCU system is present.	No exhaust fan
4.	Fresh air intake from the outside is present in the Split Air Conditioning Unit/FCU system.	Not applicable

Table 7: Inspection results of Split Air Conditioning Unit/FCU at the Teachers' Room

No	Elements	Notes
1.	Condition of Split Air Conditioning Unit/FCU (External cleanliness)	Clean
2.	Condition/Type of air filters used	Clean
3.	The use of fans/exhaust in the Split Air Conditioning Unit/FCU system is present.	No exhaust fan but uses standing fan

4.	Fresh air intake from the outside is present in the Split Air Conditioning Unit/FCU system.	Not applicable
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Table 8: Inspection results of Split Air Conditioning Unit/FCU at the Library

No	Elements	Notes
1.	Condition of Split Air Conditioning Unit/FCU (External cleanliness)	Clean
2.	Condition/Type of air filters used	Clean
3.	The use of fans/exhaust in the Split Air Conditioning Unit/FCU system is present.	No exhaust fan
4.	Fresh air intake from the outside is present in the Split Air Conditioning Unit/FCU system.	Not applicable

Table 9: Inspection results of Split Air Conditioning Unit/FCU at the Computer Lab

No	Elements	Notes
1.	Condition of Split Air Conditioning Unit/FCU (External cleanliness)	Clean
2.	Condition/Type of air filters used	Clean
3.	The use of fans/exhaust in the Split Air Conditioning Unit/FCU system is present.	No exhaust fan
4.	Fresh air intake from the outside is present in the Split Air Conditioning Unit/FCU system.	Not applicable

After the general inspection of split air-conditioning, measurements were taken, and the results for each were summarised in Table 10.

Table 10: Measured Parameters from School B

No	Location/Sampling Point	Parameter						
		Air Movement (0.15 – 0.5 m/s)	CO ₂ (C1000 ppm)	CO (10 ppm)	Temperature (23 – 26°C)	Humidity (40-70%)	TVOC (3 ppm)	Respirable Particulates (0.15 mg/m ³)
1.	Principal's Room (Split Air Conditioning Unit)	0.02	971	0.6	24.1	50.2	0.002	0.051
2.	Deputy Principal 1's Office (Split Air Conditioning Unit)	0.41	897	0.6	25	59.5	0.003	0.041
3.	Meeting Room (Split Air Conditioning Unit) 30 people	0.35	2117	0.6	23.1	54.4	0.011	0.033
4.	Teachers' Room (Split Air Conditioning Unit) 75 people	0.07	754	0.4	24.8	60.6	0.025	0.034
5.	Library (Split Air Conditioning Unit) 50 people	0.06	1050	0.3	26.7	65.5	0.029	0.042
6.	Computer Lab (Split Air Conditioning Unit)	0.07	523	0.3	28.3	54.3	0.033	0.032
7.	Classroom (5 Earth) (few) 28 students	0.1	509	0.1	30.3	72.8	0.034	0.050
8.	Classroom (6 Neptune) (many) 41 students	0.2	441	0.1	30.6	70.1	0.035	0.063
9.	Science Lab 18 people	0.39	484	0.2	31.0	67.7	0.037	0.052

4.3.2 Secondary School 1- School A

The site inspection at School A was carried out on 10 August 2023, and the following are the results based on categorisation. Table 11 to Table 16 shows the inspection of Split Air Conditioning Unit/Fan Coil Unit (FCU) results.

Table 11: Inspection results of Split Air Conditioning Unit/FCU at the Principal's Office

No	Elements	Notes
1.	Condition of Split Air Conditioning Unit/FCU (External cleanliness)	Clean
2.	Condition/Type of air filters used	Clean
3.	The use of fans/exhaust in the Split Air Conditioning Unit/FCU system is present.	It has an exhaust fan, but it was switched off at the time of inspection.
4.	Fresh air intake from the outside is present in the Split Air Conditioning Unit/FCU system.	Not applicable

Table 12: Inspection results of Split Air Conditioning Unit/FCU at the Deputy Principal 1's Office

No	Elements	Notes
1.	Condition of Split Air Conditioning Unit/FCU (External cleanliness)	Clean
2.	Condition/Type of air filters used	Clean
3.	The use of fans/exhaust in the Split Air Conditioning Unit/FCU system is present.	The exhaust fan was used
4.	Fresh air intake from the outside is present in the Split Air Conditioning Unit/FCU system.	No

Table 13: Inspection results of Split Air Conditioning Unit/FCU at the Teachers' Room

No	Elements	Notes
1.	Condition of Split Air Conditioning Unit/FCU (External cleanliness)	Clean
2.	Condition/Type of air filters used	Clean
3.	The use of fans/exhaust in the Split Air Conditioning Unit/FCU system is present.	The exhaust fan was used
4.	Fresh air intake from the outside is present in the Split Air Conditioning Unit/FCU system.	No

Table 14: Inspection results of Split Air Conditioning Unit/FCU at the Library

No	Elements	Notes
1.	Condition of Split Air Conditioning Unit/FCU (External cleanliness)	Clean
2.	Condition/Type of air filters used	Clean
3.	The use of fans/exhaust in the Split Air Conditioning Unit/FCU system is present.	It has an exhaust fan, but it was switched off at the time of inspection
4.	Fresh air intake from the outside is present in the Split Air Conditioning Unit/FCU system.	No

Table 15: Inspection results of Split Air Conditioning Unit/FCU at the Computer Lab

No	Elements	Notes
1.	Condition of Split Air Conditioning Unit/FCU (External cleanliness)	Clean
2.	Condition/Type of air filters used	Clean
3.	The use of fans/exhaust in the Split Air Conditioning Unit/FCU system is present.	The exhaust fan was used
4.	Fresh air intake from the outside is present in the Split Air Conditioning Unit/FCU system.	No

Table 16: Inspection results of Split Air Conditioning Unit/FCU at the Studio Lab

No	Elements	Notes
1.	Condition of Split Air Conditioning Unit/FCU (External cleanliness)	Clean
2.	Condition/Type of air filters used	Clean
3.	The use of fans/exhaust in the Split Air Conditioning Unit/FCU system is present.	It has an exhaust fan, but it was switched off at the time of inspection
4.	Fresh air intake from the outside is present in the Split Air Conditioning Unit/FCU system.	No

After the general inspection of split air-conditioning, measurements were taken, and the results for each were summarised in Table 17.

Table 17: Measured parameters from School A

No	Location/Sampling Point	Parameter					
		CO ₂ (C1000 ppm)	CO (10 ppm)	Temperature (23 – 26°C)	Humidity (40-70%)	TVOC (3 ppm)	Respirable Particulates (0.15 mg/m ³)
1.	Principal's Room (Split Air Conditioning Unit with exhaust fan)	614	0.1	24.6	59.7	0.012	0.047
2.	Deputy Principal 1's Office (Split Air Conditioning Unit with exhaust fan)	743	0.1	23.9	59.0	0.016	0.031
3.	Teachers' Room (Split Air Conditioning Unit with exhaust fan)	658	0.1	23.8	60.6	0.021	0.117
4.	Library (Split Air Conditioning Unit with exhaust fan)	1077	0.1	23.8	60.6	0.026	0.012
5.	Computer Lab (Split Air Conditioning Unit with exhaust fan)	1456	0.1	24.8	61.4	0.034	0.010
6.	Classroom (5 Wira Harmoni) (few) 25 students	459	0.1	29.4	64.7	0.030	0.009
7.	Classroom (1 Azam Harmoni) (many) 50 students	664	0.1	28.0	68.0	0.037	0.063
8.	Science Lab	650	0.1	28.6	69.6	0.039	0.027
9.	Studio Lab (Split Air Conditioning Unit with exhaust fan)	761	0.1	24	62	0.046	0.014

4.3.3 Secondary School 2- School C

The site inspection at School C was carried out on 16 August 2023, and the following are the results based on categorisation. Table 18 to Table 23 shows the inspection of Split Air Conditioning Unit/Fan Coil Unit (FCU) results.

Table 18: Inspection results of Split Air Conditioning Unit/FCU at the Principal's Office

No	Elements	Notes
1.	Condition of Split Air Conditioning Unit/FCU (External cleanliness)	Clean
2.	Condition/Type of air filters used	Clean
3.	The use of fans/exhaust in the Split Air Conditioning Unit/FCU system is present.	No exhaust fan
4.	Fresh air intake from the outside is present in the Split Air Conditioning Unit/FCU system.	Not applicable

Table 19: Inspection results of Split Air Conditioning Unit/FCU at the Deputy Principal's Office

No	Elements	Notes
1.	Condition of Split Air Conditioning Unit/FCU (External cleanliness)	Clean
2.	Condition/Type of air filters used	Clean
3.	The use of fans/exhaust in the Split Air Conditioning Unit/FCU system is present.	No exhaust fan
4.	Fresh air intake from the outside is present in the Split Air Conditioning Unit/FCU system.	Not applicable

Table 20: Inspection results of Split Air Conditioning Unit/FCU at the Teachers' Room

No	Elements	Notes
1.	Condition of Split Air Conditioning Unit/FCU (External cleanliness)	Clean
2.	Condition/Type of air filters used	Clean
3.	The use of fans/exhaust in the Split Air Conditioning Unit/FCU system is present.	No exhaust fan, but uses a ceiling fan
4.	Fresh air intake from the outside is present in the Split Air Conditioning Unit/FCU system.	Not applicable

Table 21: Inspection results of Split Air Conditioning Unit/FCU at the Library

No	Elements	Notes
1.	Condition of Split Air Conditioning Unit/FCU (External cleanliness)	Clean
2.	Condition/Type of air filters used	Clean
3.	The use of fans/exhaust in the Split Air Conditioning Unit/FCU system is present.	The use of ceiling fans without turning on the split air conditioning unit. No exhaust fan
4.	Fresh air intake from the outside is present in the Split Air Conditioning Unit/FCU system.	Windows

Table 22: Inspection results of Split Air Conditioning Unit/FCU at the Computer Lab

No	Elements	Notes
1.	Condition of Split Air Conditioning Unit/FCU (External cleanliness)	Clean
2.	Condition/Type of air filters used	Clean
3.	The use of fans/exhaust in the Split Air Conditioning Unit/FCU system is present.	No exhaust fan
4.	Fresh air intake from the outside is present in the Split Air Conditioning Unit/FCU system.	Not applicable

Table 23: Inspection results of Split Air Conditioning Unit/FCU at the Teachers' Room (Multipurpose Room)

No	Elements	Notes
1.	Condition of Split Air Conditioning Unit/FCU (External cleanliness)	Clean
2.	Condition/Type of air filters used	Clean
3.	The use of fans/exhaust in the Split Air Conditioning Unit/FCU system is present.	No exhaust fan
4.	Fresh air intake from the outside is present in the Split Air Conditioning Unit/FCU system.	Not applicable

After the general inspection of split air-conditioning, measurements were taken, and the results for each were summarised in **Table 24**.

Table 24: Measured Parameters from School C

No	Location/Sampling Point	Parameter						
		Air Movement (0.15 - 0.5 m/s)	CO ₂ (CI1000 ppm)	CO (10 ppm)	Temperature (23 – 26°c)	Humidity (40-70%)	TVOC (3 ppm)	Respirable Particulates (0.15 mg/m ³)
1.	Principal's Room (Split Air Conditioning Unit)	0.18	1145	1.3	23.5	62.4	0.006	0.067
2.	Deputy Principal 1's Office (Split Air Conditioning Unit)	0.01	1118	1.2	26.9	65.2	0.009	0.151
3.	Teachers' Room (Split Air Conditioning Unit)	0.17	757	1.1	28.1	63.8	0.011	0.097
4.	Library (Split Air Conditioning Unit not used)	0.06	572	0.4	30.5	65.3	0.019	0.059
5.	Computer Lab (Split Air Conditioning Unit)	0.22	665	1.3	29.8	69.8	0.015	0.081
6.	Classroom (few) 16 students	0.23	575	0.6	30.5	68.6	0.018	0.071
7.	Classroom (many) 29 students	0.37	496	0.4	30.6	67.2	0.016	0.056
8.	Science Lab 13 people	0.19	468	0.3	29.7	68.1	0.021	0.050
9.	Teachers' Room (Multipurpose Room) (Split Air Conditioning Unit)	0.07	690	1.3	28.6	63.8	0.013`	0.146

4.3.4 Acceptable Range of Specific Physical Parameters

According to the Industry Code of Practice on Indoor Air Quality 2010 (ICOP 2010), the acceptable range for specific physical parameters are as follows:

Table 25: Acceptable range of specific physical parameters

Parameter	Acceptable Range
Air temperature	23 – 26°C
Relative humidity	40 – 70%
Air movement	0.15 – 0.50 m/s

4.3.5 List of Indoor Air Contaminants and The Acceptable Limits

According to the Industry Code of Practice on Indoor Air Quality 2010 (ICOP 2010), the acceptable limits of a list of indoor air contaminants are as follows:

Table 26: List of indoor air contaminants and the acceptable limits

Indoor air contaminants	Acceptable limits		
	ppm	mg/m ³	cfu/m ³
Chemical contaminants			
Carbon monoxide	10	-	-
Formaldehyde	0.1	-	-
Ozone	0.05	-	-
Respirable particulates	-	0.15	-
Total volatile organic compounds (TVOC)	3	-	-
Biological contaminants			
Total bacterial counts	-	-	500*
Total fungal counts	-	-	1000*
Ventilation performance indicator			
Carbon dioxide	C1000	-	-

- For chemical contaminants, the limits are eight-hour time-weighted average airborne concentrations.
- mg/m³ is milligrams per cubic meter of air at 25°C and one atmosphere pressure.
- ppm is parts of vapour of gas per million parts of contaminated air by volume.
- cfu/m³ is colony-forming units per cubic meter.
- C is the ceiling limit that shall not be exceeded at any time. Reading above 1000ppm are indication of inadequate ventilation.

- *Excess of bacterial counts does not necessarily imply health risk but serves as an indicator for further investigation.

4.3.6 Air Ventilation Rates

The recommended minimum ventilation rates in a breathing zone during the normal period, as recommended in ASHRAE Standard 62.1 – 2022 for educational facilities, are as shown in **Table 27**. During the pandemic period, it is recommended to increase the ventilation rate to 10 L/s/person (as recommended by WHO and DOSH, Malaysia). The recommended rates are as in **Table 28**.

For better engineering control, especially during the outbreak of infectious diseases, it is recommended to refer to ASHRAE Standard 241 -2023 Control of Infectious Aerosols, which addresses the indoor long-range transmission resulting from inhalation of infectious aerosol emitted by an infector who is not in close proximity to a susceptible occupant.

Table 27: Minimum ventilation rates in a breathing zone

Type of education facility	L/s*person	L/s*m ²	Default occupancy (per 100 m ²)	L/s	L/s*person
Classrooms (5-8 years old)	5	0.6	25	185.0	7.4
Classrooms (9+ years old)	5	0.6	35	235.0	6.7
Art Classroom	5	0.9	20	190.0	9.5
Computer Lab	5	0.6	25	185.0	7.4
Daycare sickroom	5	0.9	25	215.0	8.6
Daycare (through age 4)	5	0.9	25	215.0	8.6
Lecture Classroom	3.8	0.3	65	277.0	4.3
Lecture Hall (fixed seats)	3.8	0.3	150	600.0	4.0
Libraries	2.5	0.6	10	85.0	8.5
Media centre	5	0.6	25	185.0	7.4
Multiuse assembly	3.8	0.3	100	410.0	4.1
Music/theatre/dance	5	0.3	35	205.0	5.9
Science laboratories	5	0.9	25	215.0	8.6
University/college laboratories	5	0.9	25	215.0	8.6
Wood/metal shop	5	0.9	20	190.0	9.5

Table 28: Top up for good and poor ventilation education facilities with air purifier to meet 10L/s/person (Recommended by WHO during pandemic).

Type of education facility	Additional Ventilation Rate Required (L/s*person)	Top up for good ventilation with Air Purifier (L/s)	Top up for good ventilation with Air Purifier (CFM)	Top up for low Ventilation with Air Purifier (L/s)	Top up for low Ventilation with Air Purifier (CFM)
Classrooms (5-8 year olds)	2.6	65.0	137.7	250.0	529.7
Classrooms (9+ years old)	3.3	115.0	243.7	350.0	741.6
Art Classroom	0.5	10.0	21.2	200.0	423.8
Computer Lab	2.6	65.0	137.7	250.0	529.7
Daycare sickroom	1.4	35.0	74.2	250.0	529.7
Daycare (through age 4)	1.4	35.0	74.2	250.0	529.7
Lecture Classroom	5.7	373.0	790.3	650.0	1377.3
Lecture Hall (fixed seats)	6.0	900.0	1907.0	1500.0	3178.3
Libraries	1.5	15.0	31.8	100.0	211.9
Media centre	2.6	65.0	137.7	250.0	529.7
Multiuse assembly	5.9	590.0	1250.1	1000.0	2118.9
Music/theatre/dance	4.1	145.0	307.2	350.0	741.6
Science laboratories	1.4	35.0	74.2	250.0	529.7
University/college laboratories	1.4	35.0	74.2	250.0	529.7
Wood/metal shop	0.5	10.0	21.2	200.0	423.8

* Poor ventilation – The education facility has poor ventilation or no ventilation.

* Good ventilation - The education facility meets the minimum ventilation as per ASHRAE 62.1(2022)

4.4 IAQ Results Discussion

The condition of the Split Air Conditioning Unit/FCU in all locations appears clean. The cleanliness of the split air conditioning units is important to prevent the accumulation of dust and dirt that can contaminate indoor air. The inspection found that several locations in School A are equipped with exhaust fans. However, there are locations where the exhaust fan was not turned on (Principal's Office, Library, and Studio Lab). The installation of exhaust fans can help improve air circulation within a room. From the observations and monitoring conducted, it was found that all sampling points in all three school locations do not have a Mechanical Ventilating and Air Conditioning System (MVAC).

Air quality parameters such as CO₂, CO, temperature, relative humidity, TVOC, and respirable particulates were measured. These results are useful for assessing the level of indoor air quality and compliance with the standards set according to ICOP IAQ 2010. Measurements taken for School B, School A and School C were summarised in Table 10, Table 17, and Table 24, respectively.

From Table 24, it was found that there are several sampling points that are outside the acceptable range for temperature and relative humidity parameters and exceed the acceptable limit for CO₂. Referring to Table 10 for the location at School A, the sampling points in the library (split air conditioning unit with exhaust fan) and Computer Lab (split air conditioning unit with exhaust fan) exceeded the acceptable limit for the CO₂ parameter. Meanwhile, for the sampling points in Classroom (5 Wira Harmoni) (few) with 25 people and Classroom (1 Azam Harmoni) (many) with 50 people, were outside the acceptable range for the temperature parameter.

Referring to the results summarised in Table 17, it was found that for the location at School B, the sampling points in the Meeting Room (split air conditioning unit) and Library (split air conditioning unit) exceeded the acceptable limit for the CO₂ parameter. Additionally, for the sampling points in the library (split air conditioning unit), Computer Lab (split air conditioning unit), Classroom (5 Earth), Classroom (6 Neptune), and Science Lab, the temperature parameters were found to be outside the acceptable range. Furthermore, for Classroom (5 Earth) and Classroom (6 Neptune), the Relative Humidity parameter was found outside the acceptable range.

From Table 24 for the location at School C, the sampling points in the Principal's Office (split air conditioning unit) and Deputy Principal 1's Office (split air conditioning unit) exceeded the acceptable limit for the CO₂ parameter. Additionally, for the sampling points in Deputy Principal 1's Office (split air conditioning unit), Teachers' Room (split air conditioning unit), Library (split air conditioning unit not in use), Computer Lab (split air conditioning unit), Classroom (few) with 16 people, Classroom (many) with 29 people, Science Lab, and Teachers' Room (Multipurpose Room) (split air conditioning unit), they the temperature parameter were outside the acceptable range.

High carbon dioxide (CO₂) readings during monitoring in schools can be caused by several factors. Here are some factors that may contribute to an increase in CO₂ levels:

a) Number of occupants

A large number of students, teachers, and staff in a confined space can lead to an increase in CO₂ levels. This is because humans exhale CO₂ during respiration.

b) Ventilation during physical activities

Engaging in physical activities that involve physical exertion and heavy breathing, such as sports, exercise, or indoor games, can also contribute to elevated CO₂ levels.

c) Use of electronic devices

The use of electronic equipment in enclosed school spaces, such as computers, projectors, tablets, and others, can raise CO₂ levels if there is insufficient ventilation.

d) Inadequate ventilation systems

The lack of or failure of ventilation systems to provide a fresh air supply from the outside into the indoor space can result in increased CO₂ levels.

e) Poorly maintained ventilation system

Ventilation systems that are not properly maintained or are malfunctioning can reduce their effectiveness, leading to an increase in CO₂ levels.

CO₂ should not exceed an acceptable limit of 1000 ppm at any given time. The acceptable limit of 1000 ppm for carbon dioxide (CO₂) as per the Indoor Air Quality Industry Code of Practice, 2010 (ICOP IAQ 2010) is a guideline set to ensure the comfort, health, and safety of individuals inside buildings. At high levels of CO₂, a person may experience discomfort, fatigue, and drowsiness. This can affect comfort and productivity in workplaces or schools.

5. Conclusion and Recommendation

5.1 Conclusion

This Position Paper on Guidelines on the Design of School Buildings for Epidemic Prevention has achieved three (3) objectives as follows.

The first objective on investigation on the design of school buildings in Malaysia for epidemic prevention was achieved. A working committee was setup and they identified many elements contributing to designing school building for epidemic prevention. However, the committee narrowed down two (2) major scope of work, which are, (i) mental health related to design of school building, and (ii) indoor air quality. Although this position paper is not a nationwide investigation, we investigated three (3) schools in Malaysia to collect data to support our initial view for this position paper. From the investigation, we found that the mental health and indoor air-quality can be further be improved, and appropriate recommendation has been made in the next section of this report.

In line with identifying the first objective, a working committee was formed to hold discussions and seek opinions among the stakeholders on two scopes of work. The stakeholders comprised The Institution of Engineers, Malaysia (IEM), Heriot-Watt University Malaysia (HWUM), Department of Safety and Health Malaysia (DOSH), Malaysian Public Works Department (JKR), Construction Industry Development Board (CIDB), and relevant members from Ministry of Economy, Ministry of Education (MoE) and Ministry of Health (MoH). The stakeholder engagement received fruitful feedback and we have considered it based on the scope of work. We thanked all the stakeholders who directly and indirectly contributed to this IEM position paper.

The final objective is to compile a report on the Position Paper on Guidelines on the Design of School Buildings for Epidemic Prevention. A research assistant from HWUM was hired to compile all investigated data in form of a position paper, and the drafted report was distributed among the stakeholders for feedback prior to the final release of the position paper report.

This concludes the IEM position paper on Guidelines on the Design of School Buildings for Epidemic Prevention. The following section discusses the recommendations from this investigation.

5.2 Recommendation

5.2.1 Mental Health

The importance of students' mental health has been widely recognised in recent times, and the design of school buildings has a significant impact on students' general well-being, especially the student's mental health. The COVID-19 pandemic has highlighted the need for schools to create a mental health-supportive atmosphere in addition to being safe from a health standpoint during the pandemic. The preliminary survey on the design of school buildings does indicate a profound impact on the mental health and well-being of students. Moreover, the consequences of the student's mental health have often been overlooked during the pandemic. As academic institutions strive to establish beneficial learning environments, it is critical to consider how architectural decisions may exacerbate or mitigate mental health problems among students, and an in-depth survey should be carried out to further establish these findings. Nonetheless, there are various recommendations to address students' mental health issues through well-considered school building design, with an emphasis on epidemic prevention strategies.

Designing flexible and inclusive spaces within school buildings is a crucial recommendation to overcome students' mental health problems (Lau et al., 2014). The American Institute of Architects also highlights the importance of these kinds of designs, realising that flexible spaces help students feel like they belong. Conventional classroom arrangements, which frequently prioritise space for health-related reasons due to the pandemic, may compromise natural interaction and teamwork, which are essential for social growth and education. It is important to create flexible and adaptive settings that can accommodate a wide range of learning demands and styles to solve this. Collaborative areas, movable furniture, and multifunctional spaces support dynamic learning environments, reducing monotony and enhancing student engagement. Unfortunately, school measures to prevent the spread of COVID-19, such as plexiglass partitions and designated areas, can exacerbate students' sense of isolation and alienation, which is especially harmful to those who already experience depression or social anxiety.

Moreover, integrating biophilic design elements into school buildings can play a pivotal role in overcoming mental health challenges (Almusaed et al., 2022). It has been demonstrated that having access to natural light, having a view of greenery, and incorporating plants and natural materials may all help students feel calmer, less stressed, and perform better cognitively (Aries et al., 2015). Biophilic design enhances students' overall well-being by giving them chances to engage with nature in the classroom. These components are necessary in creating inviting and restorative environments that improve the student's general wellbeing. Therefore, it is critical to give priority to design concepts that not only address safety issues but also create positive mental health outcomes in the context of epidemic prevention, where the focus is frequently on physical health.

Moreover, in designing schools that effectively address students' mental health concerns during epidemic prevention, the integration of outdoor spaces emerges as a critical recommendation. The therapeutic advantages of outdoor environments stressing its function in fostering children's good social interaction and overall well-being. It is crucial to include lots of green space, sports facilities, and outdoor seating in school designs as access to these areas has been linked to better mental health outcomes, with the release of endorphins during exercise contributing to stress reduction and enhanced mood. In addition to improving mental health, these outside areas provide different learning settings, which are especially helpful during times when indoor spaces may pose health risks. On the other hand, the lack of natural components like sunshine and plants can exacerbate emotions of pessimism and confinement, which can impair cognitive function and general well-being (Pérez-Urrestarazu et al., 2021). As a result, the development of warm and welcoming outdoor areas ought to be given top priority in a comprehensive approach to school building design for epidemic prevention, given its capacity to promote mental health, encourage positive social interaction, and give students essential links to the outdoors and alternative learning environments.

Furthermore, another crucial recommendation centres around the reduction of noise levels. Excessive noise in classrooms can contribute to heightened stress levels and hinder concentration, posing considerable challenges during epidemic prevention measures (Beutel et al., 2016). The use of insulated windows, strategically placed spatial planning, and sound-absorbing materials are all examples of acoustic design concepts that schools should prioritise to help minimise distractions and create a conducive atmosphere for concentration and learning. Excessive noise and a lack of sound insulation in an acoustically comfortable environment can worsen stress levels and impair cognitive function. Thermal environment is also very impactful. Cold temperatures can reduce negative mental health outcomes while hot temperatures increase them (Mullins & White, 2019). High temperatures have been associated with depression, anxiety, mood disorders, aggression and a decrease in positive mood, an increase in negative mood, and fatigue (Noelke et al., 2016). Thus, a careful approach to noise reduction and thermal environment in design becomes crucial as schools traverse the challenges of epidemic prevention, guaranteeing a supportive learning environment that protects both physical and mental well-being.

Other than that, the integration of dedicated mental health support spaces is also another very important recommendation to overcome the students' mental health problems. It is also critical to create an environment that prioritises mental health, which highlights the necessity of designated areas inside school buildings. In order to solve this, schools should set aside spaces for counselling rooms and wellness centres, giving students easily accessible, quiet settings for practising mindfulness, unwinding, and receiving expert mental health assistance (Singh et al., 2020). Especially during the pandemic, there could also be a negative impact that compartmentalised areas, such as plexiglass partitions in classrooms, might have on pupils' emotions of isolation and alienation, which is particularly harmful to those who are already struggling with depression or social anxiety (Kretchmar, 2023). These support areas should be planned and designed with an awareness of inclusion and accessibility. To make sure that

students feel supported and at ease when seeking the help they require during challenging situations, such as those challenges faced during the pandemic.

The design of school buildings plays a pivotal role in shaping the mental health of students, particularly in the context of epidemic prevention. By putting the above recommendations into practice, educational institutions may help create settings that help prioritise both physical and mental health and the well-being of students. In line with the American Institute of Architects and other research studies, thoughtful school design protects students' physical health while preventing epidemics and fosters an atmosphere that supports their emotional health. Collaboration among architects, educators, mental health professionals, and students is vital to ensure that the design is not only aesthetically pleasing but also addresses the unique needs of the school community. In conclusion, a well-designed school serves as more than simply a place for teaching; it provides a basis for the overall growth of its students, encouraging resilience and mental wellness in the face of difficulties like epidemic prevention. In conclusion, a well-designed school serves as more than simply a place for teaching; it provides a basis for the overall growth of its students, encouraging resilience and mental wellness in the face of difficulties like epidemic prevention.

5.2.2 Indoor Air Quality and Ventilation

People spend the bulk of their time inside, making indoor air the predominant pathway for exposure to airborne pollutants. Indoor air also frequently contains a variety of contaminants that come from both indoor and outdoor sources. A vulnerable individual contracts a communicable illness by airborne transmission when they breathe in enough reside pathogens to result in an infection. Particularly during the COVID crisis, the severity of the risk from aerosolised diseases has been increasingly clear. These dangers are especially high in confined structures as shown in ASHRAE Standard 241-2023 Control of Infectious Aerosol (ASHRAE, 2023). Improved ventilation can shorten exposure times and lower infectious aerosol concentrations, which is linked to lower COVID-19 incidence (Lindsley et al., 2021). The concentration of active pathogens in the air can be decreased by engineering measures such as dilution ventilation, filtration, and air disinfection, which tends to lower the risk of infection. Engineering controls are simply one component of an effective risk management strategy; they cannot completely remove risk and may not be as efficient as other risk reduction techniques. However, it has been shown that poor indoor exposure management increases danger; it's crucial to find a balance between degrees of control that increase risk and those that go beyond the threshold of diminishing returns. The design, installation, validation, operation, and maintenance of the majority of engineering controls involve technical and professional skills, indicating the need for an ecosystem and financial resources for cost-effective applications (Shen et al., 2021).

The process of delivering or removing air from an area by natural or artificial means for reasons such as controlling air pollutant levels is known as ventilation. It is also known as the flow of

outside air into a structure per unit of time is referred to as the ventilation rate. Its principal function is to dilute and displace polluted air in an area by replacing/mixing it with cleaner or uncontaminated air, which is closely connected and related to space air distribution. After effective source control, ventilation is used to dilute indoor contaminants with clean outdoor air. There is a connection between treated outside air ventilation rates and indoor air quality, including lower sick building syndrome symptom incidence and absenteeism, as well as improved task and learning performance (Sundell et al., 2011). Higher ventilation rates are associated with a lower incidence of airborne diseases. In addition to using ventilation to enhance IAQ, contaminated ambient surroundings should also aim to reduce the input of pollutants from the outside (Singer et al., 2017). Buildings that are naturally ventilated rather than mechanically ventilated are ubiquitous throughout much of the world. In these structures, a "push-pull" strategy with features designed to introduce outside air while also encouraging the evacuation of polluted air (Gilkeson et al., 2013). Natural ventilation also has a low carbon footprint. However, they are difficult to precisely manage, do not allow for temperature or humidity control, and do not filter entering air. Increased ventilation and the accompanying methods outlined here are linked to a lower risk of airborne illness, according to strong indirect evidence (Li et al., 2007). With proper ventilation systems installed, help to provide indoor filtration and protective airflow. Ventilation reduces danger, but further research is needed to determine the bare minimum ventilation needed to reduce the risk of infectious aerosols. Improved ventilation is very beneficial, for example, and has been associated with improved respiratory health, such as allergy symptoms, higher student achievement, and lower student absenteeism (Fisk, 2017).

Other than that filtration technique can also be used to remove particles from the air inside a room or from the air being circulated by centralised or distributed HVAC system components. The majority of mechanical filters used in HVAC applications are constructed of fibres that primarily employ diffusion to catch tiny particles and interception and impaction to capture bigger particles. Filtration can be used to reduce the danger from infectious aerosols while avoiding a significant increase in the quantity of cooling energy, since it is a system created to allow the recirculation of previously cooled air, as shown in The ASHRAE Position Document on Infectious Aerosols (ASHRAE, 2020). Moving air through a filter presents resistance, in comparison to moving unfiltered air, more fan energy is needed. It has been shown that filtering successfully eliminates particles that could be contagious (Bueno de Mesquita et al., 2022). A system's ducts or a space with a recirculating system can both be used for filtering. The body of research supporting the efficacy of filtration for recirculated air is comparatively strong (Bueno de Mesquita et al., 2022). The ASHRAE Position Document on Filtration and Air Cleaning (ASHRAE, 2018b) and the U.S. Environmental Protection Agency's Guide to Air Cleaners in the (Walker & Sherman, 2013) both address many important issues related to filtration and air cleaning. The implementation of higher-grade MERV filters and cleaners with HEPA filter can cause drastic improvements towards the IAQ during the pandemic. The filtration approach is unusual in that schools may buy portable air cleaners equipped with HEPA filters and deliberately place them in otherwise poorly ventilated or under-ventilated classrooms. They can also be used in high-risk situations. The use of high-efficiency air filters can dramatically lower the concentration of infectious agent-carrying particles. Particle filters

have been found to lower indoor airborne particle concentrations, and some empirical data suggests that using them may improve health. According to the Environmental Protection Agency (EPA), filters with a Minimum Efficiency Reporting Value (MERV) grade of 13 or above are highly recommended for schools. Although there is little empirical information on the effects of several sorbent air cleaners on human health, it has been demonstrated that they can lower gaseous pollutant concentrations successfully. The filtration system will mainly filter the contaminants in the air and supply clean air back to the space. It is important to pay attention to the fresh air/outdoor air supply as the CO₂ will increase if there is no sufficient outdoor air supply.

Other airborne microorganism inactivating methods exist in addition to ventilation and filtration, such as ultraviolet germicidal irradiation (UVGI). Ozone is the primary by-product that electronic air cleaners are concerned about, and it may be created by corona discharge and some UV light wavelengths. ASHRAE Position Document on Filtration and Air Cleaning (ASHRAE, 2018b) addresses ozone production. It indicates that ozone-based air cleaners shouldn't be utilized and that if air cleaners release ozone as a by-product, extra caution should be taken in which this concern have been further reflected in ASHRAE Standard 62.1 (ASHRAE,2019b)which requires that all electronic air cleaners pass the UL 2998 standard, which requires no more than five ppb ozone concentration in the emission of an air cleaner (UL, 2020). When reactive species air cleaners are utilised, numerous chemical pollutants and aerosols are produced. Ions, hydrogen peroxide and other chemicals are also reactive species that can also be potentially hazardous (Collins & Farmer, 2021). Germicidal UV can also be used, and the most commonly used germicidal wavelength is 245nm. However, the occupant's exposure to UV-C that is produced by mercury vapor or amalgam lamps poses a high risk in terms of the occupant's safety. Nevertheless, Germicidal UV is effective for airstream disinfection in HVAC systems and closed air cleaners (ASHRAE, 2019a). By concurrently preventing microbial development on cooling coils, airstream disinfection systems placed in air handling units can save maintenance costs and energy consumption (Bahnfleth, 2017). With the germicidal UV source technologies, it helps sanitise surfaces and the air to prevent the spread of airborne and fomite diseases.

Moreover, when it comes to the design and operation of HVAC systems, there are several variables that can affect the airflow patterns in interior areas and the efficiency of ventilation in such spaces. To reduce the transmission of airborne infections and allergies, high-efficiency particulate air (HEPA) filters and ultraviolet germicidal irradiation (UVGI) devices are increasingly being integrated into HVAC systems. The number, location, and type of supply diffusers in the space, supply airflow rates, air change rates, and associated diffuser throws, supply air temperature, the number, size, and locations of return/exhaust grilles, the location and strengths of various heat sources in a room, the arrangement of furniture and other obstructions to airflow, and the location, type, and capacity of heat sources can all affect the flow path of airborne contaminants and the risk of infection (ASHRAE, 2020.). Air supply diffusers and exhaust grilles can be strategically chosen and arranged to create aerodynamic

containment zones of the interior airflow patterns that can assist lower the risk of pollutant exposure in indoor environments (Khankari, 2021).

Other than that, there are also a few proposed improvement suggestions that are practical steps to enhance indoor air quality in schools. Here are some recommended suggestions from DOSH, through the Chemical Management Division (BPKimia):

- a) Ensure the full utilisation of existing exhaust fan facilities to maximise air circulation in a room/location, while maintaining CO₂ levels below 1000 ppm and other physical parameter readings within the specified range.
- b) Schools are also advised to regularly conduct periodic maintenance of the split air-conditioning system and record physical parameter readings each time after servicing is completed. This is to monitor physical parameter readings on a monthly basis. Regular FCU maintenance will ensure that it can maintain physical parameter readings within the specified range.
- c) Ensure that all workplaces in schools equipped with air conditioning systems comply with the ICOP IAQ 2010 to ensure indoor air quality is adhered to.
- d) It is recommended that the Ministry of Education Malaysia include requirements for compliance with the JKR Standard on Indoor Environmental Quality (IEQ) for Office Buildings (JKR/ SIRIM 4: 2021) for the construction of new schools in the future.

In conclusion, recognising the crucial relevance of indoor air quality (IAQ) plays a very important factor, numerous regulatory authorities and organisations have set rules and regulations to protect occupants in indoor spaces, including schools. Indoor Air Quality (IAQ) plays a crucial role in determining the well-being and health of individuals in enclosed spaces. In Malaysia, initiatives to ensure high-quality indoor air have been introduced through the implementation of the Industry Code of Practice (ICOP) of Indoor Air Quality in 2010. This ICOP encompasses a series of guidance and procedures to ensure that buildings and indoor spaces meet the established health standards. The 2010 Indoor Air Quality ICOP set comprehensive standards with the purpose of improving indoor air quality in Malaysian workplaces. This comprises the monitoring and supervision of various critical areas such as optimal ventilation, temperature and humidity regulation, the reduction of indoor pollution sources, and the management of smoking-related hazards. Many other established organizations such as the Environmental Protection Agency (EPA) and ASHRAE, have produced detailed recommendations for IAQ management in educational environments. The newly released ASHRAE Standard 241, Control of Infectious Aerosols, could be used as the reference, especially for newly built buildings to establish the minimum requirements aimed at reducing the risk of disease transmission through exposure to infectious aerosols. These recommendations cover topics including ventilation rates, filtration systems, and maintenance procedures. Compliance with these criteria not only protects occupants' health and well-being, but also fosters an environment favourable to successful teaching and learning.

Overall, a summary from DOSH stated that the condition of the Split Air Conditioning units/FCUs is good in all locations. However, attention should be given to the use of fans/exhaust and the intake of fresh air in the Split Air Conditioning Unit/FCU system to enhance ventilation and air quality in the rooms. Referring to the overall results as shown in Table 10, Table 17 and Table 24. There are several sampling points that are outside the acceptable range for temperature and relative humidity parameters and exceed the acceptable limit for CO₂.

Therefore, improvement measures may need to be taken to ensure more consistent indoor air quality across all locations. Schools are advised to monitor physical parameter readings on a monthly basis, and it is recommended that the school conduct regular maintenance for each FCU (Fan Coil Unit) in use and record each monthly reading after servicing. This approach will help address issues related to indoor air quality (IAQ) and successfully achieve its objectives.

The results will serve as a solid foundation for preparing "The Position Paper on Safe @ Schools" related to the design of school buildings that can be equipped with MVAC (Mechanical Ventilation and Air Conditioning) systems or split air conditioning units. Improvement and enhancement measures can be proposed based on these results to ensure better indoor air quality in schools in the future. This proactive approach to addressing indoor air quality issues in educational institutions can contribute to the well-being and health of students, teachers, and staff.

5.2.3 Other Recommendations

5.2.3.1 *Thermal (indoor temperature)*

When tackling the crucial problem of epidemic prevention in educational environments, especially in Malaysia, creative design approaches that improve thermal conditions are essential to promoting a healthier interior environment. The term thermal health refers to the impacts of thermal conditions on performance, cognitive function, and overall health that go beyond just “comfort” (Health, 2017). When temperatures are too warm, teachers and students are, in general, slower to react and process information from their surroundings (Amasuomo & Amasuomo, 2016). Given Malaysia's tropical environment, which may see high temperatures and high levels of humidity, school buildings should be designed with efficient ventilation systems and thoughtful window placement to promote natural circulation. Incorporating energy-efficient materials that provide insulation against heat, while also allowing for adequate sunlight, can contribute to maintaining a comfortable indoor temperature. Furthermore, by utilising smart building technologies like temperature control systems, it is possible to further optimise thermal conditions and create a setting that is beneficial for learning as well as health. With the current global health concerns, including sustainable and flexible design elements into

school buildings not only improves thermal comfort but also fits in with long-term plans for preventing epidemics, protecting the health of both teachers and students. In conclusion, developing robust and health-conscious learning environments in Malaysia requires a comprehensive approach to school building design that prioritises thermal issues.

5.2.3.2 *Lightings*

In the pursuit of creating conducive learning environments that prioritise both student well-being and epidemic prevention, the design of school buildings in Malaysia should emphasise strategic lighting solutions. With the development of new lighting technology and modifications to the location and size of windows, illumination has changed over time, impacting the classroom's internal light quality. Sufficient sunlight is essential for maintaining students' physical and emotional well-being in addition to improving the overall ambience of the classroom. The use of skylights and larger windows is also important as it helps to optimise the amount of natural daylight into the classroom, which also minimises the need for artificial lighting. This supports circadian rhythm regulation in addition to energy efficiency, thus positively influencing students' concentration and mood. According to the Illuminating Engineering Society, 350 lux is recommended for normal-sized font and 500 lux for 9-point font or less (Health, 2017). Additionally, the use of energy-efficient LED lighting systems with adjustable brightness can provide flexibility in creating different atmospheres within the school space. Light-emitting diodes (LEDs), which produce very little heat and have the potential to save a substantial amount of money, are becoming widely used in the quest for greater energy efficiency. Window coverings, like blinds or curtains, are adaptable ways to improve thermal comfort and reduce glare from direct sunshine, but they also block out daylight and can increase energy consumption from the use of artificial lights (Zomorodian et al., 2016). The human eye has evolved to be attuned to light that peaks in the blue spectrum (such as the midday sun), meaning that electrical light sources with a similar colour temperature can also stimulate the body's circadian system. Unlike the visual system, the circadian system is stimulated by higher degrees of illuminance, and its spectral sensitivity peaks at shorter light wavelengths such as blue spectrum (Lockley, 2009). A well-lit environment is crucial for upholding cleanliness standards and enabling visibility for appropriate hygiene procedures as part of epidemic control efforts.

5.2.3.3 *Water Quality*

Other than that, water quality also plays a crucial role in the design of school buildings. Designing school facilities with access to clean, safe water in mind is crucial, particularly considering Malaysia's efforts to prevent epidemics. To maintain high standards for water quality, it is imperative that modern and efficient water filtration and purification systems are integrated into the infrastructure of schools, as it is vital for eliminating waterborne pathogens. Properly designed plumbing systems and regular maintenance protocols should be implemented to prevent waterborne diseases and contamination. Hygienic behaviours are reinforced by easily accessible soap and sanitiser dispensers and conspicuously visible signage

urging children and staff to wash their hands often. Additionally, schools must provide conveniently accessible, well-maintained handwashing areas with automated soap dispensers, considering the significance of hand cleanliness in the prevention of the spreading of the viruses. The schools should also ensure that there is a regular cleaning of common touch items in the schools. To further improve health safety, ultraviolet (UV) light disinfection systems may be integrated into water tanks and distribution lines. This method eliminates hazardous bacteria and viruses without the use of chemicals. The design should prioritise the placement of these facilities in strategic locations throughout the school premises, promoting consistent and effective hand hygiene practices among students and staff. For unoccupied places in the school buildings, water systems should be flushed for a minimum period of five minutes with all the branches of piping opened simultaneously to remove potential contaminants from the stagnant equipment, piping, fixtures, or others. Rainwater harvesting systems can be incorporated to supplement the water supply, promoting sustainability and reducing reliance on external sources.

5.2.3.4 Automation

Considering the ongoing global challenges posed by epidemics, integrating automation and technology into the design of school buildings in Malaysia becomes a critical component for ensuring the safety and well-being of students, teachers and staff. By lowering the number of physical contact points and promoting touchless interactions, smart building technology can significantly lower the risk of disease transmission. Schools should use touchless entry systems using facial recognition or RFID cards that can minimise physical contact at doorways. This enables swift identification and isolation of individuals exhibiting potential symptoms. Thus reduces the chance of exposure while also offering useful information for contact tracing and controlling outbreaks. Automated temperature screening systems at entrances, contactless access controls, and sensor-based lighting and ventilation systems are certain examples of essential features that can enhance both security and hygiene within the school environment. Schools should employ touchless fixtures at washbasins and water dispensing stations, not only promoting hygiene but also reducing direct contact surfaces, a valuable tool in curbing viral transmission. The integration of reliable and flexible communication technologies, including virtual collaboration tools and online learning platforms, can offer adaptability in the provision of education, ensuring continuity of the student's education, especially when there is a high transmission of the viruses. The use of technology, it encourages a dynamic and resilient educational ecology in addition to aiding in the avoidance of epidemics. For schools with lifts, schools should turn on the elevator cab (lift) ventilation fans where possible and allow the elevators to run at a higher speed to minimise the time in the elevators. Schools should also change the elevator door from normal closed to normal open, where possible. In conclusion, the thoughtful integration of automation and technology into the design of school buildings not only enhances efficiency but also positions educational institutions in Malaysia to effectively address and adapt to evolving challenges, fostering a safer and technologically advanced learning environment.

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Appendices

Appendix A

Whooley, General Anxiety Disorder-7 (GAD-7), the Patient Health Questionnaire-9 (PHQ-9) and the Depression Anxiety and Stress Scale 21 (DASS-21) survey questions used for this position paper.

1st Set of Survey

Date: _____

Whooley Survey (For Primary Schools Standard 5 & 6 Only)

Tema: Reka Bentuk Bangunan Sekolah untuk Pencegahan Epidemik

Title: Design of School Buildings for Epidemic Prevention

Penerangan Ringkas: Reka bentuk bangunan sekolah seharusnya dapat menyokong aktiviti pengajaran dan pembelajaran walaupun semasa pandemik tanpa mengganggu perjalanan akademik dan pengalaman pembelajaran pelajar. Ia juga memainkan peranan yang penting dalam mencipta persekitaran yang menyokong atau menghalang kesejahteraan psikologi, emosi, dan kesihatan mental yang secara tidak langsung mempengaruhi pencapaian akademik mereka.

Dengan mengambil kira maklumat di atas, sila jawab soal selidik ini dengan jujur kerana penghasilan reka bentuk bangunan sekolah yang baik dapat meningkatkan kesihatan mental manakala bangunan yang direka dengan kurang baik boleh menyebabkan ketidakselesaan, tekanan, dan memburukkan lagi keadaan kesihatan mental yang sedia ada.

Short Description: The design of school buildings should be able to support teaching and learning activities even during the pandemic without interrupting the student's academic journey and learning experiences. It also plays a vital role in creating an environment that either supports or hinders their psychological well-being, emotional, and mental health, which indirectly impacts their academic performance.

With regards to the information above, please answer the survey truthfully because a thoughtfully designed school building can promote mental well-being, while poorly designed buildings can lead to discomfort, stress, and even exacerbate existing mental health conditions.

1)Apakah jantina anda?

What gender are you?

Lelaki
Boy

☐

Perempuan
Girl

☐

2)Apakah tahun anda belajar sekarang?

What standard are you studying in now?

Tahun 5
Standard 5

☐

Tahun 6
Standard 6

☐

3)

Dalam sebulan yang lepas, adakah anda terganggu oleh masalah berikut? <i>Over the past one month, have you been bothered by the following problems?</i>			
ARAHAN: Sila tanda “√” untuk menyatakan jawapan anda		Ya/Yes	Tidak/No
1.	Merasa murung, sedih atau tiada harapan? <i>Feeling down, depressed or hopeless?</i>		
2.	Kurang minat atau keseronokan dalam melakukan kerja- kerja? <i>Having little interest or pleasure in doing things?</i>		

Date: _____

2nd Set of Survey**General Anxiety Disorder (Gad-7) & Patient Health Questionnaire-9 (PHQ-9) (For Secondary Schools Only)**

Tema: Reka Bentuk Bangunan Sekolah untuk Pencegahan Epidemik

Title: Design of School Buildings for Epidemic Prevention

Penerangan Ringkas: Reka bentuk bangunan sekolah seharusnya dapat menyokong aktiviti pengajaran dan pembelajaran walaupun semasa pandemik tanpa mengganggu perjalanan akademik dan pengalaman pembelajaran pelajar. Ia juga memainkan peranan yang penting dalam mencipta persekitaran yang menyokong atau menghalang kesejahteraan psikologi, emosi, dan kesihatan mental yang secara tidak langsung mempengaruhi pencapaian akademik mereka.

Dengan mengambil kira maklumat di atas, sila jawab soal selidik ini dengan jujur kerana penghasilan reka bentuk bangunan sekolah yang baik dapat meningkatkan kesihatan mental manakala bangunan yang direka dengan kurang baik boleh menyebabkan ketidakselesaan, tekanan, dan memburukkan lagi keadaan kesihatan mental yang sedia ada.

Short Description: The design of school buildings should be able to support teaching and learning activities even during the pandemic without interrupting the student's academic journey and learning experiences. It also plays a vital role in creating an environment that either supports or hinders their psychological well-being, emotional, and mental health, which indirectly impacts their academic performance.

With regards to the information above, please answer the survey truthfully because a thoughtfully designed school building can promote mental well-being, while poorly designed buildings can lead to discomfort, stress, and even exacerbate existing mental health conditions.

1) Apakah jantina anda?

*What gender are you?*Lelaki
Boy☐Perempuan
Girl☐

2)Apakah tingkatan yang anda belajar sekarang?

*What form are you studying in now?*Tingkatan 1
Form 1☐Tingkatan 2
Form 2☐Tingkatan 3
Form 3☐

Tingkatan 4

☐Tingkatan 5
Form 5☐

Form 4

3)

SOAL SELIDIK GANGGUAN KEBIMBANGAN UMUM (GAD-7)							
ARAHAN: Sila tanda “√” untuk menyatakan jawapan anda							
Dalam tempoh 2 minggu yang lepas, berapa kerap anda terganggu oleh masalah berikut? <i>Over the last 2 weeks, how often have you been bothered by any of the following problems?</i>							
0		1		2		3	
Tidak pernah sama sekali <i>Not at all</i>		Beberapa hari <i>Several days</i>		Lebih dari seminggu <i>More than half of the week</i>		Hampir setiap hari <i>Nearly everyday</i>	
No.				0	1	2	3
1.	Berasa resah, gelisah atau tegang. <i>Feeling nervous, anxious, or on edge.</i>						
2.	Tidak dapat menghentikan atau mengawal kebimbangan <i>Not being able to stop or control worrying.</i>						
3.	Terlalu bimbang mengenai pelbagai perkara yang berlainan. <i>Worrying too much about different things.</i>						
4.	Mempunyai masalah untuk bertenang. <i>Having trouble relaxing.</i>						
5.	Terlalu resah sehingga susah untuk berdiam diri. <i>Being so restless that it is hard to sit still.</i>						
6.	Mudah menjadi rimas dan menjengkelkan. <i>Being easily annoyed or irritable.</i>						
7.	Berasa takut bahawa sesuatu yang buruk akan terjadi. <i>Feeling afraid as if something awful might happen.</i>						

4)

SOAL SELIDIK KESIHATAN PESAKIT (PHQ-9)							
ARAHAN: Sila tanda “√” untuk menyatakan jawapan anda							
Dalam tempoh 2 minggu yang lepas, berapa kerap anda terganggu oleh masalah berikut? <i>Over the last 2 weeks, how often have you been bothered by any of the following problems?</i>							
0		1		2		3	
Tidak pernah sama sekali <i>Not at all</i>		Beberapa hari <i>Several days</i>		Lebih dari seminggu <i>More than half of the week</i>		Hampir setiap hari <i>Nearly everyday</i>	
No.				0	1	2	3
1.	Sedikit minat atau keseronokan dalam melakukan kerja-kerja. <i>Little interest or pleasure in doing things.</i>						
2.	Merasa murung, sedih atau tiada harapan. <i>Feeling down, depressed or hopeless.</i>						
3.	Masalah hendak tidur / semasa tidur, tidur terlalu banyak. <i>Trouble falling asleep/ staying asleep, sleeping too much.</i>						
4.	Merasa letih atau kurang bertenaga. <i>Feeling tired or having little energy.</i>						
5.	Kurang selera atau terlalu banyak makan. <i>Poor appetite or overeating.</i>						
6.	Mempunyai perasaan buruk terhadap diri sendiri – ataupun merasa gagal terhadap diri sendiri ataupun menghampakan diri atau keluarga. <i>Feeling bad about yourself – or that you are a failure or have let yourself or your family down.</i>						
7.	Masalah menumpukan perhatian terhadap perkara-perkara seperti membaca surat khabar atau menonton televisyen. <i>Trouble concentrating on things, such as reading the newspaper or watching television.</i>						
8.	Bergerak atau bercakap dengan terlalu lambat sehingga disedari oleh orang lain. Atau pun bertentangan – terlalu resah atau gelisah sehingga anda bergerak lebih dari biasa.						

	<i>Moving or speaking so slowly that other people could have noticed. Or the opposite – being so fidgety or restless that you have been moving around a lot more than usual.</i>				
9.	Berfikiran bahawa lebih elok jika anda telah mati atau ingin mencederakan diri anda dalam sesuatu cara. <i>Thoughts that you would be better off dead or of hurting yourself in some way.</i>				

Date: _____

3rd Set of Survey

DASS-21 Survey (For All School Teachers & Staff)

Tema: Reka Bentuk Bangunan Sekolah untuk Pencegahan Epidemik

Title: Design of School Buildings for Epidemic Prevention

Penerangan Ringkas: Reka bentuk bangunan sekolah seharusnya dapat menyokong aktiviti pengajaran dan pembelajaran walaupun semasa pandemik tanpa mengganggu perjalanan akademik dan pengalaman pembelajaran pelajar. Ia juga memainkan peranan yang penting dalam mencipta persekitaran yang menyokong atau menghalang kesejahteraan psikologi, emosi, dan kesihatan mental yang secara tidak langsung mempengaruhi pencapaian akademik mereka.

Dengan mengambil kira maklumat di atas, sila jawab soal selidik ini dengan jujur kerana penghasilan reka bentuk bangunan sekolah yang baik dapat meningkatkan kesihatan mental manakala bangunan yang direka dengan kurang baik boleh menyebabkan ketidakselesaan, tekanan, dan memburukkan lagi keadaan kesihatan mental yang sedia ada.

Short Description: The design of school buildings should be able to support teaching and learning activities even during the pandemic without interrupting the student's academic journey and learning experiences. It also plays a vital role in creating an environment that either supports or hinders their psychological well-being, emotional, and mental health, which indirectly impacts their academic performance.

With regards to the information above, please answer the survey truthfully because a thoughtfully designed school building can promote mental well-being, while poorly designed buildings can lead to discomfort, stress, and even exacerbate existing mental health conditions.

1)Apakah jantina anda?

What gender are you?

Lelaki
Boy

☐

Perempuan
Girl

☐

2)

SOAL SELIDIK (DASS-21)							
ARAHAN: Sila tanda “√” untuk menyatakan jawapan anda menggambarkan keadaan anda sepanjang minggu yang lalu INSTRUCTION : Please mark “√” to state which indicates how much the statement applied to you over the past week							
0		1		2		3	
Tidak langsung menggambarkan keadaan saya <i>Did not apply to me at all</i>		Sedikit atau jarang-jarang menggambarkan keadaan saya <i>Applied to me to some degree, or some of the time</i>		Banyak atau kerap kali menggambarkan keadaan saya <i>Applied to me a considerable degree, or a good part of time</i>		Sangat banyak atau sangat kerap menggambarkan keadaan saya <i>Applied to me very much, or most of the time</i>	
No.				0	1	2	3
1.	Saya dapati diri saya sukar ditenteramkan. <i>I found it hard to wind down.</i>						
2.	Saya sedar mulut saya terasa kering. <i>I was aware of dryness of my mouth.</i>						
3.	Saya tidak dapat mengalami perasaan positif sama sekali. <i>I couldn't seem to experience any positive feeling at all.</i>						
4.	Saya mengalami kesukaran bernafas (contohnya pernafasan yang laju, tercungap-cungap walaupun tidak melakukan senaman fizikal). <i>I experienced breathing difficulty (e.g. excessively rapid breathing, breathlessness in the absence of physical exertion).</i>						
5.	Saya sukar untuk mendapatkan semangat bagi melakukan sesuatu perkara. <i>I found it difficult to work up the initiative to do things.</i>						

	Saya cenderung untuk bertindak keterlaluan dalam sesuatu keadaan.				
6.	<i>I tended to over-react to situations.</i>				
	Saya rasa menggeletar (contohnya pada tangan).				
7.	<i>I experienced trembling (e.g. in the hands).</i>				
	Saya rasa saya menggunakan banyak tenaga dalam keadaan cemas.				
8.	<i>I felt that I was using a lot of nervous energy.</i>				
	Saya bimbang keadaan di mana saya mungkin menjadi panik dan melakukan perkara yang membodohkan diri sendiri.				
9.	<i>I was worried about situations in which I might panic and make a fool of myself.</i>				
	Saya rasa saya tidak mempunyai apa-apa untuk diharapkan.				
10.	<i>I felt that I had nothing to look forward to.</i>				
	Saya dapati diri saya semakin gelisah.				
11.	<i>I found myself getting agitated.</i>				
	Saya rasa sukar untuk relaks.				
12.	<i>I found it difficult to relax.</i>				
	Saya rasa sedih dan murung.				
13.	<i>I felt down-hearted and blue.</i>				
	Saya tidak dapat menahan sabar dengan perkara yang menghalang saya meneruskan apa yang saya lakukan.				
14.	<i>I was intolerant of anything that kept me from getting on with what I was doing.</i>				
	Saya rasa hampir-hampir menjadi panik/cemas.				
15.	<i>I felt I was close to panic.</i>				
	Saya tidak bersemangat dengan apa jua yang saya lakukan.				
16.	<i>I was unable to become enthusiastic about anything</i>				
	Saya rasa tidak begitu berharga sebagai seorang individu.				
17.	<i>I felt I wasn't worth much as a person.</i>				
	Saya rasa yang saya mudah tersentuh.				
18.	<i>I felt that I was rather touchy.</i>				

19.	Saya sedar tindakbalas jantung saya walaupun tidak melakukan aktiviti fizikal (contohnya kadar denyutan jantung bertambah, atau denyutan jantung berkurangan). <i>I was aware of the action of my heart in the absence of physical exertion (e.g. sense of heart rate increase, heart missing a beat).</i>				
20.	Saya berasa takut tanpa sebab yang munasabah. <i>I felt scared without any good reason.</i>				
21.	Saya rasa hidup ini tidak bermakna. <i>I felt that life was meaningless.</i>				

Masukkan skala markah jawapan bagi soalan di atas bagi setiap kategori.
 Enter the answer scale for the questions above for each category.

STRES (STRESS)								
Soalan	S1	S6	S8	S11	S12	S14	S18	Jumlah
Markah								

ANZIETI (ANXIETY)								
Soalan	S2	S4	S7	S9	S15	S19	S20	Jumlah
Markah								

KEMURUNGAN (DEPRESSION)								
Soalan	S3	S5	S10	S13	S16	S17	S21	Jumlah
Markah								

Appendix B

Whooley mental health survey data obtained from School A

Year	Standard 5					
Gender	Male	% Male	Female	% Female	Total	% Total
0-2 (Not at Risk)	55.00	80.88	69.00	73.40	124.00	76.54
3-6 (At Risk)	13.00	19.12	25.00	26.60	38.00	23.46
Total Respondents	68.00	83.95	94.00	84.68	162.00	84.38
Total Students	81.00	42.19	111.00	57.81	192.00	100.00

Year	Standard 6					
Gender	Male	% Male	Female	% Female	Total	% Total
0-2 (Not at Risk)	61.00	78.21	59.00	70.24	120.00	74.07
3-6 (At Risk)	17.00	21.79	25.00	29.76	42.00	25.93
Total Respondents	78.00	85.71	84.00	84.00	162.00	84.82
Total Students	91.00	47.64	100.00	52.36	191.00	100.00

Year	Combination					
Gender	Male	% Male	Female	% Female	Total	% Total
0-2 (Not at Risk)	116.00	79.45	128.00	71.91	244.00	75.31
3-6 (At Risk)	30.00	20.55	50.00	28.09	80.00	24.69
Total Respondents	146.00	84.88	178.00	84.36	324.00	84.60
Total Students	172.00	44.91	211.00	55.09	383.00	100.00

Appendix C

DASS-21 mental health survey data obtained from School B

Year	Depression					
Gender	Male	% Male	Female	% Female	Total	% Total
0-4 (Minimal)	7.00	53.85	40.00	83.33	47.00	77.05
5-9 (Mild)	4.00	30.77	8.00	16.67	12.00	19.67
10-14 (Moderate)	2.00	15.38	0.00	0.00	2.00	3.28
15-19 (Moderately Severe)	0.00	0.00	0.00	0.00	0.00	0.00
20-27 (Severe)	0.00	0.00	0.00	0.00	0.00	0.00
Total Respondents	13.00	72.22	48.00	70.59	61.00	70.93
Total Teachers and Staff	18.00	20.93	68.00	79.07	86.00	100.00
Year	Anxiety					
Gender	Male	% Male	Female	% Female	Total	% Total
0-4 (Minimal)	7.00	53.85	30.00	62.50	37.00	60.66
5-9 (Mild)	4.00	30.77	16.00	33.33	20.00	32.79
10-14 (Moderate)	0.00	0.00	2.00	4.17	2.00	3.28
15-19 (Moderately Severe)	2.00	15.38	0.00	0.00	2.00	3.28
20-27 (Severe)	0.00	0.00	0.00	0.00	0.00	0.00
Total Respondents	13.00	72.22	48.00	70.59	61.00	70.93
Total Teachers and Staff	18.00	20.93	68.00	79.07	86.00	100.00
Year	Stress					
Gender	Male	% Male	Female	% Female	Total	% Total
0-4 (Minimal)	5.00	38.46	30.00	62.50	35.00	57.38
5-9 (Mild)	5.00	38.46	18.00	37.50	23.00	37.70
10-14 (Moderate)	3.00	23.08	0.00	0.00	3.00	4.92
15-19 (Moderately Severe)	0.00	0.00	0.00	0.00	0.00	0.00
20-27 (Severe)	0.00	0.00	0.00	0.00	0.00	0.00
Total Respondents	13.00	72.22	48.00	70.59	61.00	70.93
Total Teachers and Staff	18.00	20.93	68.00	79.07	86.00	100.00

Appendix D

GAD-7 mental health survey data obtained from School A

Year	Form 1							Year	Form 4					
Gender	Male	% Male	Female	% Female	Total	% Total		Gender	Male	% Male	Female	% Female	Total	% Total
0-4 (Minimal)	133.00	71.12	112.00	58.33	245.00	64.64		0-4 (Minimal)	49.00	61.25	24.00	25.00	73.00	41.48
5-9 (Mild)	43.00	22.99	49.00	25.52	92.00	24.27		5-9 (Mild)	24.00	30.00	38.00	39.58	62.00	35.23
10-14 (Moderate)	9.00	4.81	20.00	10.42	29.00	7.65		10-14 (Moderate)	5.00	6.25	26.00	27.08	31.00	17.61
15-21 (Severe)	2.00	1.07	11.00	5.73	13.00	3.43		15-21 (Severe)	2.00	2.50	8.00	8.33	10.00	5.68
Total Respondents	187.00	86.18	192.00	87.27	379.00	86.73		Total Respondents	80.00	78.43	96.00	88.07	176.00	83.41
Total Students	217.00	49.66	220.00	50.34	437.00	100.00		Total Students	102.00	48.31	109.00	51.66	211.00	100.00
Year	Form 2							Year	Form 5					
Gender	Male	% Male	Female	% Female	Total	% Total		Gender	Male	% Male	Female	% Female	Total	% Total
0-4 (Minimal)	114.00	78.08	68.00	46.90	182.00	62.54		0-4 (Minimal)	52.00	55.91	23.00	29.11	75.00	43.60
5-9 (Mild)	26.00	17.81	51.00	35.17	77.00	26.46		5-9 (Mild)	37.00	39.78	27.00	34.18	64.00	37.21
10-14 (Moderate)	5.00	3.42	19.00	13.10	24.00	8.25		10-14 (Moderate)	4.00	4.30	21.00	26.58	25.00	14.53
15-21 (Severe)	1.00	0.68	7.00	4.83	8.00	2.75		15-21 (Severe)	0.00	0.00	8.00	10.13	8.00	4.65
Total Respondents	146.00	87.43	145.00	78.38	291.00	82.67		Total Respondents	93.00	94.90	79.00	94.05	172.00	94.51
Total Students	167.00	47.44	185.00	52.55	352.00	100.00		Total Students	98.00	53.85	84.00	46.15	182.00	100.00
Year	Form 3							Year	Combination of all forms					
Gender	Male	% Male	Female	% Female	Total	% Total		Gender	Male	% Male	Female	% Female	Total	% Total
0-4 (Minimal)	76.00	64.41	52.00	38.24	128.00	50.39		0-4 (Minimal)	424.00	67.95	279.00	43.06	703.00	55.27
5-9 (Mild)	33.00	27.97	49.00	36.03	82.00	32.28		5-9 (Mild)	163.00	26.12	214.00	33.02	377.00	29.64
10-14 (Moderate)	9.00	7.63	21.00	15.44	30.00	11.81		10-14 (Moderate)	32.00	5.13	107.00	16.51	139.00	10.93
15-21 (Severe)	0.00	0.00	14.00	10.29	14.00	5.51		15-21 (Severe)	5.00	0.80	48.00	7.41	53.00	4.17
Total Respondents	118.00	81.94	136.00	84.47	254.00	83.28		Total Respondents	624.00	85.71	648.00	85.38	1272.00	85.54
Total Students	144.00	47.21	161.00	52.79	305.00	100.00		Total Students	728.00	48.96	759.00	51.04	1487.00	100.00

Appendix E

PHQ-9 mental health survey data obtained from School B

Year	Form 1						Year	Form 4					
Gender	Male	% Male	Female	% Female	Total	% Total	Gender	Male	% Male	Female	% Female	Total	% Total
0-4 (Minimal)	116.00	62.03	88.00	45.83	204.00	53.83	0-4 (Minimal)	36.00	45.00	18.00	18.75	54.00	30.68
5-9 (Mild)	55.00	29.41	57.00	29.69	112.00	29.55	5-9 (Mild)	32.00	40.00	35.00	36.46	67.00	38.07
10-14 (Moderate)	11.00	5.88	30.00	15.63	41.00	10.82	10-14 (Moderate)	10.00	12.50	25.00	26.04	35.00	19.89
15-19 (Moderately Severe)	4.00	2.14	12.00	6.25	16.00	4.22	15-19 (Moderately Severe)	1.00	1.25	12.00	12.50	13.00	7.39
20-27 (Severe)	1.00	0.53	5.00	2.60	6.00	1.58	20-27 (Severe)	1.00	1.25	6.00	6.25	7.00	3.98
Total Respondents	187.00	86.18	192.00	87.27	379.00	86.73	Total Respondents	80.00	78.43	96.00	88.07	176.00	83.41
Total Students	217.00	49.66	220.00	50.34	437.00	100.00	Total Students	102.00	48.31	109.00	51.66	211.00	100.00

Year	Form 2						Year	Form 5					
Gender	Male	% Male	Female	% Female	Total	% Total	Gender	Male	% Male	Female	% Female	Total	% Total
0-4 (Minimal)	89.00	60.96	55.00	37.93	144.00	49.48	0-4 (Minimal)	30.00	32.26	24.00	30.38	54.00	31.40
5-9 (Mild)	50.00	34.25	54.00	37.24	104.00	35.74	5-9 (Mild)	46.00	49.46	18.00	22.78	64.00	37.21
10-14 (Moderate)	3.00	2.05	23.00	15.86	26.00	8.93	10-14 (Moderate)	16.00	17.20	20.00	25.32	36.00	20.93
15-19 (Moderately Severe)	3.00	2.05	10.00	6.90	13.00	4.47	15-19 (Moderately Severe)	0.00	0.00	14.00	17.72	14.00	8.14
20-27 (Severe)	1.00	0.68	3.00	2.07	4.00	1.37	20-27 (Severe)	1.00	1.08	3.00	3.80	4.00	2.33
Total Respondents	146.00	87.43	145.00	78.38	291.00	82.67	Total Respondents	93.00	94.90	79.00	94.05	172.00	94.51
Total Students	167.00	47.44	185.00	52.55	352.00	100.00	Total Students	98.00	53.85	84.00	46.15	182.00	100.00

Year	Form 3						Year	Combination of all forms					
Gender	Male	% Male	Female	% Female	Total	% Total	Gender	Male	% Male	Female	% Female	Total	% Total
0-4 (Minimal)	49.00	41.53	30.00	22.06	79.00	31.10	0-4 (Minimal)	320.00	51.28	215.00	33.18	535.00	42.06
5-9 (Mild)	47.00	39.83	53.00	38.97	100.00	39.37	5-9 (Mild)	230.00	36.86	217.00	33.49	447.00	35.14
10-14 (Moderate)	15.00	12.71	26.00	19.12	41.00	16.14	10-14 (Moderate)	55.00	8.81	124.00	19.14	179.00	14.07
15-19 (Moderately Severe)	6.00	5.08	13.00	9.56	19.00	7.48	15-19 (Moderately Severe)	14.00	2.24	61.00	9.41	75.00	5.90
20-27 (Severe)	1.00	0.85	14.00	10.29	15.00	5.91	20-27 (Severe)	5.00	0.80	31.00	4.78	36.00	2.83
Total Respondents	118.00	81.94	136.00	84.47	254.00	83.28	Total Respondents	624.00	85.71	648.00	85.38	1272.00	85.54
Total Students	144.00	47.21	161.00	52.79	305.00	100.00	Total Students	728.00	48.96	759.00	51.04	1487.00	100.00

Appendix F

DASS-21 mental health survey data obtained from School A

Year	Depression					
Gender	Male	% Male	Female	% Female	Total	% Total
0-4 (Minimal)	11.00	91.67	41.00	97.62	52.00	96.30
5-9 (Mild)	1.00	8.33	0.00	0.00	1.00	1.85
10-14 (Moderate)	0.00	0.00	1.00	2.38	1.00	1.85
15-19 (Moderately Severe)	0.00	0.00	0.00	0.00	0.00	0.00
20-27 (Severe)	0.00	0.00	0.00	0.00	0.00	0.00
Total Respondents	12.00	100.00	42.00	43.75	54.00	50.00
Total Teachers and Staff	12.00	11.11	96.00	88.89	108.00	100.00

Year	Anxiety					
Gender	Male	% Male	Female	% Female	Total	% Total
0-4 (Minimal)	9.00	75.00	35.00	83.33	44.00	81.48
5-9 (Mild)	2.00	16.67	4.00	9.52	6.00	11.11
10-14 (Moderate)	0.00	0.00	1.00	2.38	1.00	1.85
15-19 (Moderately Severe)	1.00	8.33	1.00	2.38	2.00	3.70
20-27 (Severe)	0.00	0.00	1.00	2.38	1.00	1.85
Total Respondents	12.00	100.00	42.00	43.75	54.00	50.00
Total Teachers and Staff	12.00	11.11	96.00	88.89	108.00	100.00

Year	Stress					
Gender	Male	% Male	Female	% Female	Total	% Total
0-4 (Minimal)	11.00	91.67	40.00	95.24	51.00	94.44
5-9 (Mild)	0.00	0.00	0.00	0.00	0.00	0.00
10-14 (Moderate)	1.00	8.33	2.00	4.76	3.00	5.56
15-19 (Moderately Severe)	0.00	0.00	0.00	0.00	0.00	0.00
20-27 (Severe)	0.00	0.00	0.00	0.00	0.00	0.00
Total Respondents	12.00	100.00	42.00	43.75	54.00	50.00
Total Teachers and Staff	12.00	11.11	96.00	88.89	108.00	100.00

Appendix G

GAD-7 mental health survey data obtained from School C

Year	Form 1						Year	Form 4					
Gender	Male	% Male	Female	% Female	Total	% Total	Gender	Male	% Male	Female	% Female	Total	% Total
0-4 (Minimal)	71.00	61.74	43.00	31.62	114.00	45.42	0-4 (Minimal)	46.00	58.23	19.00	26.39	65.00	43.05
5-9 (Mild)	30.00	26.09	44.00	32.35	74.00	29.48	5-9 (Mild)	27.00	34.18	31.00	43.06	58.00	38.41
10-14 (Moderate)	11.00	9.57	20.00	14.71	31.00	12.35	10-14 (Moderate)	6.00	7.59	17.00	23.61	23.00	15.23
15-21 (Severe)	3.00	2.61	29.00	21.32	32.00	12.75	15-21 (Severe)	0.00	0.00	5.00	6.94	5.00	3.31
Total Respondents	115.00	68.05	136.00	91.89	251.00	79.18	Total Respondents	79.00	78.22	72.00	69.23	151.00	73.66
Total Students	169.00	53.31	148.00	46.69	317.00	100.00	Total Students	101.00	49.27	104.00	50.73	205.00	100.00
Year	Form 2						Year	Form 5					
Gender	Male	% Male	Female	% Female	Total	% Total	Gender	Male	% Male	Female	% Female	Total	% Total
0-4 (Minimal)	99.00	58.93	46.00	32.62	145.00	46.93	0-4 (Minimal)	22.00	48.89	19.00	32.76	41.00	39.81
5-9 (Mild)	46.00	27.38	49.00	34.75	95.00	30.74	5-9 (Mild)	15.00	33.33	15.00	25.86	30.00	29.13
10-14 (Moderate)	15.00	8.93	29.00	20.57	44.00	14.24	10-14 (Moderate)	5.00	11.11	12.00	20.69	17.00	16.50
15-21 (Severe)	8.00	4.76	17.00	12.06	25.00	8.09	15-21 (Severe)	3.00	6.67	12.00	20.69	15.00	14.56
Total Respondents	168.00	86.60	141.00	89.24	309.00	87.78	Total Respondents	45.00	54.88	58.00	61.05	103.00	58.19
Total Students	194.00	55.11	158.00	44.88	352.00	100.00	Total Students	82.00	46.33	95.00	53.67	177.00	100.00
Year	Form 3						Year	Combination of all forms					
Gender	Male	% Male	Female	% Female	Total	% Total	Gender	Male	% Male	Female	% Female	Total	% Total
0-4 (Minimal)	44.00	51.76	38.00	36.54	82.00	43.39	0-4 (Minimal)	282.00	57.32	165.00	32.29	447.00	44.57
5-9 (Mild)	33.00	38.82	41.00	39.42	74.00	39.15	5-9 (Mild)	151.00	30.69	180.00	35.23	331.00	33.00
10-14 (Moderate)	7.00	8.24	15.00	14.42	22.00	11.64	10-14 (Moderate)	44.00	8.94	93.00	18.20	137.00	13.66
15-21 (Severe)	1.00	1.18	10.00	9.62	11.00	5.82	15-21 (Severe)	15.00	3.05	73.00	14.29	88.00	8.77
Total Respondents	85.00	72.65	104.00	80.62	189.00	76.83	Total Respondents	492.00	74.21	511.00	80.60	1003.00	77.33
Total Students	117.00	47.56	129.00	52.44	246.00	100.00	Total Students	663.00	51.12	634.00	48.88	1297.00	100.00

Appendix H

PHQ-9 mental health survey data obtained from School C

Year	Form 1						Year	Form 4					
Gender	Male	% Male	Female	% Female	Total	% Total	Gender	Male	% Male	Female	% Female	Total	% Total
0-4 (Minimal)	46.00	40.00	33.00	24.26	79.00	31.47	0-4 (Minimal)	38.00	48.10	11.00	15.28	49.00	32.45
5-9 (Mild)	49.00	42.61	36.00	26.47	85.00	33.86	5-9 (Mild)	32.00	40.51	20.00	27.78	52.00	34.44
10-14 (Moderate)	18.00	15.65	32.00	23.53	50.00	19.92	10-14 (Moderate)	6.00	7.59	27.00	37.50	33.00	21.85
15-19 (Moderately Severe)	1.00	0.87	19.00	13.97	20.00	7.97	15-19 (Moderately Severe)	3.00	3.80	11.00	15.28	14.00	9.27
20-27 (Severe)	1.00	0.87	16.00	11.76	17.00	6.77	20-27 (Severe)	0.00	0.00	3.00	4.17	3.00	1.99
Total Respondents	115.00	68.05	136.00	91.89	251.00	79.18	Total Respondents	79.00	78.22	72.00	69.23	151.00	73.66
Total Students	169.00	53.31	148.00	46.69	317.00	100.00	Total Students	101.00	49.27	104.00	50.73	205.00	100.00

Year	Form 2						Year	Form 5					
Gender	Male	% Male	Female	% Female	Total	% Total	Gender	Male	% Male	Female	% Female	Total	% Total
0-4 (Minimal)	74.00	44.05	37.00	26.24	111.00	35.92	0-4 (Minimal)	14.00	31.11	10.00	17.24	24.00	23.30
5-9 (Mild)	66.00	39.29	45.00	31.91	111.00	35.92	5-9 (Mild)	23.00	51.11	15.00	25.86	38.00	36.89
10-14 (Moderate)	18.00	10.71	31.00	21.99	49.00	15.86	10-14 (Moderate)	5.00	11.11	18.00	31.03	23.00	22.33
15-19 (Moderately Severe)	8.00	4.76	19.00	13.48	27.00	8.74	15-19 (Moderately Severe)	1.00	2.22	9.00	15.52	10.00	9.71
20-27 (Severe)	2.00	1.19	9.00	6.38	11.00	3.56	20-27 (Severe)	2.00	4.44	6.00	10.34	8.00	7.77
Total Respondents	168.00	86.60	141.00	89.24	309.00	87.78	Total Respondents	45.00	54.88	58.00	61.05	103.00	58.19
Total Students	194.00	55.11	158.00	44.88	352.00	100.00	Total Students	82.00	46.33	95.00	53.67	177.00	100.00

Year	Form 3						Year	Combination of all forms					
Gender	Male	% Male	Female	% Female	Total	% Total	Gender	Male	% Male	Female	% Female	Total	% Total
0-4 (Minimal)	28.00	32.94	27.00	25.96	55.00	29.10	0-4 (Minimal)	200.00	40.65	118.00	23.09	318.00	31.70
5-9 (Mild)	33.00	38.82	41.00	39.42	74.00	39.15	5-9 (Mild)	203.00	41.26	157.00	30.72	360.00	35.89
10-14 (Moderate)	24.00	28.24	17.00	16.35	41.00	21.69	10-14 (Moderate)	71.00	14.43	125.00	24.46	196.00	19.54
15-19 (Moderately Severe)	0.00	0.00	13.00	12.50	13.00	6.88	15-19 (Moderately Severe)	13.00	2.64	71.00	13.89	84.00	8.37
20-27 (Severe)	0.00	0.00	6.00	5.77	6.00	3.17	20-27 (Severe)	5.00	1.02	40.00	7.83	45.00	4.49
Total Respondents	85.00	72.65	104.00	80.62	189.00	76.83	Total Respondents	492.00	74.21	511.00	80.60	1003.00	77.33
Total Students	117.00	47.56	129.00	52.44	246.00	100.00	Total Students	663.00	51.12	634.00	48.88	1297.00	100.00

Appendix I

DASS-21 mental health survey data obtained from School C

Year	Depression					
Gender	Male	% Male	Female	% Female	Total	% Total
0-4 (Minimal)	6.00	75.00	34.00	80.95	40.00	80.00
5-9 (Mild)	2.00	25.00	8.00	19.05	10.00	20.00
10-14 (Moderate)	0.00	0.00	0.00	0.00	0.00	0.00
15-19 (Moderately Severe)	0.00	0.00	0.00	0.00	0.00	0.00
20-27 (Severe)	0.00	0.00	0.00	0.00	0.00	0.00
Total Respondents	8.00	36.36	42.00	47.19	50.00	45.05
Total Teachers and Staff	22.00	19.82	89.00	80.18	111.00	100.00

Year	Anxiety					
Gender	Male	% Male	Female	% Female	Total	% Total
0-4 (Minimal)	2.00	25.00	31.00	73.81	33.00	66.00
5-9 (Mild)	6.00	75.00	10.00	23.81	16.00	32.00
10-14 (Moderate)	0.00	0.00	1.00	2.38	1.00	2.00
15-19 (Moderately Severe)	0.00	0.00	0.00	0.00	0.00	0.00
20-27 (Severe)	0.00	0.00	0.00	0.00	0.00	0.00
Total Respondents	8.00	36.36	42.00	47.19	50.00	45.05
Total Teachers and Staff	22.00	19.82	89.00	80.18	111.00	100.00

Year	Stress					
Gender	Male	% Male	Female	% Female	Total	% Total
0-4 (Minimal)	2.00	25.00	30.00	71.43	32.00	64.00
5-9 (Mild)	4.00	50.00	9.00	21.43	13.00	26.00
10-14 (Moderate)	1.00	12.50	3.00	7.14	4.00	8.00
15-19 (Moderately Severe)	1.00	12.50	0.00	0.00	1.00	2.00
20-27 (Severe)	0.00	0.00	0.00	0.00	0.00	0.00
Total Respondents	8.00	36.36	42.00	47.19	50.00	45.05
Total Teachers and Staff	22.00	19.82	89.00	80.18	111.00	100.00

Appendix J

Compiled GAD-7 and PHQ-9 survey data from both School A and School C for Figure 15 and Figure 16 respectively

Whooley						
Year	Combination of all schools					
Gender	Male	% Male	Female	% Female	Total	% Total
0-2 (Not at Risk)	116.00	79.45	128.00	71.91	244.00	75.31
3-6 (At Risk)	30.00	20.55	50.00	28.09	80.00	24.69
Total Respondents	146.00	84.88	178.00	84.36	324.00	84.60
Total Students	172.00	44.91	211.00	55.09	383.00	100.00
GAD-7						
Year	Combination of both schools					
Gender	Male	% Male	Female	% Female	Total	% Total
0-4 (Minimal)	706.00	63.26	444.00	38.31	1150.00	50.55
5-9 (Mild)	314.00	28.14	394.00	33.99	708.00	31.12
10-14 (Moderate)	76.00	6.81	200.00	17.26	276.00	12.13
15-21 (Severe)	20.00	1.79	121.00	10.44	141.00	6.20
Total Respondents	1116.00	80.23	1159.00	83.20	2275.00	81.72
Total Students	1391.00	49.96	1393.00	50.04	2784.00	100.00
PHQ-9						
Year	Combination of both schools					
Gender	Male	% Male	Female	% Female	Total	% Total
0-4 (Minimal)	520.00	46.59	333.00	28.73	853.00	37.49
5-9 (Mild)	433.00	38.80	374.00	32.27	807.00	35.47
10-14 (Moderate)	126.00	11.29	249.00	21.48	375.00	16.48
15-19 (Moderately Severe)	27.00	2.42	132.00	11.39	159.00	6.99
20-27 (Severe)	10.00	0.90	71.00	6.13	81.00	3.56
Total Respondents	1116.00	80.23	1159.00	83.20	2275.00	81.72
Total Students	1391.00	49.96	1393.00	50.04	2784.00	100.00

Appendix K

Compiled DASS-21 data from all three schools involved in this research which are School A, School B and School C

Year	Depression					
Gender	Male	% Male	Female	% Female	Total	% Total
0-4 (Minimal)	24.00	72.73	115.00	87.12	139.00	84.24
5-9 (Mild)	7.00	21.21	16.00	12.12	23.00	13.94
10-14 (Moderate)	2.00	6.06	1.00	0.76	3.00	1.82
15-19 (Moderately Severe)	0.00	0.00	0.00	0.00	0.00	0.00
20-27 (Severe)	0.00	0.00	0.00	0.00	0.00	0.00
Total Respondents	33.00	63.46	132.00	52.17	165.00	54.10
Total Teachers and Staff	52.00	17.05	253.00	82.95	305.00	100.00

Year	Anxiety					
Gender	Male	% Male	Female	% Female	Total	% Total
0-4 (Minimal)	18.00	54.55	96.00	72.73	114.00	69.09
5-9 (Mild)	12.00	36.36	30.00	22.73	42.00	25.45
10-14 (Moderate)	0.00	0.00	4.00	3.03	4.00	2.42
15-19 (Moderately Severe)	3.00	9.09	1.00	0.76	4.00	2.42
20-27 (Severe)	0.00	0.00	1.00	0.76	1.00	0.61
Total Respondents	33.00	63.46	132.00	52.17	165.00	54.10
Total Teachers and Staff	52.00	17.05	253.00	82.95	305.00	100.00

Year	Stress					
Gender	Male	% Male	Female	% Female	Total	% Total
0-4 (Minimal)	18.00	54.55	100.00	75.76	118.00	71.52
5-9 (Mild)	9.00	27.27	27.00	20.45	36.00	21.82
10-14 (Moderate)	5.00	15.15	5.00	3.79	10.00	6.06
15-19 (Moderately Severe)	1.00	3.03	0.00	0.00	1.00	0.61
20-27 (Severe)	0.00	0.00	0.00	0.00	0.00	0.00
Total Respondents	33.00	63.46	132.00	52.17	165.00	54.10
Total Teachers and Staff	52.00	17.05	253.00	82.95	305.00	100.00

Appendix L

Whooley mental health survey data that was obtained from the government of Malaysia

Year	Year 2021-2022					
Gender	Male	% Male	Female	% Female	Total	% Total
0-2 (Not at Risk)	2621.00	81.91	2327.00	75.36	4948.00	78.69
3-6 (At Risk)	579.00	18.09	761.00	24.64	1340.00	21.31
Total Respondents	3200.00	50.89	3088.00	49.11	6288.00	100.00
Year	Year 2022-2023					
Gender	Male	% Male	Female	% Female	Total	% Total
0-2 (Not at Risk)	3355.00	93.66	3082.00	88.95	6437.00	91.34
3-6 (At Risk)	227.00	6.34	383.00	11.05	610.00	8.66
Total Respondents	3582.00	50.83	3465.00	49.17	7047.00	100.00
Year	Combination					
Gender	Male	% Male	Female	% Female	Total	% Total
0-2 (Not at Risk)	116.00	79.45	128.00	71.91	244.00	75.31
3-6 (At Risk)	30.00	20.55	50.00	28.09	80.00	24.69
Total Respondents	6782.00	50.86	6553.00	49.14	13335.00	100.00

Appendix M

GAD-7 mental health surveys results that was obtained from the government of Malaysia

Year	2021-2022					
Gender	Male	% Male	Female	% Female	Total	% Total
0-4 (Minimal)	3552.00	67.27	2298.00	48.11	5850.00	58.17
5-9 (Mild)	1215.00	23.01	1290.00	27.00	2505.00	24.91
10-14 (Moderate)	363.00	6.88	724.00	15.16	1087.00	10.81
15-21 (Severe)	150.00	2.84	465.00	9.73	615.00	6.12
Total Respondents	5280.00	52.50	4777.00	47.50	10057.00	100.00
Year	2022-2023					
Gender	Male	% Male	Female	% Female	Total	% Total
0-4 (Minimal)	3679.00	63.58	2331.00	44.07	6010.00	54.27
5-9 (Mild)	1569.00	27.12	1742.00	32.94	3311.00	29.90
10-14 (Moderate)	407.00	7.03	796.00	15.05	1203.00	10.86
15-21 (Severe)	131.00	2.26	420.00	7.94	551.00	4.98
Total Respondents	5786.00	52.24	5289.00	47.76	11075.00	100.00
Year	Combination					
Gender	Male	% Male	Female	% Female	Total	% Total
0-4 (Minimal)	7231.00	65.34	4629.00	45.99	11860.00	56.12
5-9 (Mild)	2784.00	25.16	3032.00	30.12	5816.00	27.52
10-14 (Moderate)	770.00	6.96	1520.00	15.10	2290.00	10.84
15-21 (Severe)	281.00	2.54	885.00	8.79	1166.00	5.52
Total Respondents	11066.00	52.37	10066.00	47.63	21132.00	100.00

Appendix N

PHQ-9 mental health surveys results that was obtained from the government of Malaysia

Year	2021-2022					
Gender	Male	% Male	Female	% Female	Total	% Total
0-4 (Minimal)	2206.00	41.74	1241.00	25.97	3447.00	32.59
5-9 (Mild)	2060.00	38.98	1714.00	35.87	3774.00	35.68
10-14 (Moderate)	764.00	14.46	1013.00	21.20	1777.00	16.80
15-19 (Moderately Severe)	205.00	3.88	558.00	11.68	763.00	7.21
20-27 (Severe)	50.00	0.95	252.00	5.27	302.00	2.86
Total Respondents	5285.00	52.52	4778.00	47.48	10063.00	100.00

Year	2022-2023					
Gender	Male	% Male	Female	% Female	Total	% Total
0-4 (Minimal)	2843.00	49.03	1646.00	31.12	4489.00	40.49
5-9 (Mild)	2074.00	35.77	1959.00	37.03	4033.00	36.37
10-14 (Moderate)	657.00	11.33	965.00	18.24	1622.00	14.63
15-19 (Moderately Severe)	169.00	2.91	494.00	9.34	663.00	5.98
20-27 (Severe)	55.00	0.95	226.00	4.27	281.00	2.53
Total Respondents	5798.00	52.29	5290.00	47.71	11088.00	100.00

Year	Combination					
Gender	Male	% Male	Female	% Female	Total	% Total
0-4 (Minimal)	5049.00	45.56	2887.00	28.68	7936.00	37.52
5-9 (Mild)	4134.00	37.30	3673.00	36.48	7807.00	36.91
10-14 (Moderate)	1421.00	12.82	1978.00	19.65	3399.00	16.07
15-19 (Moderately Severe)	374.00	3.37	1052.00	10.45	1426.00	6.74
20-27 (Severe)	105.00	0.95	478.00	4.75	583.00	2.76
Total Respondents	11083.00	52.40	10068.00	47.60	21151.00	100.00

Designing Resilient School Buildings: Enhancing Indoor Air Quality and Mental Health in the Post-Pandemic Era

This position paper presents key recommendations on designing resilient school environments, with a focus on improving indoor air quality and supporting mental health, in the post-pandemic era.

It provides practical guidance for policymakers, engineers, and stakeholders involved in the planning, design, and management of educational facilities, contributing towards safer, healthier, and more sustainable school buildings in Malaysia.

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