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Impact of the COVID-19 pandemic on child malnutrition in Selangor, Malaysia: A pilot study



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ABSTRACT

Background: Child malnutrition risk factors are globally recognized, but the specific impact of the COVID-19 pandemic on the prevalence of child malnutrition, considering socioeconomic burdens and changes in family lifestyles, remains underexplored. This study aims to identify the significance of COVID-19-related factors in relation to the prevalence of child malnutrition in Selangor, Malaysia.

Methods: Purposive sampling was employed in this pilot study to select the households with under-5 children and, a structured questionnaire was developed to gather data. Chi-squared tests, logistic regression modelling and World Health Organisation AnthroPlus software-based visualization were used for analyses. *Results:* The present study's findings indicate that demographic and social factors, including 'Citizenship,' Type of House,' Number of Earning Members,' 'Father's Highest Educational Level,' and 'Number of Children in a Family,' have a statistically significant association with Wasting. Additionally, the mother's 'Highest Educational Level' is found to be linked to underweight prevalence. Within COVID-19 factors, "COVID-19 Impact on Employment/Business" demonstrated significance for both stunting and wasting. Multivariate analysis revealed disparities in childhood malnutrition by gender, age, and factors such as "COVID-19 impact on children's physical activity" and "COVID-19 impact on children's decrease in health over the last two weeks."

Conclusions: This study identified COVID-19 factors alongside sociodemographic variables with statistically significant relationships impacting childhood malnutrition in Selangor, Malaysia. The results underscored the substantial influence of the COVID-19 pandemic on child malnutrition prevalence. Decision-makers at family and community levels can benefit by considering these factors in their actions. However, the study's limitation lay in its dataset, urging larger-scale analyses to explore further sub-categories of the examined variables.

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Background

Malnutrition refers to imbalances in nutrient consumption and is often a result of inadequate dietary intake, defying standard or recommended measures usually established by global health organizations such as the World Health Organization (WHO). It considers the state of overnutrition or undernutrition, which arises from either an excess or deficiency of nutritional intake, both of which are also associated with other resulting conditions of malnutrition, such as stunting and wasting [1]. These conditions are associated with overlapping syndromes, including inhibited growth in children, child development delay, and adult muscle atrophy [2]. It is widely known to be more prevalent in children and is considered a high-risk factor for child deaths and illnesses globally [3–6]. In Malaysia, studies have seemingly identified a decrease in the prevalence of malnutrition in children; however, the decline is not rapid enough to neglect child malnutrition as a concern, as its prevalence still poses a worrisome threat [7,8].

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Abbreviations: CI, Confidence Interval; FET, Fisher Exact Test; OR, Odds Ratio; PET, Pearson Chi-square Test; WHO, World Health Organization

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Child malnutrition study in Malaysia

Several studies about child malnutrition have already been carried out within the Malaysian population. However, at the time of writing, none explicitly targeted the state of Selangor, which has the highest number of children under 18 years, according to the Department of Statistics Malaysia [9]. In reference to the standards set by the World Health Organization, the prevalence of child malnutrition classified as "underweight" has decreased in Malaysia from 19.6% in 2011 to 17.7% in 2015 [9]. A study in 2019 investigated factors associated with undernutrition in children in Malaysia using the National Health and Morbidity Survey conducted in 2016 [8]. The study used a questionnaire to collect data from 11,845 households with children under the age of five years old (under-5 children) and showed that 9.4% and 13% were underweight children for the age groups 0-11 and 12-23 months, respectively. In addition, undernutrition appeared more prevalent in rural Malaysia and had a higher frequency in male children and low-income households.

Moreover, a study in 2014 investigated associations between household food insecurity and nutritional outcomes in children [10] and found that 83.9% of the households were experiencing some form of food insecurity. The total monthly income was identified to be a significant risk factor for household food insecurity, including other factors such as household size, number of children, and food expenditure. Furthermore, another study in Kelantan identified a 63.4% rate of underweight in their study's participant and also concluded that total household income and expenditure were variables that had significant associations with underweight condition, and thus, child malnutrition [11].

These claims suggest that households with lower household incomes are generally more at risk of child malnutrition due to the inability to provide children with the means to improve their dietary intake with the necessary nutrients required during child development. These findings align with a study in Terengganu that investigated child development and nutritional status via a cross-sectional study in a fishermen's community and concluded that there is a 31.7% suspected development delay in under-5 children [12]. Furthermore, early nutrition was generally recognized to play a significant role in preventing child malnutrition, suggesting that appropriate dietary intake and feeding practices are essential in child development, especially during early growth [13].

Many other studies in Malaysia have also looked into relationships between malnutrition and other household factors [7,8,10,11–17]. For example, in investigating the association of biological and physical environmental factors on the nutritional status of children in Sabah, East Malaysia, the researchers found unimproved sanitation as one of the main significant risk factors of child malnutrition [17]. As a result, efforts were made to aid this struggle against childhood malnutrition with school-based intervention programs aiming to develop healthy food intake within school environments [18]. Nevertheless, these varying findings and discovery of new associations between malnutrition and many different household factors suggest the need for continuous investigation to help raise awareness in order to improve bodies that aim to support these issues, such as policymakers that aim to provide assistance to households struggling with child malnutrition and childcare in general.

Child malnutrition study in neighbouring countries of Malaysia

Southern Asia has the highest underweight prevalence at 30% compared to other regions, such as Western Africa at 21%, Oceania and Eastern Africa at 19%, South-Eastern Asia and Middle Africa at 16%, and Southern Africa at 12%. Countries in these areas are

identified to have been struggling with childhood malnutrition as of 2013 [4]. In 2015, the prevalence of malnutrition in South Asia was investigated via a meta-analysis, revealing the condition as a significant public health crisis due to its high disease burden and mortality within the region [3]. Understanding the broader regional context of malnutrition prevalence, particularly in neighbouring Asian countries, provides valuable insights into the challenges faced by countries like Malaysia. An in-depth understanding and review of past studies that look into other risk factors of child malnutrition allows our study to have a more comprehensive discussion.

Numerous studies conducted throughout Southeast Asia provide strong support for the majority of the conclusions about child malnutrition in Malaysia. One such study [19] identified an association between food security and household socioeconomic characteristics in the context of child malnutrition in Southeast Asia as a whole. The study concluded that although different household-level indicators account for some food security measures, they failed to fully account for stunting in under-5 children. Hence, the study concluded that further research must still be conducted on other intra-household indicators to solidify the analysis results. Similarly, another study investigated data from 36 developing countries to conclude that favourable socioeconomic conditions result in a lower prevalence of malnutrition [6]. It was further supported by evidence from 10 developing countries in Asia which concluded that the aspects of household and parental socioeconomic status and its role are the determinants for child malnutrition [20-22].

These claims are accurate with the findings of neighboring countries, such as Indonesia, Thailand, and the Philippines. The general finding seems to corroborate the assertion that child malnutrition is, in fact, a persistent issue worldwide and that a number of factors, primarily household-related, contribute to its prevalence [23–27]. However, an Indonesian study argued that a sudden growth in income does not automatically resolve the child malnutrition crisis [28]. This study found that the occurrence of child stunting remained high even in households that were considered "wealthy". Furthermore, a study in Thailand conducted in 2020 examined the factors associated with stunting, wasting, and overweight separately and found that the difference in household wealth and size was only significant for overweight and not necessarily underweight [29]. As long-established determinants of child malnutrition continue to guide research and policy, varying claims and findings, as evidenced by these studies in Indonesia and Thailand, underscore the ongoing complexity and evolving understanding of this critical issue [22,30]. These varying results encourage more research into the complex nature of child malnutrition and the efficacy of interventions across various socioeconomic contexts.

Statement of the study: COVID-19 and its effects on child malnutrition

At first glance, it can be assumed that COVID-19 would have some sort of impact on child malnutrition. Directly, it can be caused by specific lifestyle changes that were forced due to either the regulations of the pandemic or the socioeconomic burden it presented [31–37], and thus impacting the prevalence of child malnutrition [7]. Several studies during COVID-19 pandemic have in fact concluded that the pandemic had a significant impact on the lifestyle of people [38–46,37]. Besides, the COVID-19 pandemic was generally considered a public health emergency, and many laws, regulations, and emergency measures were quickly implemented to help curb the spread of the virus [32,34–37]. Hence, the physical and mental health of children and adolescents were expected to be impacted due to the changes in physical activity and sedentary behaviour that were brought upon by the closure of schools and an extended period of home confinement [45,47–49]. From these findings, interest was



Fig. 1. Summary of Nutritional Status (n = 25) among under 5 Children in Selangor State.

formed in considering the impacts of the COVID-19 pandemic on the long-established predictors of child malnutrition.

Study aim and significance

The recent global shift in lifestyles brought on by the COVID-19 pandemic has not garnered much attention in the context of child malnutrition studies, despite abundant research on the pandemic itself. This pilot study aims to bridge the gap in research by examining the direct and indirect effects of the COVID-19 pandemic on child malnutrition in Selangor, Malaysia. Our objective is to contribute valuable insights about how conventional risk variables of child malnutrition interact with the novel difficulties presented by the COVID-19 pandemic. The above objective will be achieved by using existing concept and analytical tools and techniques developed by the WHO [50] and other researchers [7,11,17,51]. Thus, this study not only tackles prevailing assumptions about child malnutrition prevalence, but also endeavours to enhance families' awareness of how these risk factors may be modified in the context of the pandemic. Recognizing the inconsistency in research on the risk factors of child malnutrition within Malaysia and its neighbouring countries, particularly when considering the added dimension of the COVID-19 impact, our study aims to play a pivotal role. The study's overarching goal is to provide information to public health departments and organizations to formulate the best support for children's healthy development and growth in Malaysia [7,8].

Methods

Sampling design

This pilot study employed a purposive sampling design targeting 35 families with under-5 children. The child inclusion criteria for this study were as follows: (a) the child must be under the age of 5 years old at the time of data collection, and (b) a resident of the state of Selangor, Malaysia. The sample responses were collected using a structured questionnaire developed from several related studies [7,11,17,51]. The survey questionnaire was designed via Google Forms and it was distributed to the targeted 35 families during a study period from 1st February 2021 to 28th February 2021. Out of the 35 families contacted, 20 families responded to participate in the study, resulting in a response rate of 57.14%. Among the 20 responded households, fifteen families reported having one child each, and five

other families reported having two children each that met the inclusion criteria. Hence, this study sample comprised data of 25 children under five years of age living in Selangor.

Research instrument

The questionnaire (Supplementary information) was divided into two main sections: "Sociological/Demographic Factors" and "COVID-19 Factors." The first category, "Sociological/Demographic Factors", consisted of questions that related to the children and their family's social standing and socioeconomic status [7,11,17]. The second category, "COVID-19 Factors", was about the possible impact of the pandemic on the children's day-to-day activities and lifestyles [51]. This categorization resulted from our aim to investigate the complex interactions among sociological factors, demographic traits, and the COVID-19 pandemic's effects on children's nutritional status. The survey questions and instructions were written and distributed in English to ensure accessibility and inclusivity.

Data processing and variables constructing

The overall data processing involved cleaning, editing, and coding the data (i.e., sub-categories of variables) into a suitable format specifically for the use of the statistical software, IBM Statistical Package for Social Sciences (SPSS) version 26. The z-scores of Weight-for-age (Underweight), Height/Length-for-age (Stunting), and Weight-forheight/length (Wasting) were computed using the WHO AnthroPlus software [50]. A new variable, the "Malnourished" status, was also measured by combining the codes of the three nutritional grades: Underweight, Stunting and Wasting. A score of 1 was assigned if the child had a malnutrition condition as indicated by each anthropometric or nutritional index; otherwise, they were assigned a score of 0. Thus, the highest total possible score was 3, and the lowest was 0. Based on the total scores, the children were classified as either malnourished (total scores > 0) or non-malnourished (total scores = 0). The four variables (underweight, stunting, wasting, and malnourished) were thus used as the dependent variables.

The independent variables assessed in the study were categorized into two main categories: 'Sociological and Demographic Factors' and 'COVID-19 Factors'. The 'Sociological and Demographic Factors' contained variables that considered the family's identification, primary status, household and living conditions, whilst the 'COVID-19 Factors' considered changes in the family's lifestyles primarily impacted by the COVID-19 pandemic.

Table 1

Summary of Frequencies for all Factors.

Variable	Sub-categories	Count	Percentage (%)
Citizen	Malaysian	15	60
	Non-Malaysian	10	40
Living District	Petaling	13	52
Ũ	Outside Petaling	12	48
Type of House	Condominium	14	56
	Other than condominium	11	44
Household Members	Two adult members	19	76
	Other than two adults*	6	24
Earning Members	Single earning member	15	60
5	Two or more earning members	10	40
Household Monthly Income Threshold*	B40	7	28
, , , , , , , , , , , , , , , , , , ,	M40	14	56
	T20	4	16
Father's Highest Educational Level	Primary-Bachelors	15	60
0	Masters/PhD	10	40
Mother's Highest Educational Level	Primary-Diploma	11	44
5	Bachelors-Masters/PhD	14	56
COVID-19 Impact on Employment/Business	No	11	44
I I I I I I I I I I I I I I I I I I I	Yes	14	56
COVID-19 Impact on Food Accessibility	No	18	72
	Yes	7	28
COVID-19 Impact on Food Buying Capacity	No	18	72
1	Yes	7	28
COVID-19 Impact on Lateness of Children's Sleeping and Awaking Time	No	13	52
	Yes	12	48
COVID-19 Impact on Decreased Children's Food Intake	No	21	84
1	Yes	4	16
COVID-19 Impact on Children's Lack of Response	No	20	80
i i	Yes	5	20
COVID-19 Impact on Decrease of Children's Health (over last 2 weeks)	No	21	84
	Yes	4	16
COVID-19 Impact on Children's Quality of Sleep	Same (No change)	22	88
	A little worse	3	12
COVID-19 Impact on Children's use of TV/Computer/Mobile for Leisure	Same (No change)	6	24
	A little more	10	40
	A lot more	9	36
COVID-19 Impact on Children's Home Teaching	No	9	36
- •	Yes	16	64
COVID-19 Impact on Children's Physical Activity	No	11	44
	Yes	14	56

* Household Monthly Income Threshold: The terms Bottom 40% (B40), Middle 40% (M40), Top 20% (T20) refer to the income threshold standardization in Malaysia

Statistical analyses

A series of statistical analyses were performed on the dataset, beginning with descriptive statistics wherein each categorical variable was presented in the format of count and percentage.

The significant associations between the nutritional status and sociological and demographic factors were tested using chi-square tests. In addition, logistic regression analyses were also performed on each variable to identify the factors associated with 'underweight', 'stunting', and 'wasting' respectively. The p-value < 0.05 was used to identify significant results. The statistical software, IBM SPSS (version 26) was primarily used to run the chi-square test and logistic regression analysis. In addition, the WHO AnthroPlus software was utilized to visualize the data acquired in contrast with the World Health Organization (WHO) Child Growth Standards for children aged 0–5 years.

Ethical considerations

The study obtained approval from the Monash University Human Research Ethics Committee (MUHREC) under Project ID 27579. Potential participants' families received an email invitation and an explanatory statement that included a study summary and consent form. This aimed to ensure that the responsible adults, who are the primary caregivers of the children, fully understood the nature and purpose of the research before sharing their children's information. The voluntary nature of participation was also emphasized, and the right to withdraw from the study at any point without consequences. The research team made themselves available to address any questions or concerns raised by the parents or guardians, ensuring that they were well-informed and comfortable in the study. Additionally, the research team ensured that the consent process was culturally sensitive and conducted in a language understood by the participants, further facilitating comprehension and voluntary participation.

Results

An initial inspection of the data distribution in Fig. 1 within the sample population revealed that 16% of the children studied were considered underweight, with 20% identified as stunting, and 20% as wasting.

It could be noted that each of these indices provides somewhat different information about the nutritional status of children. A drop in wasting reflects an acute problem; that is, one that occurred recently. A drop in stunting signals a chronic problem, one that has persisted for several months, but is not necessarily present when the measurement is taken. A decline in underweight may be connected with one or the other or both of the explanations mentioned above, since it expresses an overall situation. The combined "malnutrition"

Table 2

Associations between Nutritional Status of under 5 Children and their Demographic and Social Factors.

Characteristic with categories	N (%)	Malnutrition Status (%)			p-value (FET)
		Stunting (S)	Underweight (U)	Wasting (W)	
Citizenship	15 (60.0)	26.7	13.3	0	0.615 (S)
Malaysian	10 (40.0)	10.0	20.0	50.0	1.000 (U)
Non-Malaysian					0.005 (W)***
Type of House	14 (56.0)	14.3	14.3	35.7	0.623 (S)
Condominium	11 (44.0)	27.3	18.2	0	1.000 (U)
Other than Condominium					0.046 (W)**
Earning Members	15 (60.0)	20.0	20.0	33.3	1.000 (S)
Single Member	10 (40.0)	20.0	10.0	0	0.626 (U)
Two or more Members					0.061 (W)*
Highest Educational Level (Father)	15 (60.0)	26.7	13.3	0	0.615 (S)
Primary – Bachelors	10 (40.0)	10.0	20.0	50.0	1.000 (U)
Masters/ PhD					0.005 (W)***
Highest Educational Level (Mother)	11 (44.0)	27.3	36.4	27.3	0.623 (S)
Primary – Diploma	14 (56.0)	14.3	0	14.3	0.026 (U)**
Bachelors - Masters/ PhD					0.623 (W)
Number of Children in a Family	15 (75.0)	13.3	6.7	33.3	0.358 (S)
One Child	5 (25.0)	30.0	30.0	0	0.267 (U)
More than One Child					0.061 (W)*

***p < 0. 01, **p < 0.05, *p < 0.10;

All p-value is based on the Fisher Exact Test (FET).

index signals a child is malnourished by at least one of the three indices. The result revealed that four out of each 10 children were malnourished, which could be considered a significant public health issue for any society. Table 1 summarizes the questionnaire responses recorded in the present study. From a quick overlook of the results, the demographics of the sample population can be inspected and understood.

The sample population consisted of 60% Malaysians and 40% non-Malaysians, of which a majority currently reside within the Petaling district (52%), with a condominium being the most likely type of house at 56%. A large majority of the sample population (76%) consisted of having two adults in the household, while the remaining households were as follows: two households consisting of a single adult member, two households with three adult members, and two households with four adult members. Moreover, the most common theme in these households consisted of having a single earning member instead of two or more earning members, with 56% of the sample population belonging to the M40 group. All these subjects were considered to be independent and did not indicate towards having any association between the variables. A notable observation is that a majority (60%) of the fathers in the sample population acquired an education level of Primary-Bachelors, whilst Mother's highest educational level is Bachelors-Masters/PhD at 56%.

For the COVID-related variables, most of the questions comprised of "yes" or "no" options for answers, and most of the answers to the questions were observed to have a skewed distribution. For instance, the impact of COVID-19 on food accessibility had 72% of the responses stated that the pandemic did not affect families' access to food. The same reactions were observed for the impact of COVID-19 on food buying capacity. Whilst the responses were split on whether COVID-19 affected the time that children went to sleep and the duration of the sleep, with 52% responding with having observed no impact. Additionally, about 84% of respondents indicated that the COVID-19 pandemic did not impact the children's food intake. The same was also observed for the effects of COVID-19 on the children's lack of response, decline in health over the past 2-weeks, and quality of sleep, with over 80% for all three variables suggesting that the COVID-19 pandemic had little to no impact.

Additionally, the results for "COVID-19 Impact on Employment/ Business" was interesting to take note of as the responses for this variable were initially predicted to be more skewed towards our expectations of seeing a higher number of people having lost their jobs, laid off from employment, or have had their businesses closed down due to the pandemic. A higher number of people responding that they have been impacted in this regard would have allowed for relatedness with the parents' or primary carers' ability to provide the child with high-quality care and nutrition, due to the lack of business or employment consequently indicating a lower income overall from either source, whether business revenue or employment salary. However, this was not the case for our sample population.

Furthermore, 40% of the responses that enquired on the impact of the COVID-19 pandemic on the children's use of TV/Computer/ Mobile for Leisure found that there were "a little more" in terms of changes in the children's behavior, suggesting a slight increase in the children's use of TV/Computer/Mobile for Leisure. Moreover, there was a 64% response rate to "yes" when asked whether the COVID-19 pandemic had an impact on the children's home teaching. In addition, 56% also agreed that the pandemic affected the children's physical activity. However, these frequencies do not fully indicate any direct relevance towards the prevalence of child malnutrition in Selangor and require it to be discussed in addition to the results of the statistical analyses to form more conclusive associations and determine relationships between the variables and its impact towards child malnutrition prevalence.

The results of the bivariate analyses are presented in Tables 2 and 3. The results revealed that demographic and social factors such as 'Citizenship', 'Type of House', Number of 'Earning Members', Highest Educational Level (Father), and 'Number of Children in a Family' have a statistically significant association with the prevalence of wasting (see Table 2). There was also a significant association between the mother's 'Highest Educational Level' and the prevalence of being underweight. Apparently, the father's 'Highest Educational Level' and 'Citizenship' produced the strongest association (p-value < 0.01) for wasting.

Moreover, wasting was more prevalent in children with 'non-Malaysian' Citizenship (p-value < 0.005). Similarly, other variables such as type of house, father's educational level and number of children in a family show a significant relationship with wasting at the 5% significance level. This finding supports a similar study that suggested the number of children in the family is an important determinant of childhood malnutrition [16]. These findings were also backed by references from past research that reported similar findings across various countries, including Pakistan and Vietnam. It was suggested that competition for scarce household resources and quality care and time provided by the parents/guardians were inevitable burdens imposed by having more children within a family [16]. The rest of the selected variables also demonstrated a significant association with wasting (p-value < 0.10), except for the mother's educational level, which showed a significant relationship with underweight only. Moreover, none of the variables revealed a statistically significant association with stunting, which is reasonable as stunting signals a chronic problem that has persisted for several months, but may not necessarily be present when the measurement is taken [50,52].

The difference between the resulting nutritional status ("wasting" versus "underweight") due to the father's education level and mother's education level, respectively, may not be indicative of any specific differentiation between a mother and a father as the variation in resulting nutritional status may only be a result of nonresponse bias due to having a small sample size [53]. Thus, it can be generalized and concluded that a parent/guardian's education level overall impacts a child's nutritional status and does not indicate a gender-based specific role. Overall, wasting was thus identified to be the most prominent nutritional status as it has the most significant associations as observed in five of the six Sociological/Demographic factors discussed. This contrasts with previous studies showing a 40-65% prevalence of underweight and stunting among Aborigine children in Malaysia [15]. However, as this present study was situated solely within the state of Selangor, such differences in the children's nutritional status observed may be explained by the sample population possibly having lifestyles that differ from children that are considered aboriginal.

As for the COVID-19 factors, Table 3 (provided in the appendix) includes the results of all the variables, with only one factor, "COVID-19 Impact on Employment/Business", observed to produce significant results with both stunting (p-value = 0.046) and wasting (pvalue = 0.009). Since Employment/Business is related to a household's income and purchasing capabilities, it can have both long- and short-term impacts on health. Therefore, it can be concluded that sociological and demographic factors appear to be more prominent contributors to child malnutrition compared to the COVID-19 factors as six sociological and demographic factors were identified to be significant predictors for child malnutrition versus only one significant result under COVID-19 factors. These results are consistent with the findings of another local study [7], which concluded that household income and socioeconomic status were the main determinants of the prevalence of child malnutrition in Kelantan. Furthermore, food, health, and care were found to be the three primary factors influencing a child's nutritional status, according to UNICEF [15], which also supports these findings. Because the sociological and demographic factors observed to have a significant association with child malnutrition mainly fall under the childcare category, the results of the present study appears to be supported by this claim.

Discussion

Because the nature of child malnutrition is a continuous and long-founded topic of interest, common predictors have long been established and stable [7]. However, one such result from this present study that may question the seemingly established predictors of child malnutrition is the impact of household income. In Malaysia, household income is categorized by the following income groups: "B40", "M40", and "T20" [54]. These categories identify the levels at which income earners are classified, with "B40" classifying the bottom 40% of income earners, "M40" as the middle 40% of income

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Fig. 2. Data Distribution (n = 25) by Age Group and Gender among under 5 Children in Selangor State.

earners, and "T20" as the top 20% of income earners. The results of this study have identified household income as an insignificant factor in childhood malnutrition despite being established as one of the most common factors that contribute to malnutrition among children [8,10,11].

In focusing on under-5 children, the present study aimed to draw upon established research emphasizing the critical vulnerability of this age group to the detrimental effects of malnutrition. The importance of young ages in influencing long-term health outcomes have been emphasised repeatedly in prior research, especially when it comes to growth and cognitive development [55]. In order to establish the distinctiveness of 'child' malnutrition and its significance in identifying patterns and trends regarding nutritional status and related factors, the focus was restricted to this particular age group, as past similar studies [17,24,56,57] have also implemented. The data set used in the present study consisted of unequal distributions in terms of age group and sex. As presented in Fig. 2., the sample population consisted of more children aged 2-4 years old compared to less than 2 years old and more than 4 years old. It can also be observed that no male participants were aged less than 2 years old. Additionally, more than half (about 64%) of the children in the study identified as females and only 36% were males.

There appear to be disparities between gender and nutritional status measured by the four nutritional indices visualized by Fig. 3. In particular, the wasting index showed that most of the females in the population were malnourished compared to their counterparts. Moreover, the distribution of male data was quite unsmoothed, with relative departure from the standard unimodal feature of Normal distribution.

Many past studies have discussed the association of gender with the prevalence of child malnutrition. A 2014 study [16] conducted in Terengganu found more girls to be malnourished compared to boys, similar to the present study's findings. However, various other studies and epidemiological evidence that suggest gender to be a risk factor for child malnutrition conclude that biological boys are more susceptible to child malnutrition, which is contrary to the present study's findings [54]. The inconsistencies in these claims may be explained by cultural differences due to varying countries in which the research was conducted, as the studies conducted were not specific to Malaysia, among many other possible external factors, including errors and limitations of the analysis and results.

Table 4 presents the logistic regression analysis of the three selected variables that showed a significant effect on at least one of the nutritional status measurements. The variable 'Age Group' was the only socio-demographic variable that showed significant results, and this was also observed for the nutritional status 'wasting'. This analysis showed that the higher age groups had higher odds of the



Fig. 3. The z-Score Distribution by Nutritional Index and Gender.

nutritional status 'wasting' than the other two. For the COVID-19related variables, 'COVID-19 impact on children's physical activity' and 'COVID-19 impact on children's decrease in health over the last two weeks' were the only 2 variables that showed significance at the p-value < 0.10. The former variable demonstrated a significant impact on wasting, whilst the latter showed a significant impact on underweight prevalence. This is in line with the studies that have suggested and provided evidence for children's decrease in physical activity ever since the COVID-19 pandemic began in 2020 [42,45,47–49].

It must be noted that the present study exclusively utilized data collected during the pandemic. While the study investigates COVID-19's impact on a specific set of sociodemographic parameters and how it relates to the prevalence of child malnutrition, the absence of pre-pandemic data hinders meaningful comparisons and raises questions about the verification and validity of the present study's results. Without a baseline comparing, it is difficult to assess the true influence of the pandemic on these findings and whether these observed patterns existed before, which is another potential limitation of the current study. However, an analysis for primary data collected pre-COVID-19 also presents significant challenges because of the unexpected occurrence of the pandemic, making it difficult to predict the occurrence of such a global-scale event and thus, presenting it to be difficult to set up an observational study using primary data. For future replications or further studies on the topic, a comparative analysis is highly recommended to identify the distinct influence of the pandemic on the patterns of child malnutrition.

Another major limitation of this study that must be highlighted is the relatively small sample size, comprising only 25 children. While every effort was made to ensure the validity and reliability of the findings, the restricted number of participants may limit the generalizability of the results to the broader population [58]. A larger sample size would have provided a more comprehensive understanding of the prevalence and nuances of child malnutrition in the context of the COVID-19 pandemic. Small sample sizes can introduce variability, potentially affecting the study's statistical power and the ability to detect significant associations or trends [58]. Additionally, questions may be raised in regard to the validity of the findings because the small sample size might not accurately reflect the wide range of demographic and socioeconomic traits of the child population in Selangor, Malaysia. A more diverse sample population and larger sample sizes would be advantageous for future research projects in this field in order to improve the study's results' robustness and applicability.

Conclusions

This study aimed to examine the effects of the COVID-19 pandemic on child malnutrition in Selangor, Malavsia, identifying particular focus on changes in household income, food insecurity, and children's lifestyles. The impact of several lifestyle shifts caused by the pandemic was particularly examined in the COVID-19 portion of the survey to determine its impact on the prevalence of child malnutrition. In terms of sociodemographic factors, several variables were found to be significant predictors of child malnutrition, including parental "highest educational level", "type of house", "earning members", "number of children", and "citizenship". Of the 11 COVID-19-related factors tested, only one ('COVID-19 impact on business or employment') was identified to have a statistically significant impact on child nutrition. The present study recognizes various limitations, notably a small sample size that could result in bias and underreporting. Future research should consider a larger sample population with more extensive and diverse samples for comprehensive and conclusive findings. Recommendations for improved questionnaire distribution methods and direct data collection from clinics and hospitals are also suggested for more accurate results and generalizability to the entire state of Selangor, as well as

Table 4

Logistic Regression Analysis for Selected Risk Factors for Stunting, Underweight and Wasting.

Variable	Stunting		Underweight		Wasting	
	p-value	OR (95% CI)	p-value	OR (95% CI)	p-value	OR (95% CI)
Age Group	0.641	0.457 (0.017, 2.301)	0.962	1.075 (0.053, 21.838)	0.072*	7.143 (0.836, 1.030)
COVID-19 impact on children's physical activity	0.295	7.092 (0.181, 277.343)	0.946	0.869 (0.015, 51.955)	0.096*	0.067 (0.003, 1.618)
COVID-19 impact on children's decrease in health over the last two weeks	0.786	1.417 (0.115, 17.460)	0.071*	9.500 (0.826, 109.235)	0.786	1.417 (0.115, 17.460)

***p < 0.001, **p < 0.05, *p < 0.10.

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having other states or country level comparisons amongst population groups.

Ethics approval and consent to participate

The study was approved by the Monash University Human Research Ethics Committee (MUHREC) (Project ID: 27579). Families of the subject participants were invited to participate in the study via personal email invitation, which included a brief description of the study, along with the participant consent form, which they were required to read to understand its implications fully. All participants signed the informed consent form.

Consent for publication

Not Applicable.

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CRediT authorship contribution statement

Conceptualization and design: AR; Methodology: AR, MZH; Validation: AR, MAK, MZH; Formal analysis: NO, MZH, AR;

Appendix

Table 3

Associations between Nutritional Status of under 5 Children and COVID-19 Factors.

Investigation and resources: AR, NO, MAK, MZH; Data curation: MZH, AR; Writing – original draft: NO, AR, MZH; Writing – review & editing: AR, MAK; Visualization: MZH, NO, AR, MAK; Funding acquisition and supervision: AR; Project administration: AR, MZH. All authors have read, reviewed, and approved the manuscript.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Characteristic with categories	N (%)	Malnutrition Status (%)			p-value (FET)
		Stunting (S)	Underweight (U)	Wasting (W)	or (PCT) ^p
COVID-19 Impact on Employment/Business	11 (44.0)	0.0	9.1	45.5	0.046 (S)**
No	14 (56.0)	35.7	21.4	0.0	0.604 (U)
Yes					0.009 (W)***
COVID-19 Impact on Food Accessibility	18 (44.0)	16.7	11.1	27.8	0.597 (S)
No	7 (56.0)	28.6	28.6	0.0	0.548 (U)
Yes					0.274 (W)
COVID-19 Impact on Food Buying Capacity	18 (72.0)	16.7	11.1	27.8	0.597 (S)
No	7 (28.0)	28.6	28.6	0.0	0.548 (U)
Yes					0.274 (W)
COVID-19 Impact on Lateness of Children's Sleeping and Awaking Time	13 (52.0)	15.4	15.4	23.1	0.645 (S)
No	12 (48.0)	25.0	16.7	16.7	1.000 (U)
Yes					1.000 (W)
COVID-19 Impact on Decreased Children's Food Intake	21 (84.0)	19.0	14.3	19.0	1.000 (S)
No	4 (16.0)	25.0	25.0	25.0	0.527 (U)
Yes					1.000 (W)
COVID-19 Impact on Children's Lack of Response	20 (80.0)	20.0	10.0	20.0	1.000 (S)
No	5 (20.0)	20.0	40.0	20.0	0.166 (U)
Yes					1.000 (W)
COVID-19 Impact on Decrease of Children's Health (over last 2 weeks)	21 (84.0)	19.0	9.5	19.0	1.000 (S)
No	4 (16.0)	25.0	50.0	25.0	0.106 (U)
Yes					1.000 (W)
COVID-19 Impact on Children's Quality of Sleep	22 (88.0)	22.7	18.2	18.2	1.000 (S)
Same	3 (12.0)	0.0	0.0	33.3	1.000 (U)
A little worse					0.504 (W)
COVID-19 Impact on Children's use of TV/Computer/Mobile for Leisure	6 (24.0)	33.3	33.3	16.7	.517 ^P (S)
Same (No change)	10 (40.0)	10.0	10.0	10.0	.413 ^P (U)
A little more	9 (36.0)	22.2	11.1	33.3	.435 ^P (W)
A lot more					
COVID-19 Impact on Children's Home Teaching	9 (36.0)	22.2	22.2	11.1	1.000 (S)
No	16 (64.0)	18.8	12.5	25.0	0.602 (U)
Yes					0.621 (W)
COVID-19 Impact on Children's Physical Activity	11 (44.0)	18.2	27.3	36.4	1.000 (S)
No	14 (56.0)	21.4	7.1	7.1	0.288 (U)
Yes					0.133 (W)

****p < 0. 01, **p < 0.05, *p < 0.10;

All p-value is based on the Fisher Exact Test (FET) and ^pPearson Chi-square Test (PET).

Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.jiph.2024.02.019.

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