

Mariana Gonçalves

Food insecurity in children during the COVID-19 pandemic: literature review

Ciências da Nutrição

Faculdade de Ciências da Saúde

Universidade Fernando Pessoa

Porto, 2021

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Declaro para os devidos efeitos ter atuado com integridade na elaboração deste Trabalho de Projeto, atesto a originalidade do trabalho, confirmo que não incorri em plágio e que todas as frases que retirei de textos de outros autores foram devidamente citadas ou redigidas com outras palavras e devidamente referenciadas na bibliografia.

(Mariana de Fátima Rodrigues de Pinho Gonçalves)

Trabalho apresentado à Universidade Fernando Pessoa
como parte dos requisitos para obtenção do grau de
licenciado em Ciências da Nutrição

Orientadora: *Maria Raquel G. Silva*

I. Dedicatória

Antes de mais gostava de prestar o meu reconhecimento à Prof^a. Doutora Raquel Silva pela disponibilidade, por todo o conhecimento transmitido e confiança no meu trabalho. Quero agradecer pela ajuda na orientação deste trabalho, pois proporcionou vários momentos de reflexão e que culminou em crescimento pessoal e profissional.

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IV. List of abbreviations and acronyms

COVID-19 – Coronavirus 2019

CHFI - Children's household food insecurity

FI – Food Insecurity

FPL - Federal poverty line

LFS – Low food security

SES – Social economic status

SNAP - The Supplemental Nutrition Assistance Program

UK – United Kingdom

US – United States

VLFS – Very low food security

V. Title/authors/academic affiliation

Food insecurity in children during COVID-19 pandemic: literature review

A insegurança alimentar em crianças durante a pandemia COVID-19 – Revisão da literatura

Mariana Gonçalves¹

Maria Raquel G. Silva²

1. Estudante finalista do 1º ciclo de Ciências da Nutrição da Universidade Fernando Pessoa.

2. Professora da Faculdade de Ciências da Saúde da Universidade Fernando Pessoa

Mariana de Fátima Rodrigues de Pinho Gonçalves

E-mail: 18270@ufp.edu.pt

Faculdade de Ciências da Saúde da Universidade Fernando Pessoa

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VI. Abstract

In 2020, it is estimated that 149.2 million children under 5 years of age were affected by short stature, 45.4 million suffered from wasting and 38.9 million were overweight. Despite although it's not yet possible to fully account the impact of the COVID-19 pandemic, the estimated increase in 2020 is that it has been equal to the previous five years combined.

Therefore, this study aims to analyze how the COVID-19 pandemic globally affected children's food insecurity, after more than a year after the virus outbreak. This study is a literature review on the theme, using the PubMed and Science Direct databases that included 33 scientific articles.

All associations between food insecurity in children and food consumption, home environment, socioeconomic conditions and mental aspects, were explored.

The association between food insecurity and the COVID-19 pandemic in children is particularly strong. Most articles revealed an increase in children's food insecurity. The prevalence has increased since the beginning of the pandemic, especially in the most vulnerable communities and families with lower socio-economic status ($p < 0.0001$). Families with more than one child had a significantly higher risk of having FI ($p=0.01$) and a higher educational level proved to be protective factors against FI ($p=0.001$).

Lessons from this COVID-19 pandemic must be learned to be well prepared for future crises by improving existing weaknesses; thus, the impact of a new public health crisis would be smaller.

Keywords: COVID-19, food insecurity, children.

VII. Resumo

Em 2020, estima-se que 149,2 milhões de crianças menores de 5 anos sofreram de baixa estatura, 45,4 milhões sofreram de fome e 38,9 milhões apresentaram excesso de peso. Embora ainda não seja possível contabilizar totalmente o impacto da pandemia COVID-19, o aumento estimado em 2020 é que seja igual ao dos cinco anos anteriores combinados. Portanto, este estudo tem como objetivo analisar como a pandemia COVID-19 afetou globalmente a insegurança alimentar infantil, após mais de um ano após o surto do vírus.

Este estudo é uma revisão da literatura sobre o tema, utilizando as bases de dados PubMed e Science Direct que incluíram 33 artigos científicos. Todas as associações entre a insegurança alimentar em crianças e o consumo alimentar, ambiente doméstico, condições socioeconômicas e aspectos mentais foram exploradas.

A associação entre a insegurança alimentar e a pandemia de COVID-19 em crianças é particularmente forte. A maioria dos artigos revelou um aumento na insegurança alimentar das crianças. A prevalência aumentou desde o início da pandemia, especialmente nas comunidades mais vulneráveis e famílias com status socioeconômico mais baixo ($p < 0,0001$). Famílias com mais de um filho apresentaram risco significativamente maior de apresentar IA ($p = 0,01$) e uma maior escolaridade mostrou ser um fator de proteção contra IA ($p = 0,001$).

As lições desta pandemia de Covid-19 devem ser aprendidas, de maneira a estar bem preparado para futuras crises, pois ao melhorar as fraquezas existentes, o impacto de uma nova crise de saúde pública será muito menor.

Palavras-Chave: COVID-19, insegurança alimentar, crianças

1.Introduction

With the unexpected emergence of the Coronavirus (COVID-19) pandemic in December 2019 there was a drastic change in the lives of all people worldwide, becoming an unprecedented public health crisis with profound impacts in several areas, including economic, social and cultural, representing a global threat significant to general development and health (1-3). In fact, COVID-19 is estimated to have caused a dramatic increase of 82-132 million malnourished people, depending on each country economic growth scenario (4).

The need to take safety and security measures in controlling and preventing contagion has brought a change in almost every sector of the economy. From the demand for lockdowns, the closing of offices and markets, and even the closing of borders, have led millions of people losing their jobs and, consequently, their income (5,6).

Thus, the cumulative impact of rising unemployment, loss of income, decreased social mobility, disruption of food supply has resulted in major changes in food systems, making food access and availability challenging, forcing millions of adults and children, already struggling to afford a decent diet, to limit the quantity and quality of their meals. Some households with children who never imagined needing help before the pandemic, experienced food insecurity for the first time (3,7).

Food insecurity (FI) is defined as not having regular access to sufficient safe and nutritious food for normal growth and development and an active and healthy life, which may be due to unavailability of food and/or lack of resources to obtain it (8,9). While the global prevalence of food insecurity has been slowly on the rise since 2014, the estimated increase in 2020 was equal to that of the previous five years combined (10). Globally, in 2019, it was estimated that 144 million children under 5 years of age were malnourished and at least 340 million children suffered from micronutrient deficiencies. Since the appearance of COVID-19, these numbers have dramatically increased (4,11). Although it's not yet possible to fully account the impact of the COVID-19 pandemic, in 2020, it is estimated that 22.0% (149.2 million) of children under 5 years of age were affected by stunting, 6.7% (45.4 million) were suffering from wasting and 5.7% (38.9 million) were overweight (10)

The estimates of these drastic increase in FI due to COVID-19 are especially worrisome for children where lack of access to nutritious and safe food jeopardizes their development, as it can contribute to complications in children's future health, particularly in short term, which can cause acute chronic diseases and, in long term, increase the risk of developing chronic diseases, morbidity and even mortality (6,9).

Although child FI is mainly related to food is also interconnected with other domains of children's daily lives, because FI a known detrimental factor to a child's mental health because children who are food insecure mean they are also under stress, given the important role that food plays in their well-being. Anxiety, shame and even depression are some of the symptoms that can result from childhood food insecurity and is associated with a range of negative developmental consequences like disrupted social interactions, delayed early childhood language development, poor dietary intake, high intake of energy-dense foods, less healthy diets, school absenteeism, behavioral and attention problems in school and poor academic performance (12,13).

One of the most important measures coming from the lockdown that drastically changed the daily lives of the children and with important implications for children's nutrition and food security around the world was the closing of schools due to the temporary suspension of midday meals and supplementary nutrition programs and even compelling some parents to leave their jobs to support children at home (14).

School food services in many countries represent the foundation of education programs and nutrition policies, programs that improve educational outcomes, gender equality, nutrition and food security for children and their families (15). Another factor that has the potential to influence children's food insecurity is the residential context through physical and socioeconomic characteristics and the resources available (or not) in the communities (9).

So, in this sense, the impacts of the pandemic are likely to differ between households with children with different socioeconomic status, including those with underlying vulnerabilities. For example, poorer households are more likely to bear the impact of disruptions to school feeding programs as they are more likely to rely on school feeding services. However, families with children living in remote areas and experiencing more disruptions in value chains and markets are expected to witness an increase in food

insecurity due to disruptions in school food services (15,16). Likewise, it is expected that large, single-parent families are more likely to experience FI (16).

Therefore, the economic consequences of COVID-19 exacerbated the pre-existing weaknesses, worsening the severity of the global food crisis in 2020.

This review aims to analyze how the COVID-19 pandemic globally affected children's household food insecurity, more than a year after the virus outbreak, based on available empirical results.

2. Methodology

This study is a literature review about the impact of food insecurity in children during the COVID-19 pandemic. Articles were selected through the PubMed and Science Direct databases until June 2021.

The keywords used in the research phase were: "COVID-19", "food insecurity", "children" and were used without limitations of date or language. Manual search was also used for some review articles.

Exclusion criteria included studies performed only in adults, elderly, pregnant women, as well as literature reviews and/or systematic review, dissertations and theses. Furthermore, studies outside the scope of interest of our objective were excluded, i.e., those not reporting an association between COVID-19 and food insecurity in children and studies with different outcomes of interest.

In the methodical evaluation phase of the publications, we tried to answer the question "How did the COVID-19 pandemic influence food insecurity in children?". Therefore, all associations with food insecurity in children and food consumption, home environment, socioeconomic conditions and mental aspects were explored.

The selection process of articles corresponding to the steps of the bibliographic research is shown in Figure 1.

After an initial research in the PubMed database, 84 articles were identified. Subsequently, the title and abstract were analyzed to exclude articles that did not meet the predefined criteria, leaving 45 articles. After this step, articles were read in full to verify inclusion and exclusion criteria. Thus, 24 articles were selected, where 15 were the original article type.

In Science Direct, 700 articles were initially identified, and after an advanced search, in which studies were limited to be specific for the keywords, 18 articles were obtained. After reading the title, 12 were excluded because were repeated articles or did not meet the pre-defined criteria, 4 articles remained for analysis.

Through manual search, 6 more articles were obtained.

A total of 33 publications was included, from which 21 were original studies (Figure 1).

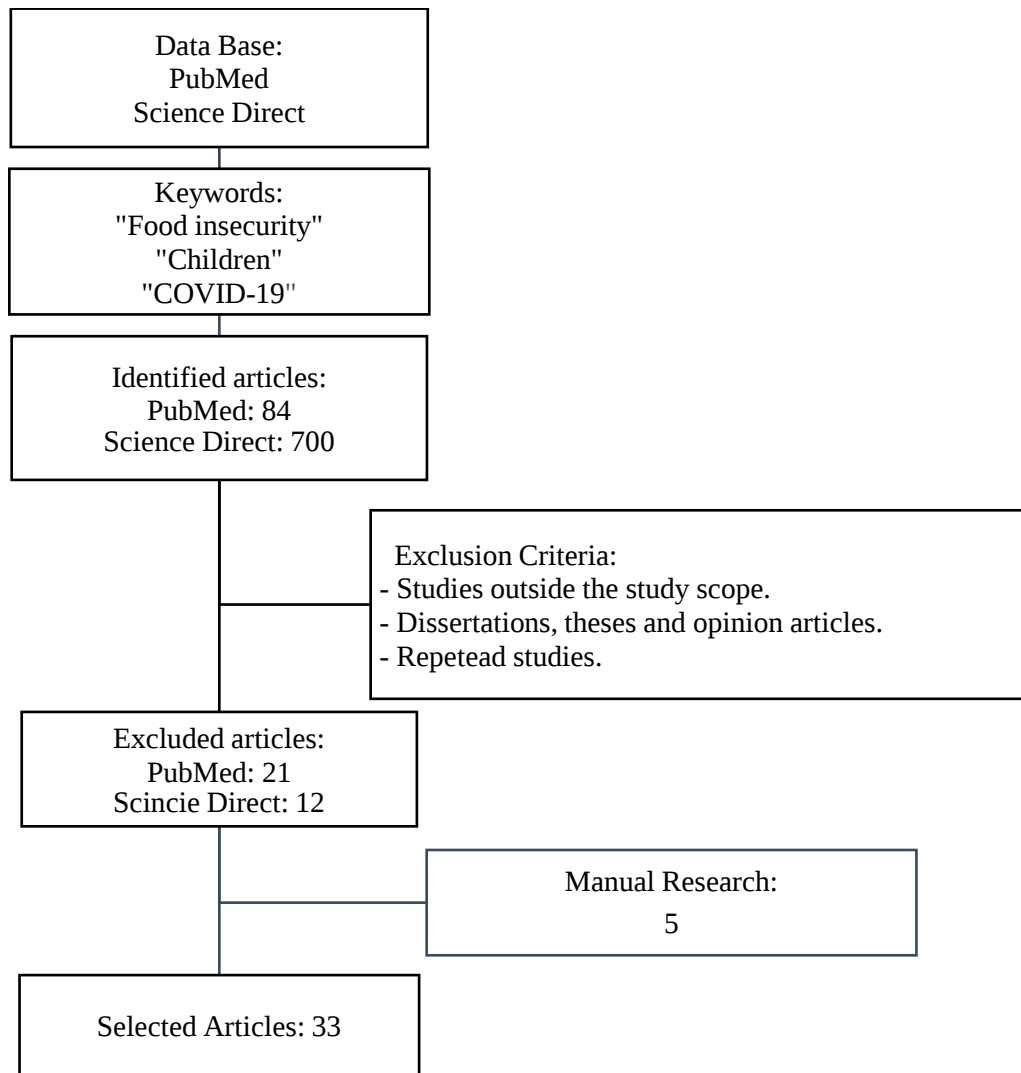


Figure 1 - Flowchart of the process of choosing the articles selected for content evaluation in this review.

3. Prevalence of Food insecurity in Children

3.1. Impact of food insecurity across the globe during the pandemic by COVID-19

Of the studies done with families with children, as shown in Figure 1, most were studies carried out in the United States of America and the data collection of the majority were carried out between the months of April and September 2021.

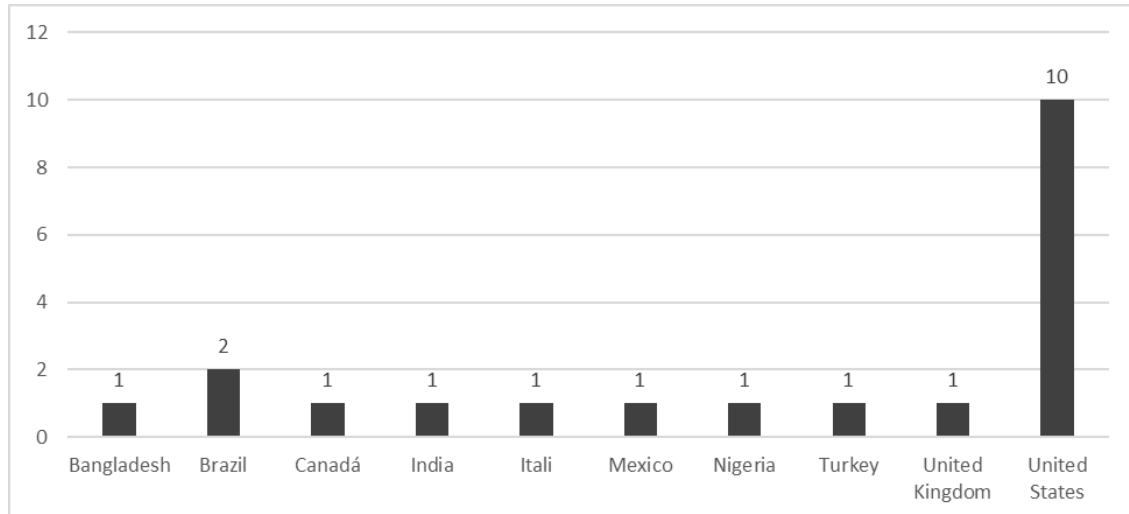


Figure 2: Number of articles according to the countries of the analyzed studies.

The methodology and main results of the original studies analyzed are explained in the annexes (Table 1).

The prevalence of FI was quite high in most of the studies. Six studies evaluated and analyzed the prevalence of CHFIs after the emergence of the pandemic.

In Brazil, a study conducted in two low-income populations in São Paulo city, of which 92% were household with a child under 10 years, a total of 89% of the households with children were in a situation of moderate or severe FI (OR: 1.0; 95% CI: 1.59 - 4.76). In this study, moderate and severe FI was associated with a low level of education, occupation, income and presence of children ($P < 0.0001$) (17).

In Turkey, a study that included 211 households with at least one child, revealed that 57.8% of the families had some kind of food insecurity. 17% were food security at risk, 22% were FI but not with hunger, 11% were FI with moderate hunger and 8% were FI with severe hunger (3).

In the US, one study found that 30% of the families experienced some type of FI (16). Ferrante et al. found that 69% of parents met the criteria for food insecurity as 66% reported not having food or money to buy it, or the food did not last and they did not have the money to buy more (56%) (5).

Abrams et al. observed that 47% of families with children were food insecure. Among these families, 94% of households indicated that concerns about FI started or worsened during the pandemic (19).

In Canada - Ontario, it was found that 8.5% of mothers and 6% of fathers of the children reported FI in their households (20).

3.2. Prevalence of food insecurity before and during the COVID-19 pandemic

As shown in Figure 3, nine studies evaluated the prevalence of food insecurity before and during COVID-19 in families with children (13,16,21-17).

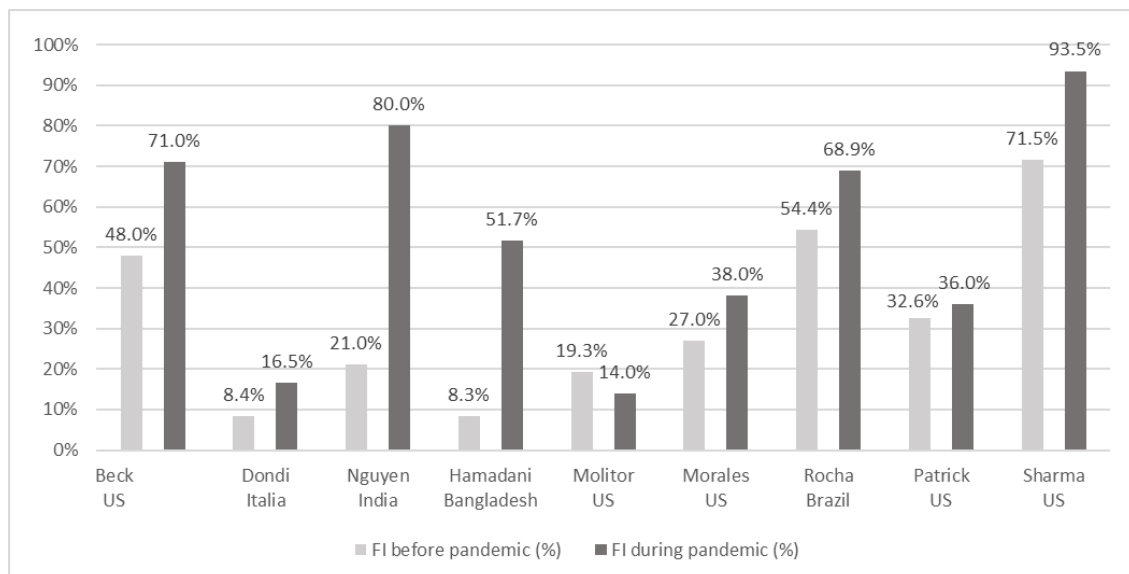


Figure 3 - Prevalence of children's household food insecurity before and during the COVID-19 pandemic.

Prevalence before and after the outbreak of the COVID-19 pandemic increased in all studies except the one by Molitor et al., a study conducted in California to low-income families in which 11,653 mothers with children completed a questionnaire, the 6-item USDA Food Security Survey Module. After analyzing the data and comparing with results from previous years, it was found that in 2020 post-COVID-19 (November 2019 to March 2020), 14.0% of mothers reported very low food security and in 2020 pre-

COVID it was 19.3% (adjusted OR = 1.49; 95% CI: 1.15-1.94; $p = 0.003$), a decrease of -5.3%, as shown in the figure 4. Continuing and enhanced benefits specific to COVID-19 namely the Supplemental Nutrition Benefits Assistance Program (CalFresh Program in California) are possible explanations for such results (25).

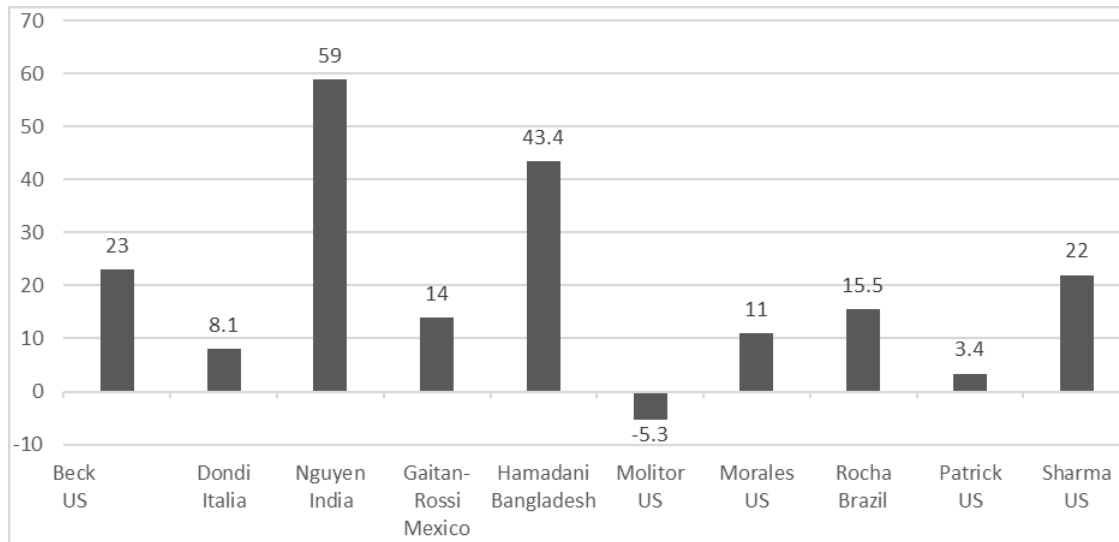


Figure 4 - Rate difference between the prevalence of children's household food insecurity before and during the COVID-19 pandemic.

In the United States, Beck et al. found that FI increased among the families with children 23% ($p < 0.001$) (21) and Patrick et al. discovered that any FI increasing from 32.6% (95% CI: 29.4-35.8) to 36.0% (95% CI: 32.7-39.3) an increase of 3.4% ($p < 0.001$) (25). Sharma et al., after analyzing 4 geographic zones in the US (Houston, Dallas, District of Columbia and Southwest Florida) found that 93.5% reported FI, an increase of 22% compared to 2019 ($P < 0.001$) (13). Morales et al, in a cross-sectional study, in the US observed an increase of 11% in FI¹⁶ and Nguyen et al. in India, found that six months after the start of the pandemic, the prevalence of any level of FI increased from 21% to 80% ($p < 0.001$), an increase of 59% (23).

In Italy, Dondi et al. analyzed households with children, most of whom were Italian, living in Northern Italy, and with a wealthy household economy, found that 8.4% of families reported they were at risk of food insecurity before the appearance of COVID-19 and that this percentage increased to 16.5% ($p < 0.001$), six months after the emergence of the pandemic (22).

In Bangladesh, Hamadani et al. study the prevalence of FI in families' of 2016 children and found that the number of households with children that had some level of FI increased from 8.3% before the pandemic to 51.7% (CI: 48.1-55.4; $p < 0.001$) during the pandemic (24).

A study in Mexico compared the prevalence in 2018 and June 2020 and found that families with some kind of FI increased 14% after the beginning of the pandemic in which the prevalence of mild food insecurity increased by 7.1%; in 2018 mild FI were 31.1% (CI: 30.4-31.7) and in June 2020 were 39.2% (CI: 36.4-42.9). Moderate FI increased by 3.71%; in 2018 were 14.9% (CI: 14.4-15.4) and in June 2020 were 18.6% (CI: 16.4-20.9), Severe food insecurity increased by 3.17%; in 2018 were 9.3% (CI: 8.8-9.7) and in June 2020 were 11.5% (CI: 9.6-13.5). Also, found that FI was more common among households with children (75%) than without children (64%) (29).

3.3. Factors associated with CHFI

3.3.1. Demographics of children and their households

A few studies analyze the basic child demography including the children's age, gender, ethnicity, and also the characteristics of the households that these children lived, namely education level, how many people lived together and whether the families were single parents or not. After analysis, some studies not all, evaluated the association between these characteristics and food insecurity.

In Adams' study, Hispanic ethnicity ($p < 0.001$) but not sex ($p = 0.13$) was found to be associated with food insecurity (28).

In Italy, families with more than one child had a significantly higher risk of becoming FI ($p = 0.01$). Parents with a higher educational level proved to be protective factors against FI ($p = 0.001$) (22).

Morales et al., also verified that households with more children are more likely to become food insecure ($p = 0.016$) (16).

3.3.2. Unemployment and decreased income

Several studies have also evaluated the reasons for the increase in CHIF, and the great majority cited unemployment or decreased income as main reasons (3,21,23,28). In fact,

as shown in Figure 4, the prevalence was quite high, thus leading families with children to change their food patterns and eating habits which will be discussed later.

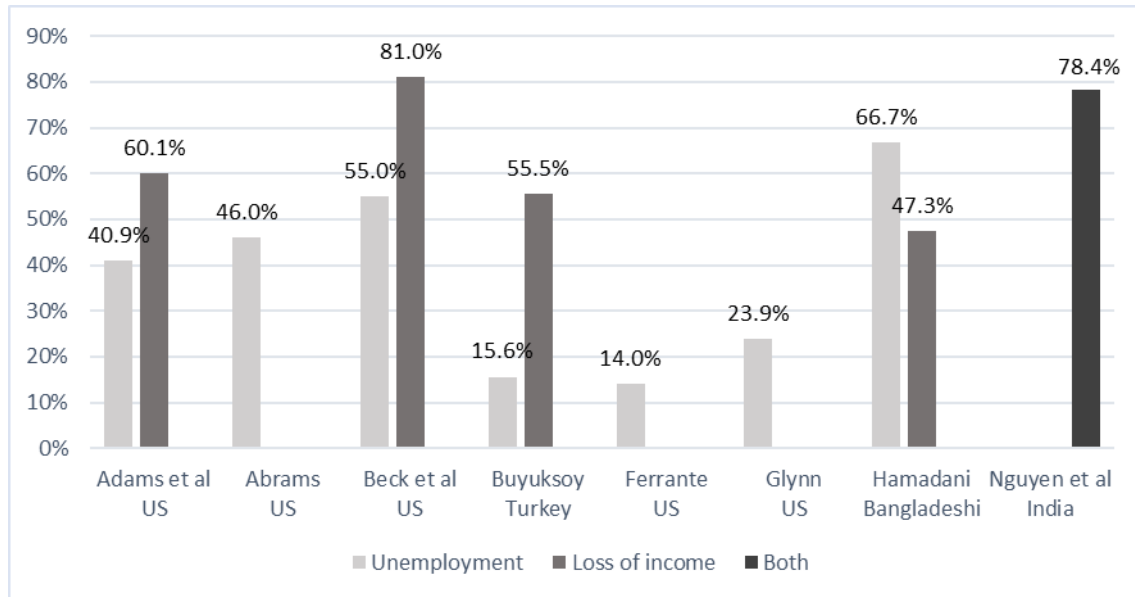


Figure 5 - Percentage of unemployment and loss of income of households with children since the beginning of the COVID-19 pandemic.

As we can be seen in Figure 5, in all studies the unemployment and loss of income rate was quite high. For example, in the US, in one study 60.1% of families experienced a decrease in income, 40.9% lost their jobs leading to 34.6% applying for unemployment benefits (28).

CHFI in a study in Turkey, increased 2.5 times when the household employees were worker or self-employed (95% CI: 0.93 - 4.12; $p = 0.002$) (3).

3.3.3. Socioeconomic status (SES)

A study that analyzed FI according to SES very well was carried out in Mexico, in a cross-sectional survey, where they assessed FI through the Latin American and Caribbean Food Security Scale. In this study, they found that the raw score of FI and SES was negative and statistically significant (-0.4 ; 95% CI= - 0.37, - 0.43). Furthermore, although mild food insecurity was present in people of all SES, as demonstrated in Figure 6, moderate and severe food insecurity increased as the socioeconomic status decreased. Households from low SES levels had a high prevalence of moderate and severe food insecurity (28.9% and 20.9%, respectively) (29).

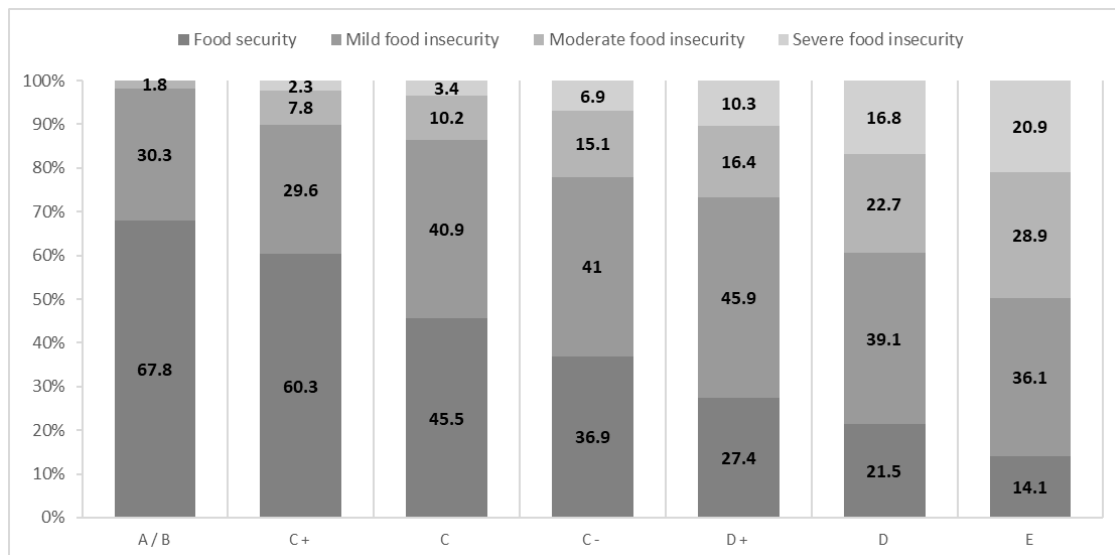


Figure 6 - FI prevalence by socio-economic status in the households of the study. SES is ordered from highest (A/B) to lowest (E). (From Gaitán-Rossi et al., 2020).

Denney's study, analyzed FI using USDA's 18-item food insecurity scale on 8,600 children from families with incomes below 400% of the federal poverty line. In this study, they saw that 55% of the food insecure sample lives in the poorest neighborhoods. Among those families with FPL <400%, the adjusted odds of household food insecurity are smaller the further away the family is from the FPL ($p < 0.001$) (9).

In Bangladesh, it was found that although the impact of income and CHFI were profound in the entire population, FI was more prevalent in households with a father in an unskilled job (63.1%; 95% CI: 53.6 – 72.5; $p < 0.0001$) compared with a skilled job (50.0%; 95% CI: 45.9 – 54.2; $p < 0.0001$) (24).

In Turkey, a study shown that FI after the pandemic increased two times when total monthly income of the household fell below poverty line (95% CI: 0.01-3.9; $p < 0.0049$) (3).

3.3.4. School's closure

UNESCO has estimated that since the start of the pandemic, 1.6 billion students in 199 countries around the world have been affected by school closures with nearly 370 million children not receiving school meals in 150 countries. Globally, it is estimated that by 2020, 39 billion school meals were lost during school closings. It further estimates that children around the world have missed an average of 4 out of every 10 meals at school

they regularly received, with children in some countries missing 9 out of every 10 meals at school (30).

One study carried out in the UK observed that with the impact of the school's closure, lower-income children were 14 times more likely to have used a food bank recently (31).

Abay et al., analyzed the impact of school closures in Nigeria in a study that incorporated 1950 households with children and found that closing schools increased the IF experience of families with children, where the incidences of skipping a meal, running out of food, and going without eating increased by 47% (95% CI: 0.44-0.50, $p < 0.001$), 32% (95% CI: 0.29-0.35, $p < 0.001$), and 20% (95% CI: 0.18-0.22, $p < 0.001$), respectively, increasing the probability of skipping a meal by 9 percentage points (95% CI: 3-17, $p < 0.05$). This suggests that the pandemic had a significant adverse impact among Nigerian households (15).

3.3.5. Changes in children's eating behaviors

In India, in a study with mothers with children less than 2 years old, it was found that since the pandemic, children living in households that became food insecure were less likely to consume a diversified diet (18% vs 28%; adjusted OR 0.57; 95% CI 0.34 - 0.95) as well as vegetables and nuts (57% vs 69%; adjusted OR 0.61; 95% CI 0.38 - 0.97) compared to children living in households with consistent food security. Furthermore, only 19% of the children achieved minimal dietary diversity (≥ 4 food groups), only 1% ate meat or eggs, and 4% ate fruits and vegetables rich in vitamin A (23).

Sharma et al., found that 41.4% of households demonstrated a decrease in fruit and vegetable consumption due to COVID-19 (27).

A study carried out in Canada stated that 60% of children changed their eating habits after the appearance of COVID-19. Of these, 55% started to eat more snack foods (20).

Adams et al. observed that the consumption of takeout/fast-food/pre-confectioned meals decreased considerably (62.0%), while the consumption of meals at home increased (73.3%). Also, found that the changes in children's eating behavior differed by food security status (all $P < 0.01$), for example, the decrease in the consumption of fruits and vegetables was more observed by children's households that were in a very low food security situation (36%) than families that were food secure (11%) ($p < 0.01$). The consumption of high-calorie snacks increased 34.1% ($p < 0.001$) compared with 32.7% in

families with food security. In the other hand, the consumption of desserts and sweets increased 41.4% ($p < 0.01$) in families with food security and only 28.5% in households with children in situation of very low food security (28).

In Italy, 40.2% of children changed their food intake. Furthermore, of the 27.3% of the families who stated that their children were eating more, 60.3% declared an increase in the consumption of snacks, 14% of fruit juices and 10.4% of soft drinks (22).

In contrast, one study in San Francisco, found an increase of 41% in fruit and vegetable consumption in families with children with 4-12 years old with only 17% of the households reported a decrease intake. This result may have been due to the high number of families that accessed food banks and may have received fresh products from them (21).

3.3.6. Children's mental health

Another variable that can influence food insecurity is the psychological state of children.

Dondi et al, discover that the feeling of loneliness was associated with a modification in children's food consumption that led with both weight gain (OR:1.43; 99% CI: 1.15-1.77; $p < 0.01$) and weight loss (OR: 1.70; 99% CI: 1.11-2.61; $p < 0.01$). Furthermore, they found that during the lockdown, children over 14 years old were at significant risk of weight loss (OR: 3.19; 99% CI: 1.44-7.09; $p < 0.01$) (22).

Glyn et al. evaluated 169 preschool children, and found that in households with children where routines were more practiced, it was observed lower levels of depressive symptoms ($p < 0.01$) and externalizing behavior ($p < 0.05$). Adjusting for the characteristics of children (age and sex) and family (income, food security, two-parent family) did not change the association between child mental health and family routines (18).

Carrol et al., observed that 87% of children increased recreational screen use since COVID-19 which is a concern because higher levels of screen time seem to be strongly associated with greater adiposity, less healthful diets, depressive symptoms as well as lower quality of life (20).

In the study of Patrick et al, 14.3% (95% CI: 12.0-16.7) of the parents reported worsening in their children's behavioral health. Among the families in which parents reported

worsening children's behavioral and mental health, 19.9% (95% CI: 6.3 – 31.6) also reported worsened food security (13).

4. Discussion and Conclusion

This review summarized the results. on the prevalence and determinants of food insecurity in households with children since the appearance of the COVID-19 pandemic.

At the time of our research, there's still limited data on the impact of COVID-19 on FI in children and these data continue to be updated as new evidence emerges. The evidence reviewed here provides several possible directions for future research on children's age, gender, parental factors, household composition, education, and psychological factors and the link with food insecurity in children.

In most studies, information was collected via online, which was the most appropriate method due to restrictions caused by the pandemic. However, since the results obtained were through the parents' reports, they may be subject to bias.

This review shows that the association between food insecurity and the COVID-19 pandemic in children is particularly strong. In all countries where the studies analyzed were carried out, the prevalence of FI in children increased after the appearance of COVID-19. Only one study, carried out in California, the prevalence decreased, and the authors cited as a possible explanation the use of continuous and enhanced benefits specific to COVID-19 (25).

In fact, it's important to note that a few studies (5,17,27) found that some families with children benefited from nutritional assistance programs and others accessed food banks, which may have helped to mitigate food insecurity in these families. However, only one study reports that their results suggest that funded economic assistance programs can decreased FI (25).

It's also important to note that the influence of children's age and sex is lacking in the research included in this review and may be an important area for future research, as it interferes with the amount of food they consume and consequently with food choices and associated expenses; nine articles considered the age and six considered the sex of the population evaluated, but none explained the importance of this information.

The risk factors identified for an increase in FI are not surprising, as they are almost all linked to disposable economic means available.

In fact, the prevalence of food insecurity in children has increased since the beginning of the pandemic, especially in the most vulnerable communities and families with lower socio-economic status. Financial issues due to high rates of unemployment or decreased of income were the most reason cited for the increase of FI prevalence in the households with children (19,21,23).

Focusing on subgroup analyses, FI in households with children from lower SES levels had a higher prevalence and also in families whose income comes from unskilled labor, although the impacts of COVID-19 on income and food insecurity are deep and transversal to the entire population, regardless of the source of income (9 24,29).

Since financial instability was one of the major contributors to the increase in food insecurity among children, one of the countermeasures would be that governments should increase the wages of low-income families and keep essential food prices affordable so that in the future, families will be able to guarantee food security for their children both in normal times and in times of crisis.

In addition, larger families with more than one child had a significantly higher risk of having FI, as the costs associated with feeding were higher, in contrast to children with parents or caregivers with higher education, that they proved to be protective factors against FI, probably because they had better paid jobs (12,19).

Furthermore, a single parent, a younger, or a less educated person is more likely to be food insecure than their respective counterparts (22).

Abrams et al., analyzed the ethnicity of families with children, and found that FI was more reported by Hispanic families, whose immigrant status and language barriers can explain racial disparities, employment and health difficulties (19).

So, according to the heterogeneity of geographical areas and their respective food needs, direct and specific guidance from governments is needed in order to improve the provision system of emergency food services.

Several studies analyzed the quality of the diet and how the children's food environment has changed since the outbreak of the COVID-19 pandemic and found a significant decrease in fruit and vegetable consumption and an increase in processed food. The main

reason cited for this was the affordable price of less healthy foods, which is a concern as this trend can become permanent rather than temporary (20, 23, 28).

It would be interesting to analyze and that no study in this review had done was the link between FI and children's nutritional profile in this time of pandemic.

Another factor which contributed to the increase for the children's FI was the closure of schools as they play an important role in the direct delivery of health and nutrition services essential for each child's development (15,31). One of the important consequences of this situation was the temporary suspension of meals at mid-day (30). For many children, school lunch represents half of their caloric intake in a day (32).

In addition, it can improve the quality of food as several studies have shown that children who eat school lunch every day consume more fruits and vegetables, fiber and grains compared to those who do not (6,14,32).

Therefore, when children lost their school lunches due to the closing schools, parents ended up spending more at the end of the month, which further contributed even more to financial instability and thus, ending up in a situation of FI.

Another factor addressed in some studies analyzed that also contributed to the FI in children during the pandemic was their mental state. With the restrictions all imposed due to COVID-19, especially the closing of schools, symptoms of anxiety, worsening behavioral health and even depression were reported by the parents, with the consequences of lack of appetite and less healthy diets (18,20). For example, Patrick et al., found that families in which parents reported worsening behavioral and mental health of their children also reported worsening food security (13).

As with any research study, the results of this review also have some limitations. First, the use of self-reports for multiple variables is subject to response bias and can affect reliability. Second, the classification of FI presented by several studies, in which they used different methods/scales. Third, the main findings of this review cannot be considered representative of the general population, because there are no studies yet in poorer countries, such as in African (only one in Nigeria) or Asian countries, where in some country's poverty is very high and access to food is very limited. This limitation is important, in the sense of understanding how the COVID-19 pandemic influenced the food insecurity of children in the poorest countries.

On the other hand, this is the first review on the influence of the COVID-19 pandemic on food insecurity exclusively in children and provides interesting and unique results on these issues.

To conclude, the COVID-19 pandemic had a significant negative impact on children's food security. This review highlights the importance of this problem, which has already affected millions of children and which, unfortunately, COVID-19 has exacerbated.

It is necessary to make good quality food accessible and ensure that food supply chains are re-established during and after the pandemic. In addition, it's also important that policy restriction measures are planned considering potential negative effects on children's health and nutrition, and alternative means are secured.

Therefore, we must learn from the COVID-19 pandemic and how important it is to be well prepared for potential future crises by improving existing weaknesses; thus, the impact of a new public health crisis might be less prevalent.

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6. Attachments

Table 1- Prevalence of children's food insecurity in selected studies

Author. Year	Country	Participants	Metodology	FI measure	Prevalence of FI (%)	Main findings
Abay et al. 2021	Nigeria	1950 households with children	Phone survey	Living Standards Measurement Study-Integrated Agriculture Survey	N.A	• Closing schools increased the IF increasing incidences of: - Skipping a meal (47%, 95% CI: 0.44-0.50, $p<0.001$), - Running out of food (32%, 95% CI: 0.29-0.35, $p<0.001$), and - Going without eating (20%, 95% CI: 0.18-0.22, $p<0.001$),
Adams et al. 2020	US	584 parents with child 5 to 18 years of age	Single online survey	6-item USDA Food Security Survey Module	20% experience VLFS $p<0.01$	• Hispanic ethnicity ($p < 0.001$) but not sex ($p= 0.13$) was found to be associated with FI.
Abrams et al. 2020	US	200 families with children	Interview	American Academy of Pediatrics 2-question food insecurity screen	47% reported FI.	• Number of children in the household showed a strong association with FI ($p=0.13$) • Hispanic families had higher FI (54%) than non-Hispanic ($p<0.001$)

Beck et al. 2021	US	145 parents with children being the ages of 4 and 12 and having BMI $\geq 85^{\text{th}}$	Online or telephone survey	2-item Huger Vital Sign	48% had FI pre-pandemic 71% had FI during pandemic p<0.001	• 54% used foodbanks (p<0.001) • No association between FI during the pandemic and child consumption was found
Buyuksoy et al. 2021	Turkey	211 households with at least one child	Online survey	U.S. Household Food Security Survey Module	57.8% had FI	• FI increased 2.5 times when the household employees was worker or self-employed (p=0.002)
Carrol et al. 2020	Canada	254 families with young children	Online survey	Two-item food security measure adapted from Gundersen	8.5% of mothers and 6% of fathers of the children reported FI	• 60% of children changed their eating habits • 87% of children increased recreational screen
Denney et al., 2020	US	8,600 children	Early Childhood Longitudinal Study-Kindergarten	USDA's 18-item food insecurity scale	58.4% reported FI.	• FI is less likely for children in more highly educated households (p<0.05)
Dondi et al., 2020	Italy	5811 parents of children <18	Online survey	Wilcoxon signed-rank test	8.4% reported being at risk of FI before pandemic 16.5% reported FI during pandemic	• Families with lower SES, more than one child, with at least one parent on furlough, with any worsening of the household economy, showed a significantly higher risk of becoming FI. (p<0.01)

Escobar et al. 2020	US	1875 Latinx families	Three longitudinal studies (TAB, LEAD and HEN)	18-item USDA Household Food Security Module	12%, 26.15% and 32.4% reported child LFS	• There were no associations between socio-demographics including maternal education level and employment status with CHFI.
Ferrante et al. 2021	US	1000 parents who have at least one 4–8-year-old child	Online survey	Hager 2-item brief screen	69% were FI.	• 66% felt that they might run out of food and not have money to purchase more; • 56% of the families the food purchased hadn't lasted and they didn't have money to purchase more.
Gaitán-Rossi et al. 2020	Mexico	1563 mexicans 18 years	3 cross-sectional survey	Latin American and Caribbean Food Security Scale	24.92% were food secure 41.86% had mild FI 20.35% had moderate FI 12.87% had severe FI	• FI was more common on households with children (75%) than without children (64%) • Food insecurity was negatively correlated with SES (-0.4, 95%CI = -0.37, -0.43).
Glynn et al. 2020	US	169 preschool children	Online survey	5-questions USDA food security module	30% experienced some FI.	• Lower levels of depressive symptoms ($p<0.01$) and externalizing behavior ($p<0.05$) was observed in households with children where routines were more practiced.

Hamadani et al. 2020	Bangladesh	2424 mothers of children	Interrupted time-series design	Household Food Insecurity Access Scale	FI increased from 8.3% before the pandemic to 51.7% (CI: 48.1-55.4; $p<0.001$) during the pandemic.	• FI was more prevalent in households with a father in an unskilled job (63.1%; 95% CI: 53.6 - 72.5; $p<0.0001$) compared with a skilled job (50.0%; 95% CI: 45.9 - 54.2; $p<0.0001$).
Manfriato et al. 2020	Brazil	909 householders which 92% were householders with child <10 years	Online questionnaire	Brazilian Food Insecurity Scale	89% of the householders with children had moderate or severe FI.	• FI was associated with low level of education, occupation, income and presence of children ($p<0.0001$).
Molitor et al., 2021	US	11.653 mothers with child(ren) 5 to 17 years	Telephone interviews	Very Low Food Security, USDA Food Security Module	2020 pre-pandemic, VLFS was 19,3%: 2020 post-pandemic, VLFS was 14%. OR: 1.49; $p=0.003$	• Publicly funded economic assistance programs can decrease FI

Morales et al. 2021	US	20,543 households with children	Survey	Household Pulse Survey	38% had FI	• Women headed households experienced higher levels of food insecurity than men-headed households ($p = 0.025$); • Black-headed ($p=0.003$) and Hispanic-headed ($p < 0.001$) households faced greater FI; • Low income ($p < 0.001$) and poor ($p = 0.002$) households experienced higher levels of FI.
Nguyen et al., 2021	India	569 mothers with children < 2 years	Longitudinal survey	Food and Nutrition Technical Assistance Project/United States Agency for International Development (FANTA/ USAID) HFI Access Scale	Any FI increased from 21% to 80%.	• Children in FI situation were less likely to consume a diversified diet (18% vs 28%; adjusted OR 0.57; 95% CI 0.34 - 0.95) as well as vegetables and nuts (57% vs 69%; adjusted OR 0.61; 95% CI 0.38 - 0.97) • Only 19% of children achieved minimal food diversity (≥ 4 food groups).
Parnham et al., 2020	UK	635 children	Questionnaire	Reporting using a food bank in the last four weeks and reporting a household member feeling hungry but being unable to eat in the past week	N.A	• With the impact of the school's closure, lower-income children were 14 times more likely to have used a food bank recently.

Patrick et al., 2020	US	1011 parents with children under 18	National survey	Categorized FI as: Mild (“could always afford enough to eat but not always the kinds of food we should eat”), Moderate (“sometimes could not afford enough to eat”), Severe (“often could not afford enough to eat”).	Before COVID-19: None: 67.4% (64.2, 70.6) Mild FI: 26.7% (23.7, 29.7) Moderate FI: 4.6% (3.1, 6.1) Severe FI: 1.3% (0.4, 2.2) After COVID-19: None: 64.0% (60.7, 67.3) Mild FI: 28% (25.0, 31.1) Moderate FI: 6.2% (4.4, 8.1) Severe FI: 1.8% (0.7, 2.8)	• 11% (CI: 3.7-18.5%) of parents that reported worsening behavioral and mental health of their children also reported worsening food security.
Rocha et al. 2021	Brazil	577 mothers	Telephonic survey	Brazilian Food Insecurity Scale	68.9% reported FI.	• FI was 15.5 % higher (95 % CI 5.9, 25.1, $p < 0.001$) during the pandemic as compared with November 2017. • Increased FI was associated with unemployment (OR: 6.70; 95 % CI 3.14, 14.30). • Families that received government assistance also had increased likelihood of FI (p-values < 0.001).

Food insecurity in children during COVID-19 pandemic: literature review

Sharma et al. 2020	US	1048 families with children	Online survey	2-item Hunger Vital Sign	An increase of 22% compared to 2019 reported FI ($p<0.001$).	- Hispanic families had higher FI (94.7%) than other racial/ethnic groups ($p<0.001$) 41.4% reported a decrease consumption of fruits and vegetables.
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N.A – Not available

Table 2: Demographic characteristics of children and their households

First Author	Child Demographics		Race-ethnicity (%)	Household Structure		
	Age (years)	Sex (%)		Parent's education level (%)	No of children in the household (%)	Other characteristics
Adams	5-18	Male – 47.9 Female – 52.1	White – 82.4 African American – 10.1 Asian – 5.0 American/ Indian – 3.3 Other – 9.1	High school or less – 19.0 Some college – 18.3 Associate's degree – 14.4 Bachelor's degree – 21.9 Some graduate school or more – 26.4	NA	Married or in a domestic partnership – 78.1 Single – 14.2 Divorced or widowed – 7.7
Abrams	0-6	NA	Hispanic – 82.0 Non-Hispanic – 17.5 No data – 0.5	NA	0 – 55.0 1 - 38.5 2 – 5.0 >2 – 1.0 No data - 0.5	Number of other household members: 1 – 7.0 2 – 64.0 >2 – 28.5
Beck	4-12	Male – 45.0 Female – 55.0	Latino – 77.0 African-American – 8.0 Asian – 2.0 White – 2.0 Pacific Islander – 0.7 Mixed race-ethnicity – 10.0	Less than high school degree – 36.0 High school degree – 48.0 College degree or beyond – 16.0	NA	NA
Buyuksoy	-	-	-	Graduate – 8.5 Undergraduate – 40.3 High school 24.6 Middle school – 19.0 Primary school – 7.6	1 or 2 - 86.3 3 or 4 - 13.7	No of individuals living in the household: 3 or 4 – 75.4 5 or more – 24.6

Food insecurity in children during COVID-19 pandemic: literature review

Dondi	0-18	NA	Na	Middle school or less – 15.3 High school – 44.5 University degree or more – 41.2	1 – 41.4 2 – 48.6 3 – 7.7 >3 – 2.3	The parents live together: Yes – 91.7 No – 7.4 Single parenthood – 0.9
Ferrante	4-8	Male – 55 Female - 45	White – 69 Black or African American – 12 Asian – 11 Other – 8 Hispanic – 22	≤ High School – 20 Some College/Tech – 27 Bachelor's Degree – 17 ≥ Graduate Degree - 26	1 – 18.0 2 – 45.0 3 – 24.0 4+ – 12.0	Married/ Living with partner – 83.0 Single – 9.0 Divorced/ Separated/ Widowed – 8.0
Glynn	2-6	Male – 53.3 Female – 46.7	Latino – 47.9 White – 32.0 Asian – 11.2 Multi-Ethnic – 5.9	High School or less – 40.3 / 22.5 Some College or Associates – 26.8 / 42 College Degree – 16.7 / 16 Graduate Degree – 16.1 / 19.5	Na	Dual Parent Household – 83.3
Nguyen	0-2	Male – 49.0 Female – 51.0	Na	Never attended school – 24.8 Primary school - 13.9 Middle school – 24.3 High school – 30.1 Graduate and above – 17.8	NA	NA

N.A – Not Available