# Mental stress and sleeplessness during the COVID-19 pandemic associated with socioeconomic status, preventive behaviors, and indoor environments

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**Abstract.** The outbreak of the SARS-CoV-2 virus forced people to work from home. This study aimed to examine the relationship between residents' mental stress, indoor environment quality (IEQ), preventive behaviors, and socioeconomic status (SES) in Indonesia by using a cross-sectional study with a questionnaire survey in Indonesia. A total of 1004 valid responses were obtained during the survey during the COVID-19 pandemic period (November-December 2021). Logistic regression and odds ratio (OR) was used to evaluate the association between the possibility of mental stress and sleeplessness relying on the classified group of income, education, and age. In addition, a structural equation model (SEM) was used to analyze the inter-relationship between these characteristics and their effects on mental stress and sleeplessness as a crisis variable. The results indicate that mental stress was more inclined among low-income households during the COVID-19 pandemic than middle-up and high-income groups, with OR = 0.48 and 0.50, respectively. Moreover, the SEM suggested that SES also had significant direct effects (p-value < 0.05) on preventive behaviors (ω = 0.105), IEQ (ω =0.102), and crisis (ω = –0.237). It evidenced that the higher socioeconomic levels could have less possibility of experiencing a crisis. The findings of this study could add to practical implications that support the researchers and public policy stakeholders in mitigating the long-term effect of COVID-19 in Indonesia related to mental health and indoor environments.

*Keywords*: Mental stress, sleeplessness, SES, COVID-19 preventive behaviors, indoor environment quality

## 1 Introduction

COVID-19 pandemic has enormously impacted public health, prosperity, and socio-cultural cohesion since the first case of COVID-19 was identified in Wuhan, China, in December 2019 and announced as a global pandemic in March 2020 [1–3]. By April 2022, the number of people infected by COVID-19 exceeded 520 million and claimed nearly 6.2 million deaths worldwide [4]. Furthermore, the short-term impacts of the COVID-19 pandemic among people from developing countries were 36-65% losing their jobs and decreasing income, whereas 30% of the children could not continue learning during the school closure [5]. Particularly in Indonesia, the Ministry of Health has confirmed more than 6 million positive cases of COVID-19 by April 2022, with 155,288 death since the first case was found in March 2020 [6]. In addition, the economic growth shrunk to -2.1% in the period 2020-2021 [7], which led to one of the most severe recessions in the history of Indonesia while 1.8 million people became unemployed, and 2.8 million people fell into poverty [8].

On the other hand, during the pandemic, the circumstances arising due to the outbreak of the SARS-CoV-2 virus forced people to work from home and maintain social distancing to minimize the risks [9,10]. Given this situation, people's lifestyles have become more solitary, socially isolated, and lonely [11]. Thus, in terms of the effect on mental health and well-being, the COVID-19 pandemic has had prejudicious impacts [12]. For example, in the United States, psychological distress increased approximately three times compared to the results with national data in 2018 [13]. On the other hand, around 80% of people had mental health problems during the pandemic in developing countries due to joblessness, decreasing income, and food insecurity [14,15]. Specifically in Indonesia, the Indonesian Psychiatric Association reported that at least 69% of COVID-19 infected people suffered psychological problems including anxiety, depression, and psychological trauma during the pandemic due to a lack

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of knowledge, misinformation, and social stigma [10,16,17].

Previous works have demonstrated the association among the buildings' indoor environmental factors, occupants' mental health, and well-being [18–21]. Furthermore, due to the COVID-19 pandemic, studies on indoor environments related to occupants' mental health and productivity have significantly increased [14,22]. For instance, a questionnaire survey in the United States on 998 office workers revealed that mental distress such as anxiety was significantly correlated with satisfaction with air quality, temperature, and noise of their indoor environmental quality [23]. In addition, the study based on a national survey of 3000 Canadian adults confirmed that those who have experienced a period of COVID-19 quarantine are prone to adverse mental health impacts such as suicidal ideation and deliberate self-harm compared to individuals who have not [24]. Moreover, a study to investigate the effect of the COVID-19 on the students' mental health was performed in India when the second wave of COVID-19 occurred. The findings suggested a strong relationship between poor environmental conditions such as air quality and lack of greenery to the severity of anxiety and depressive symptoms among the students [25]. Meanwhile, in Indonesia, COVID-19 survivors were reported to be more vulnerable to mental distress when they returned to their living space and community after discharge and rehabilitation based on a cross-sectional study conducted in East Java Province from October to December 2020 [26].

Given this background, examining the causal factors between mental stress and indoor environmental quality is essential to alleviate mental stress. However, mental health studies concerning COVID-19, indoor environmental quality, and socioeconomic status are still limited, particularly in developing countries including Indonesia [27,28]. Hence, to address the research gap, this study aimed to examine the relationship between residents' mental stress, indoor environment quality, preventive behaviors, and socioeconomic status in Indonesia by using a cross-sectional study with a questionnaire survey.

## 2 Methods

### 2.1 Study design

This cross-sectional study was performed by using an online questionnaire survey in Indonesia. The survey was conducted between November 1 to December 1, 2020. In this survey, the primary outcome of interest was the respondent's stress which is assessed by the questions: "How frequently have you felt mental stress while maintaining the health protocol during the pandemic?" and "How frequently have you experienced sleeplessness during the pandemic?", the participants answered these questions by selecting one option from "never", "sometimes", or "always." Furthermore, several questions pertained to demographic factors such as age, gender, household income, job type, and the district where the respondents live. The survey also

**Table 1.** The questionnaire details

| Variables | No | Questions | Measures |
|---|---|---|---|
| Socio-demographic status | 1 | What is your gender? | 1) Male; 2) Female |
| | 2 | How old are you by 2020? | 1) Less than 25; 2) Between 26 and 40; 3) More than 40 |
| | 3 | What type of area/district do you live currently? | 1) Rural; 2) Sub-urban; 3) Urban |
| | 4 | How much is your monthly household income? | 1) Less than 140 USD (Low); 2) Between 141 and 348 USD (Low-middle); 3) Between 349 and 557 USD (Middle-up); 4) More than 557 USD (High) |
| | 5 | What is your highest education level? | 1) High school or lower; 2) College; 3) Bachelor; 4) Master; 5) Ph.D |
| Crisis | 6 | Have you felt a mental stress while maintaining the health protocol during the pandemic? | 1) Never; 2) Sometimes; 3) Always |
| | 7 | Have you experienced sleeplessness during the pandemic? | 1) Never; 2) Sometimes; 3) Always |
| Indoor Environments | 8 | How do you evaluate the quality of indoor environments of your living space? | 1) Poor; 2) Not too good; 3) Good; 4) Very good |
| | 9 | How do you evaluate the air quality of your indoor environments? | 1) Poor; 2) Not too good; 3) Good; 4) Very good |
| | 10 | How do you evaluate the air ventilation effectiveness of your house? | 1) Poor; 2) Not too good; 3) Good; 4) Very good |
| COVID-19 preventive behaviors | 11 | How often do you clean your hands and use hand sanitizer? | 1) Never; 2) Almost never; 3) Sometimes; 4) Fairly often; 5) Always |
| | 12 | How often do you wear a mask? | 1) Never; 2) Almost never; 3) Sometimes; 4) Fairly often; 5) Always |
| | 13 | How often do you maintain the social or physical distancing? | 1) Never; 2) Almost never; 3) Sometimes; 4) Fairly often; 5) Always |

contained the questions about the subjective evaluation of living space quality, such as "How do you evaluate the quality of indoor environments of your living space?", "How do you evaluate the air quality of your indoor environments?", and "How do you evaluate the air ventilation effectiveness of your house?". In addition, factors related to maintaining health protocol such as avoiding closed and crowded spaces, wearing a mask, and washing hands were also included in the questionnaire survey. In total, the questionnaire was comprised of 13 questions (see Table 1). This cross-sectional study design and survey procedure were conducted according to Helsinki declaration, and it was approved by the Ethics Committee of Kyushu University.

## 2.2 Data collection

During the survey period, there were 1037 respondents participated in an online questionnaire. The surveyors targeted respondents on social media that fit the criteria such as those aged between 18 and 80 years old. After excluding incomplete responses, data from 1004 respondents were included in the analysis. The survey was anonymous, and participants had informed consent for their responses to be captured and included in a published article. Table 2 provides a detailed breakdown of the participants in this survey. In terms of district types, respondents from sub-urban areas were dominant with 45.8 percent (n = 460) compared to rural and urban areas with 42.1 and 12.1 percent respectively. According to gender, around fifty-six percent (n = 560) of the respondents were males and forty-four percent (n =444) were females. In the context of household monthly income, the low-income group (below USD 140) has the largest portion of respondents with 37.1%. The income classification was adopted based on the OECD economic survey conducted in Indonesia [7]. Furthermore, regarding the education level, the highest fraction of the respondents is in high school or lower (38.9 percent, n = 391), followed by bachelor (35.5 percent, n = 356). The rest of the respondents' education are master, college, and Ph.D levels with a portion of 14.0 percent (n = 141), 10.9 percent (n = 109), and 0.7 percent ( n = 7) respectively.

**Table 2**. Socioeconomic information of respondents

| Characteristic of respondents | Total number (n) | Percentage | National percentage [29] |
|---|---|---|---|
| *District* | | | |
| Rural | 423 | 42.1% | 42.1% |
| Sub-urban | 460 | 45.8% | 40.8% |
| Urban | 121 | 12.1% | 17.1% |
| *Household monthly income* | | | |
| <140 USD (Low) | 372 | 37.1% | 32.8% |
| 141-348 USD (Low-middle) | 294 | 29.3% | 44.0% |
| 349-557 USD (Middle-up) | 178 | 17.7% | 19.6% |
| >557 USD (High) | 160 | 15.9% | 3.6% |
| *Gender* | | | |
| Male | 560 | 55.8% | 50.6% |
| Female | 444 | 44.2% | 49.4% |
| *Age group* | | | |
| 18-25 | 520 | 51.8% | 16.1% |
| 26-40 | 285 | 28.4% | 23.4% |
| 41-60 | 199 | 19.8% | 24.9% |
| *Education level* | | | |
| High school or lower | 391 | 38.9% | 58.1% |
| College | 109 | 10.9% | 1.7% |
| Bachelor | 356 | 35.5% | 4.1% |
| Master | 141 | 14.0% | 0.3% |
| Ph.D | 7 | 0.7% | 0.02% |

## 2.3 Statistical analysis

We hypothesized that socioeconomic conditions are the primary driving factors that directly affect mental distress [30,31]. Thus, this study initially analyzed the data using logistic regression with the odds ratio (OR) to assess the relationship between a particular variable from socio-demographic status and the likelihood of mental stress and sleeplessness experienced during the COVID-19 pandemic. The variables used for this analysis are shown in Table 3. Rural areas, low-income, male, age group more than 25 years old, and students are treated as reference groups for the district, monthly household income, gender, age, and job type variables, respectively. It is worth mentioning that the value of OR>1 means the observed variable is more prone to suffering such difficulties than the reference variable. Conversely, OR<1 indicates the respondents from the observed group are less prone to mental stress [28,32,33]. In addition, to make a binary outcome from the measures of mental stress and sleeplessness, we encoded the response of "Never" as zero, while "Sometimes" and "Always" as one. Furthermore, all results with 95% confidence interval and p-value less than 0.05 indicated statistical significance and R software version 4.1.3 was used to run the analysis.

**Table 3**. Variables for logistic regression and odds ratio analysis

| Variable | Number of categories | Values | Reference group |
|---|---|---|---|
| District | 3 | Rural, urban, capital city of the province | Rural area |

| | | | |
|---|---|---|---|
| Household income | 4 | <140 USD (low), 141-348 USD (low-middle), 349-557 USD (middle-up), >557 USD (high) | <140 USD |
| Gender | 2 | Male, female | Male |
| Age group | 4 | <25, 26-40, >40 | <25 |
| Education level | 5 | High school or lower, college, bachelor, master, Ph.D | High school or lower |

### 2.4 Statistical analysis

The structural equation modelling (SEM) is used to reveal the relationship between indoor environment, SES, preventive behaviors, and the occupants' crisis (mental stress and sleeplessness) during COVID-19 pandemic. These variables were considered to be latent variables (LVs). SES was reflected by measured variables (MVs) such educational (A1) and income levels (A2), while preventive behaviors consisted washing hands (B1), wearing a mask (B2), and physical distancing (B3). Additionally, indoor environment was measured by indoor environment satisfaction (C1), indoor air quality (C2), and ventilation effectiveness (C3). The latent variable (LV) is theoretically expressed as [34]:

$$LV = \sum \eta \, MV + \varepsilon \quad (1)$$

Where $\eta$ is called the outer loading which represents the estimated value from a scale of −1 to +1 among reflective measurement models, whereby −1 indicates the greatest negative and +1 greatest positive contribution to its assigned construct [35]. Meanwhile, ε represents the measurement error. Furthermore, this study hypothesized that: 1) SES, preventive behaviors, and indoor environment have direct effects on the occupant' crisis; and 2) SES have direct effects on preventive behaviors and indoor environment. By taking it into account, the hypothetical model on SEM based on the questionnaire survey conducted in this study is shown in Fig. 1. Furthermore, the relationships between the latent variables are described in Eq. 2-4. Where ω is called path coefficient which represents the weighting effect from some latent variable to another. The data analysis was carried out using SmartPLS 3 [36].

$$LV_{crisis} = \omega_{AD} LV_{SES} + \omega_{BD} LV_{Behaviors} + \omega_{CD} LV_{IEQ} + \varepsilon_{crisis} \quad (2)$$

$$LV_{behaviors} = \omega_{AB} LV_{SES} + \varepsilon_{behaviors} \quad (3)$$

$$LV_{IEQ} = \omega_{AC} LV_{SES} + \varepsilon_{IEQ} \quad (4)$$

It is noteworthy that the measurement variable (MV) results were calculated based on the criteria such as composite reliability (CR) to evaluate internal consistency which should be >0.7 [37], the average variance extracted (AVE) value to evaluate convergent validity should be >0.5 [34], and the significance by using p-value that should be lower than 0.05 [38]. Furthermore, the latent variable (MV) results were evaluated in terms of discriminant validity. It implies the difference among the constructs for each latent variable. By implementing Fornell-Lacker criterion, the square root of the AVE of the similar construct within the latent variable should be higher than other constructs [35].

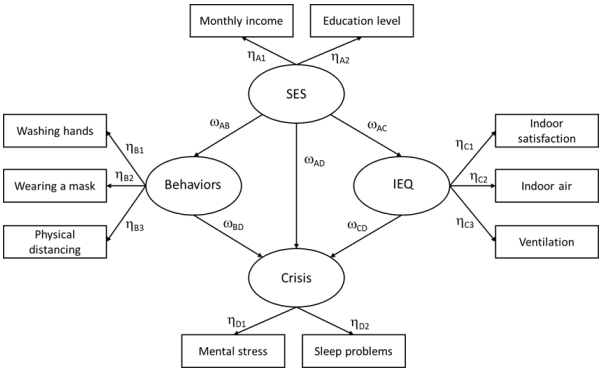


**Fig. 1.** The model based on SEM developed in this study associating SES, preventive behaviors, IEQ, and crisis.

## 3 Results

### 3.1 Sankey diagram of respondent's behavior, SES, and indoor evaluations

The Sankey diagram was used to show respondents' flow fraction divided into three nodes related to SES, preventive behavior, IEQ resulting the stress and sleeplessness. The width of connection nodes is proportional to the number of respondents (see Fig. 2). Accordingly, the majority of the respondents who answered "always" suffering mental stress and sleeplessness during the pandemic have performed frequent preventive behavior such as hand washing. They were from a lower educational background. It implies that respondents with lower educational levels generally exhibited preventive behavior regarding hand hygiene. However, it is thought that people with this background have mental stress due to minor literature on COVID-19 and not enough knowledge about the importance of handwashing [39,40]. A similar tendency also was found among the respondents with low-income levels who suffered the crisis affected indoor satisfaction. Most of them subjectively justified that their indoor conditions were "Good" and "Very good" but the extra economic burden during the pandemic made them vulnerable to the crisis compared to respondents with higher income levels. Hence, indoor satisfaction in this study did not play a significant role in suffering mental stress and sleeplessness.

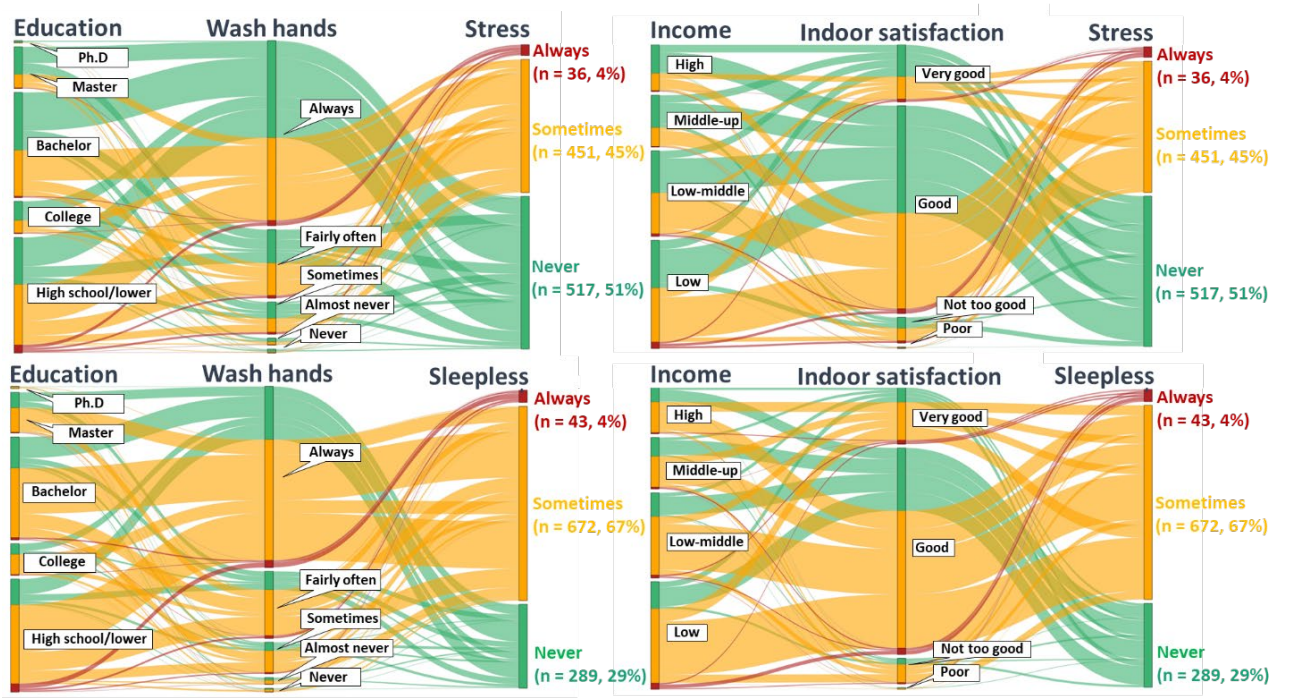


**Fig. 2.** A Sankey diagram of mediating flows of wash hands and indoor satisfaction to the crisis based on the respondent's

### 3.2 Mental stress and sleeplessness associated with socio-demographic factors

Table 4 summarizes the results of the odds ratio analysis on mental stress and sleeplessness associated with socio-demographic factors. Regarding the monthly income level, the group of respondents classified as low-income was found to be more prone to mental stress compared to the group of middle-up (OR=0.48) and high income (OR= 0.50) level with a p-value of 0.001. The tendency pertaining to the mental stress among low-income households during the COVID-19 pandemic found in this study is in line with a report that provides converging evidence on the association between financial anxiety and depression during the global pandemic COVID-19 [2,31,41]. On the other hand, the tendency of respondents to have sleeplessness experiences during the COVID-19 pandemic was found to be significant among the lower compared to the middle-up income group (OR = 0.48, p-value = 0.005). In this context, the study is consistent with a previous study conducted by [42], who examined an empirical analysis to measure sleeplessness phenomena in China. These results confirmed the economic and financial uncertainty during the COVID-19 pandemic significantly aggravated the negative impact on mental stress and sleep quality.

Furthermore, regarding gender, this study found that males tended to experience sleeplessness more often than females (OR = 0.73, p-value = 0.027). Based on previous studies, the sleeplessness experience is caused by some factors, including concerns related to work, school, health, finances, and family [42–44]. Accordingly, the tendency of males to have more sleeplessness experience than females in Indonesia is cogent based on the fact that the average male labor participation rate was about 81.5 percent and 56.7 percent of them work in the informal sector [45]. Interestingly, the cross-sectional study conducted in the UK involving 8547 respondents reported that females were more sleepless than males due to being more influenced by their emotional reaction to the pandemic. Meanwhile, the male's sleeplessness problem was more affected by changes in their financial situation and employment status [46].

In the context of age, this study confirmed that young people under 25 are more likely to have mental stress and sleeplessness than older age groups. It is consistent with the study conducted in Italy targeting the young (n = 670, age range 18-20 years) and older adults (n = 253, age range 65-75 years) through a web-based survey. The younger population showed a higher possibility of experiencing depression which was indicated by sleeplessness, insomnia, and anxiety during the COVID-19 outbreak [47]. In Indonesia, it even worsens as the supply of opportunities for young people is shrinking significantly and the prospects of finding decent jobs become more complex [48].

Moreover, in terms of education level groups, we found that people with high school or lower education were associated with significant 0.48, 0.56, and 0.35-times odds of experiencing mental stress compared with those with college, bachelor, and master levels, respectively. Since the odds were lower than 1, people with high school or lower education were likely prone to mental stress compared to those with higher education levels. We also found this tendency among the people with high school or lower education for sleeplessness experience compared with college, bachelor, and master levels with significant odds 0.57, 0.68, and 0.47, respectively. Parallel with [49], the study suggested that despite struggling to ensure the continuity the education, the people with low education reported having learnt less and it is likely dominated by fear and uncertainty during the COVID-19 pandemic due to the outlook for

the limited job prospects or the transition of the school-to-work pressure.

**Table 4**. The odds ratio of mental stress and sleeplessness associated with socio-demographic

| Variables | Mental stress | | | Sleeplessness | | |
|---|---|---|---|---|---|---|
| | OR | (95% CI) | p-value | OR | (95% CI) | p-value |
| *District* | | | | | | |
| Rural | (ref) | - | - | (ref) | - | - |
| Sub-urban | 1.07 | (0.82-1.40) | 0.606 | 1.22 | (0.91-1.63) | 0.190 |
| Urban | 0.72 | (0.47-1.08) | 0.112 | 1.01 | (0.65-1.57) | 0.974 |
| *Household monthly income* | | | | | | |
| <140 USD (Low) | (ref) | - | - | (ref) | - | - |
| 141-348 USD (Low-middle) | 0.82 | (0.60-1.12) | 0.209 | 0.86 | (0.61-1.22) | 0.400 |
| 349-557 USD (Middle-up) | 0.48* | (0.33-0.68) | 0.001 | 0.58* | (0.39-0.85) | 0.005 |
| >557 USD (High) | 0.50* | (0.34-0.73) | 0.001 | 0.73 | (0.49-1.11) | 0.137 |
| *Gender* | | | | | | |
| Male | (ref) | - | - | (ref) | - | - |
| Female | 1.10 | (0.85-1.41) | 0.474 | 0.73* | (0.56-0.97) | 0.027 |
| *Age group* | | | | | | |
| < 25 | (ref) | - | - | (ref) | - | - |
| 26-40 | 0.52* | (0.38-0.69) | 0.001 | 0.38* | (0.27-0.52) | <0.001 |
| > 40 | 0.44* | (0.32-0.62) | 0.001 | 0.42* | (0.29-0.60) | <0.001 |
| *Education level* | | | | | | |
| High school or lower | (ref) | - | - | (ref) | - | - |
| College | 0.48* | (0.31-0.74) | <0.001 | 0.57* | (0.36-0.92) | 0.018 |
| Bachelor | 0.56* | (0.42-0.75) | <0.001 | 0.68* | (0.49-0.94) | 0.019 |
| Master | 0.35* | (0.24-0.53) | <0.001 | 0.47* | (0.31-0.72) | <0.001 |
| Ph.D | 0.27 | (0.04-1.23) | 0.124 | 0.74 | (0.16-5.20) | 0.717 |

### 3.3 SEM results of mental stress and sleeplessness associated with indoor environment satisfaction, preventive behaviors, and SES

Fig. 3 shows the results of SEM. In terms of model reliability, the values of latent variables demonstrated to fulfill the consistency standard (CR > 0.7) [34], with the lowest value of 0.731 (crisis) and 0.801 (IEQ) as the highest value. Additionally, the model's validity by assessing the convergency based on the average variance extracted (AVE) shows the values were above the required minimum level of 0.5. The detail of the model evaluation results is presented in Table 5. Concerning the reflective measurements, it is noteworthy that all reflective indicators were significant ($p < 0.05$). Moreover, the variance inflation factor (VIF) indicates the collinearity among the measured variables of each latent variable and the values of the present study were uniformly within the threshold value between 1 and 5 [35]. In terms of measurement variables (MV), the greatest outer loading to the socio-economic status variable was education level ($\eta = 0.852$), followed by income level ($\eta = 0.778$). On the other hand, washing hands ($\eta = 0.769$) and indoor satisfaction ($\eta = 0.815$) were the highest outer loading coefficients among the measured variables reflecting the preventive behaviors and IEQ respectively. Additionally, the outer loading coefficients of the crisis were 0.893 and 0.609 for mental crisis and sleeplessness respectively.

**Table 5**. The model evaluation results

| Latent var. | Constructs | Code | $\eta$ | VIF | CR | AVE |
|---|---|---|---|---|---|---|
| SES | Income | A1 | 0.778* | 1.126 | 0.799 | 0.666 |
| | Education | A2 | 0.852* | 1.126 | | |
| BE | Wash hands | B1 | 0.769* | 1.167 | 0.786 | 0.551 |
| | Wear a mask | B2 | 0.717* | 1.211 | | |
| | Physical distancing | B3 | 0.741* | 1.216 | | |
| IEQ | Indoor satisfaction | C1 | 0.815* | 1.239 | 0.801 | 0.575 |
| | Air quality | C2 | 0.802* | 1.348 | | |
| | Ventilation | C3 | 0.647* | 1.221 | | |
| Crisis | Sleeplessness | D1 | 0.609* | 1.036 | 0.731 | 0.584 |
| | Mental crisis | D2 | 0.893* | 1.036 | | |

***** *p-value < 0.05; η-outer loadings; VIF-variance inflation factor; CR-composite reliability; AVE-average variance extracted*

Regarding the path coefficients, we found that SES and indoor environment satisfaction directly affected the crisis. However, only SES shows significance (p-value < 0.05, $\omega = -0.237$). It implies that the higher socioeconomic levels could reduce the possibility of experiencing a crisis such as sleeplessness and mental stress during the COVID-19 pandemic in Indonesia. A similar tendency was found in a prior study conducted in Bangladesh which suggested that financially interrupted by the COVID-19 pandemic indicated a great economic problem and mental stress among the people. The most important factor was to enable them to become financially self-sufficient [50]. Additionally, we identified that the SES also had significant direct effects on preventive behaviors ($\omega = 0.105$) and IEQ ($\omega = 0.102$). This finding confirmed that economic conditions and educational backgrounds have a significant role for people in perceiving the indoor environment, practicing COVID-19 preventive behaviors, and suffering a crisis. It is consistent with some previous cross-sectional studies conducted in Indonesia [16,28,37]. Furthermore, we found the indirect effects of SES on the crisis through the mediating roles of preventive behaviors and IEQ were not statistically significant. It means the explanatory

variance of preventive behaviors and IEQ as the mediators were at a weak level to affect the crisis. However, it is worth exploring how these latent variables could affect some respondents to answer the measures of mental stress and sleeplessness in the questionnaire survey.

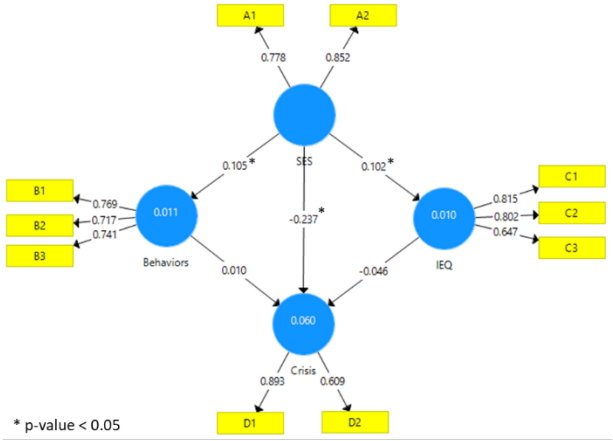


**Fig. 3.** The SEM results revealed from the hypothetical concept of association between SES, preventive behaviors, IEQ, and crisis

### 3.4 Importance-performance analysis based on the type of districts

The multi-group SEM analysis was performed to observe the differences between subgroups based on the type of districts comprised rural, sub-urban, and urban in terms of the loading effects of SES, preventive behaviors, and IEQ measurement variables on the crisis. The loading effects value representing how importance the MV to contribute the construct model. The negative value demonstrated the MV could possibly reduce the crisis and vice versa. On the other hand, to make the performance results easily to compare, each measurement threshold of the MVs was rescaled from the lowest level (0) to highest level (100). For instance, the response of physical distancing from a respondent was "Sometimes" which has encoded as 3 on a given threshold 1-5 as mentioned in Table 1. Accordingly, this value becomes 3/5 times 100 (as the scale length) which equals 60. The mean of these rescaled scores of the responses from each group then we called the performance of physical distancing.

Fig. 4 illustrates the importance and performance of the MVs based on the type of districts. Regarding the performance of SES, income and educational levels of the respondents from urban area had the highest performance with the value 47.4 and 41.7 respectively comparing to other districts. It means the average income and educational levels of the respondents living in urban area relatively higher than sub-urban and rural areas. In addition, the SES loading effects from all districts were in negative value which can be interpreted that the respondents from all districts consider that SES was important to mitigate the crisis. Consequently, the policy to improve the SES condition during COVID-19 should become priority as suggested also in the previous studies [21,51]. With regard to indoor environment, air quality satisfaction in the rural area shows highest performance with the value 72.4 comparing to the other districts. Moreover, regarding ventilation, it is considered high importance among the respondents from sub-urban area compared to respondents from other area with the value 0.05. In terms of preventive behaviors, the diverse perspective and knowledge of this among the respondents from these districts was found. Respondents in sub-urban had a highest performance on handwashing (87.2) comparing to respondents from other districts. Interestingly, respondents from urban and rural had an opposite tendency each other. Handwashing among the respondents in rural area showed that handwashing in negative loading effect (-0.041), but people in urban area had a different perspective by assuming the handwashing was one of the factors that could relate positively to the crisis with the loading effect of 0.039.

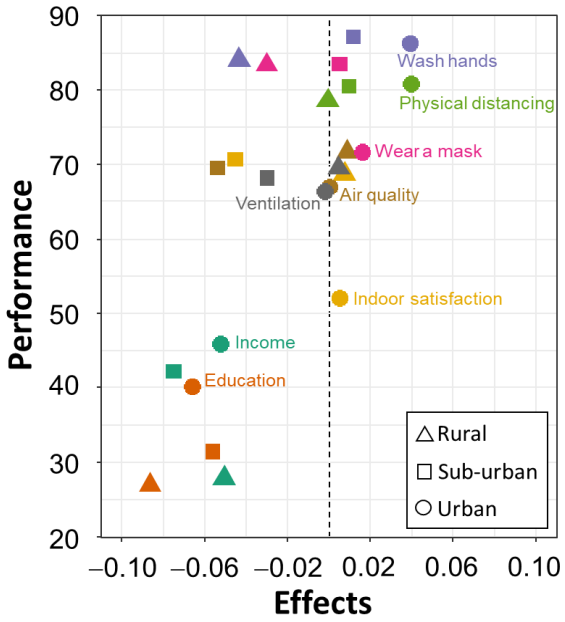


**Fig. 4.** The importance-performance results of the measurement variables (MVs) based on type of districts

## 4 Conclusions

This study presents the prevalence of mental stress and sleeplessness during the COVID-19 pandemic associated with socioeconomic status (SES), preventive behaviors, and indoor environments in Indonesia. A cross-sectional study was performed by using an online questionnaire survey to acquire 1004 validated responses with the diverse background of socioeconomic conditions. The main findings are as follows:

- The tendency pertaining to the mental stress and sleeplessness among low-income households during the COVID-19 pandemic was found to be significant compared to middle-up and high-income group.
- Regarding the path coefficients, we found that SES showed significance (p-value < 0.05) to directly associate with the crisis. It evidenced that the higher

socioeconomic levels could have less the possibility of experiencing a crisis such as sleeplessness and mental stress during the COVID-19 pandemic in Indonesia.
- By conducting importance-performance analysis, SES effects from all districts were in a negative value, which can be interpreted that the respondents from all districts considering that SES was important to mitigate mental stress and sleeplessness.

The findings of this study could add to practical implications that support the researchers and public policy stakeholder to mitigate the long-term effect of COVID-19 in Indonesia specific on mental health. The longitudinal study design to examine the effect on lifestyle and indoor environments should be employed in the future.

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