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Hunger, Food Sovereignty and Public Health

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Editorial: Hunger, Food Sovereignty and Public Health

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Keywords: hunger, food security, public health, climate change, vulnerable populations

Editorial on the Special Issue

Hunger, Food Sovereignty and Public Health

The escalating environmental and social crises have long warned of worsening challenges related to food security and sovereignty [1]. However, the COVID-19 pandemic revealed the fragility of food systems across geographic scales. In Latin America, 247.8 million people in 2022 were forced to reduce the quality or quantity of their food, experienced hunger, or went days without eating [2]. The current climate crisis has emerged as a significant public health challenge due to its direct and indirect impacts on various dimensions of wellbeing. Notably, the second goal of the 2030 Agenda for Sustainable Development Goals— "Zero Hunger"— increasingly appears unattainable, partly because of climate change [3]. Unsurprisingly, the impacts of climate change are unevenly distributed across regions and social groups. For example, 95% of crops in Africa rely on rainfall for irrigation, making the continent particularly vulnerable to climate variability, such as unpredictable rainfall patterns. Conversely, California irrigates 90% of its crops with advanced technology, yet much of this agricultural production is industrial [4].

Hunger is not merely an environmental or technical issue—it is a political one. Decisions made by those in power directly affect what families can place on their tables daily. While technological innovations play a role in increasing food production, addressing hunger requires broader measures. These include ensuring adequate and sufficient land for food cultivation (e.g., agrarian reform), promoting agroecological models that counter industrial monocultures, protecting marine ecosystems, and advancing fair trade in food markets. States must also confront violence against environmental leaders and improve public awareness, as misinformation about the climate crisis, its drivers, and the role of the agribusiness industry continues to spread through mass media and social networks [5].

In response to these challenges, international technical cooperation agencies have proposed various agendas to mitigate global hunger. Meanwhile, communities persist in their resistance and develop collaborative initiatives to ensure food security in rural and urban areas. For example, La Vía Campesina continues to advocate for food sovereignty, while agroecological family farming initiatives are gaining momentum in rural Colombia [6].

This Special Issue features seven papers that explore diverse strategies and innovations aimed at addressing the multifaceted challenges of hunger and public health. They highlight how to integrate food insecurity into routine clinical care to improve risk assessment and management in patients Choe and Pak; examine the unique challenges of food insecurity faced by older women, less educated individuals and those in impoverished geographic areas in Thailand Phulkerd et al.; demonstrate that food bank users in Canada exhibit diverse strategies to cope with food insecurity Pérez et al., show how community initiatives (e.g., communal kitchens)

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proved more effective than food distribution platforms in addressing hunger and fostering social solidarity during the COVID-19 lockdown in Colombia Chavarro and Mosquera-Becerra; call for a paradigm shift from viewing recipients of nutrition programs as beneficiaries to acknowledging them as human rights holders and policy allies Mejía Toro et al.; and propose evidence-based strategies to eradicate hunger Arigbede et al. Additionally, these papers serve as examples of measuring food insecurity and other relevant methods.

The current food landscape is undeniably complex and demanding. Despite significant progress over recent decades, hunger remains a grim reality for millions. The guiding principle for addressing this challenge must be the universal right to food. Achieving this requires medium-term investments in early warning and rapid response systems to prevent and mitigate food crises, alongside long-term local and international actions grounded in environmentally respectful agroecological agriculture and the production of nutrient-rich foods. Let us strive for a world where food security is not a privilege but a fundamental right, achieved through collective commitment, equity, and sustainable practices.

AUTHOR CONTRIBUTIONS

JM wrote the first draft of the editorial. LO prepared the final version of the editorial. All authors contributed to the article and approved the submitted version.

CONFLICT OF INTEREST

The authors declare that they do not have any conflicts of interest.

GENERATIVE AI STATEMENT

The authors declare that Gen AI was used in the creation of this manuscript. During the preparation of the manuscript the authors used Chat GPT version 4 (OpenAI) to translate the draft of the manuscript from Spanish to English. The authors reviewed the translated document and made adjustments to confirm its accuracy and to reflect the authors' writing style. The authors take full responsibility for the content of this editorial.

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Food Insecurity, Healthcare Utilization, and Healthcare Expenditures: A Longitudinal Cohort Study

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Objective: This study examines the longitudinal association between household food insecurity and healthcare utilization and expenditure.

Methods: A multi-wave longitudinal cohort study was conducted using the 2008–2019 and 2021 waves of the Korean Welfare Panel Study. The baseline data included participants aged ≥19 years with valid responses to the food insecurity and healthcare questionnaires in the 2008 wave (n = 12,166). Healthcare outcomes encompassed outpatient visits, inpatient admissions, days hospitalized, and personal healthcare expenditure. Random effects Poisson and linear regressions were estimated.

Results: Severe food insecurity was associated with a higher incidence rate of outpatient visits (IRR, 1.14; 95% CI, 1.12–1.17), days of hospitalization (IRR, 1.18; 95% CI, 1.13–1.22), and inpatient admissions (IRR, 1.40; 95% CI, 1.18–1.65). Moderate food insecurity was associated with 10.4% (β = −0.11; 95% CI, −0.14 to −0.07) or 238,276 KRW reductions in personal healthcare expenditures in the subsequent year.

Conclusion: Household food insecurity was linked to increased healthcare utilization and reduced personal healthcare expenditure among Korean adults. Our findings present opportunities to identify target populations for healthcare policies and interventions.

Keywords: food insecurity, poverty, hunger, healthcare utilization, healthcare expenditure

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INTRODUCTION

Food insecurity occurs when households are unable to acquire nutritionally adequate and safe food due to insufficient financial means and resources. Between 2019 and 2021, more than 2.7 million or 5.3% of the Korean population reported experiencing food insecurity in the preceding 12 months [1]. Approximately 0.7% experienced 24-h periods of caloric deprivation, a condition referred to as "severe food insecurity" [1]. Food insecurity constitutes a complex social and economic problem with significant health and wellbeing implications [2]. Individuals in food insecure households face tradeoffs between food and other necessities, including medication, housing, and utilities [3, 4].

The growing evidence points to food insecurity as a strong predictor of preventable chronic conditions, as well as poor physical and mental health [5–11]. Food insecurity can lead to adverse health outcomes through several mechanisms, including nutritionally inadequate diets, stress and anxiety, challenges in managing chronic conditions, and medication non-adherence [5, 11–13]. These

factors jointly contribute to higher mortality rates and premature deaths among food insecure populations in the United States [14] and Canada [15].

Prior research has documented the challenges that food insecure households face when obtaining medical services; they are more susceptible to illnesses and have greater medical needs, yet they often delay care when it is needed [16–18]. Some studies have shown that food insecurity leads to increased medical expenditure and greater use of acute care services among children [19, 20], older adults [17, 21], and individuals with chronic conditions [22]. On the other hand, several studies have reported reduced outpatient visits and lower access to modern healthcare in food insecure populations [20, 23, 24]. In South Korea (Korea, hereafter), where healthcare provision is universal, food insecure individuals can access primary and routine care at an affordable rate, but they may encounter financial barriers to advanced medical services that require significant co-payments or out-of-pocket expenses [25, 26]. Consequently, they may opt for cheaper treatment alternatives instead of the suggested treatment plan, and be unable to receive timely care for their medical conditions. The co-payment burden can result in delayed or insufficient healthcare utilization, which can further exacerbate health problems [27, 28].

Conceptual models suggest that food insecurity can have both positive and negative effects on medical service use. The neoclassical model of household production [29] predicts that household consumption, including medical care, is restricted by resource constraints. Healthier diets generally cost more, and food insecure households may sacrifice basic necessities to secure food-related budgets [3]. This sacrifice may include limiting budgets for healthcare, leading food insecure individuals to forgo necessary healthcare and medications. An alternative framework by Andersen and Newman proposes that healthcare utilization is determined by three factors: a) predisposing component (one's predisposition to healthcare use); b) enabling component (one's ability to access healthcare); and c) illness level (one's need for healthcare services) [30]. Food insecurity is considered a predisposing factor for healthcare use, as increased vulnerability among food-insecure individuals may generate demand for medical services [23]. The comorbidities associated with food insecurity may induce the need for healthcare, resulting in a positive association between food insecurity and healthcare utilization [19–22, 31–37].

Currently, there exists limited research on how food insecure Korean adults address the dual challenges of healthcare access and food insecurity. In this study, we utilized data from the Korean Welfare Panel Study to examine the longitudinal associations between food insecurity and subsequent healthcare utilization and expenditure in a nationally representative cohort of Korean adults aged ≥19 years. This study improves upon prior research by a) employing multi-wave longitudinal data with 12 years of follow-up, b) controlling for employment, income, and consumption variables that may confound the effect of food insecurity, and c) examining a healthcare system characterized by high co-payments and out-of-pocket expenses for medical services [25]. We hypothesize that food insecurity is associated with greater healthcare use but lower out-of-pocket medical spending among Korean adults.

Healthcare Delivery in South Korea

The National Health Insurance (NHI) in Korea is a critical component of the nation's healthcare delivery, providing access to medical services for the general population [38, 39]. The NHI was established in 1977, initially mandating health insurance coverage for businesses with more than 500 employees. By 1989, it expanded to include all citizens, becoming a universal healthcare program. In 2000, the Korean government consolidated 370 insurance funds and unions into a single insurer, the National Health Insurance Corporation, to manage mandatory participation and operation of the NHI [40]. Korean citizens can enroll in the NHI through two channels: the employer-provided program and the locally provided program [39]. The employer-provided program serves employees whose insurance premiums are partially paid by their employers. The locally provided program caters to those who are neither employed by others nor family members of policy-holding employees.

The NHI is comprehensive in its coverage, yet it falls short in certain areas. While the benefits package includes most high-probability inpatient and outpatient services, it excludes low-probability, high-cost medical services used to treat severe health conditions [41]. High out-of-pocket cost burdens are also imposed on covered services. On average, a Korean citizen pays 1,065 USD or 30.3% of their annual healthcare expenses out-of-pocket [42]. The co-payment rates vary depending on the types of care and provider characteristics, ranging from 30% for outpatient services at local clinics to 50%–60% for outpatient services and doctors' fees at tertiary care hospitals [26]. The NHI has gradually expanded to alleviate co-payment burden for severe conditions [43]. Despite the program's continued expansion, medical examinations and services essential for survival remain not fully covered by the NHI, thereby creating a financial barrier to healthcare utilization [44].

As low-income individuals carry greater health risks, they tend to spend a disproportionately large portion of their financial resources on outpatient care and medications [45]. Studies have demonstrated that catastrophic health expenditure is a significant predictor of poverty among marginalized households in Korea [45–47]. Furthermore, researchers found that high out-of-pocket medical expenses deter these households from seeking necessary medical care, which can exacerbate their health conditions and widen the health gap between wealthier and poorer households [48]. The co-payment structure of the NHI poses a greater financial burden on low-income families with severely ill members [46], and these costs can rapidly accumulate over the course of treatments. In the United States, such households often cut back on other necessities such as food and housing [49], exhaust savings [50], or even fall into a medical debt trap [51], although evidence is not concrete in the Korean context.

METHODS

Data Source and Study Sample

This study utilized multi-wave data from the Korean Welfare Panel Study (KoWePS). The KoWePS is a longitudinal and nationally representative survey of community-dwelling Korean adults, administered by the Korean Institute of Social and Health Affairs

and Seoul National University. The initial sample was drawn from the Census using a two-stage stratified cluster sampling design and has been tracked every year since 2006. The KoWePS includes data on demographic background, household assets, welfare use, health status, subjective wellbeing, and healthcare utilization. Food insecurity was first assessed in the 2008 survey and has been recorded annually since then. The study sample includes KoWePS participants aged ≥19 years who provided valid responses to the food insecurity and healthcare questionnaires in 2008 (N = 12,166), and their follow-up measurements in the 2009–2019 and 2021 surveys. The participants in the baseline sample were tracked for an average of 10 years, allowing us 122,241 observations (**Supplementary Table S1**). The Institutional Review Board at Sungkyunkwan University exempted this study from human subject review as it used de-identified data.

Food Insecurity

Food insecurity was assessed using the Korean Household Food Security Survey (KHFSS), which inquires household food access over the last 12 months. The measurement items consist of (a) "In the preceding year, because of economic hardship, I did not have enough money to buy food even when I was out of food"; (b) "In the preceding year, because of economic hardship, I did not have enough money to have balanced meals (in sufficient amounts of various diets)"; (c) "In the preceding year, have any adults in your household reduced the amount of meals or skipped meals because there was not enough money to buy food?" (d) (If answered yes) "How often did this happen?"; (e) "In the preceding year, have you eaten less than you felt you should because there was not enough money to buy food?"; (f) "In the preceding year, have you been unable to eat even when you were hungry because there was not enough money to buy food?". For items (a) and (b), the responses "often" and "sometimes" were coded as 1, and "never" was coded as 0. For items (c), (e), and (f), "yes" was scored as 1 and "no" as 0. For item (d), the responses "almost every month" or "some months but not every month" were scored as 1 and "1 or 2 months" was scored as 0. The response "don't know" and refusal to participate were considered missing and excluded from the sample. The summed responses range from 0 to 6, indicating the degree of food insecurity. Indicators of food security (total score ≤1), moderate food insecurity (total score 2–4), and severe food insecurity (total score ≥5) were defined according to thresholds validated in previous literature (**Table 1**). The food security category includes households with no limitations in fulfilling their food preferences or dietary needs. Moderate food insecurity pertains to households that report anxiety about food access or experience reduced quality of diets. Finally, severe food insecurity indicates households that undergo disrupted eating patterns and reduced food intake due to financial hardship.

TABLE 1 | Response to the Korean household food security survey (Korean Welfare Panel Study, South Korea, 2008).

Affirmative responses	% of 2008 wave
0 (food security)	84.8
1 (food security)	9.2
2 (moderate food insecurity)	3.7
3 (moderate food insecurity)	0.8
4 (moderate food insecurity)	0.6
5 (severe food insecurity)	0.6
6 (severe food insecurity)	0.5

Healthcare Utilization and Expenditures

Measures of healthcare utilization include the number of outpatient hospital visits, inpatient hospital admissions, and days spent as a hospital patient between 1 January and 31 December in the preceding year. Participants were instructed to report their access to care and services provided by legally accredited medical institutions and not to include preventive care. They were further instructed that visits to multiple departments within a hospital should be counted as one. The responses were reported as counts (outpatient visits, inpatient admissions) and days (inpatient days). Those with no healthcare utilization were instructed to fill in "00" as their response.

Personal healthcare expenditure is defined as the mean monthly spending on healthcare services in the preceding year. This includes out-of-pocket expenditures for inpatient and outpatient services, dental care, surgeries (including dental and plastic surgery), medications, nursing care, preventive care, dietary supplements, and miscellaneous healthcare products (e.g., corrective lenses and knee guards). The response was reported in 10,000 KRW (equivalent to approximately 8 USD) and converted to 2020 KRW using the Korean Consumer Price Index. This variable was transformed using $ln(x+1)$ to address the skewness of the distribution.

Covariates

Covariates were selected based on the literature and include demographic and socioeconomic variables that might be correlated with food insecurity or healthcare utilization. These include indicators of age (in years), sex (female or male), educational background (middle school or less; high school graduate; college graduate), marital status (not in a marital relationship; currently married), number of household members, region of residence (rural area, urban area, metropolitan city), chronic conditions (high blood pressure, diabetes, cancer, heart disease, stroke, arthritis), self-rated health (very poor, poor, fair, good, very good), disability, employment status (employed, self-employed, retired), yearly household income (in quintiles), monthly household consumption (in quintiles), and year of survey. The category "not in a marital relationship" includes participants who were separated from their partners and those who were divorced, widowed, or never married. The "retired" category of employment status includes individuals who were retired, unemployed, and not in the labor market. Disability is determined by whether a participant is registered as disabled for welfare claiming purposes. Household income and consumption are re-scaled into 2020 KRW and collapsed into quintiles.

Statistical Analysis

Our main empirical specification comprises individual random effects Poisson regression (outpatient visits, inpatient admissions, days hospitalized) and individual random effects linear regression (log of healthcare expenditures). We first estimated unadjusted regression models, including only the food insecurity indicator and year of survey dummies. The association between food insecurity and healthcare outcomes was then adjusted for demographic factors, health status, and socioeconomic characteristics in separate analyses. Our preferred specification is a fully adjusted model that controls for all the covariates. For the Poisson regression results, we obtained incidence rate ratios (IRR) by exponentiating the coefficient estimates. Across all regressions, the adjusted IRR and adjusted beta coefficients were reported, along with their 95% confidence intervals (CI). Coefficients with p <0.05 for a two-sided test were considered statistically significant. All analyses were performed using Stata/SE 16.1. The estimated results were weighted using the sampling weights provided by the KoWePS. Data cleaning and analyses were performed from 1 February to 27 March 2022.

RESULTS

The baseline sample includes 12,166 participants aged ≥19 years in 2008 (**Table 2**). The sample consists of 6,631 women (54.5%), 5,535 (45.5%) men, 3,276 (26.9%) college graduates, 8,007 (65.8%) married individuals, and 5,311 (43.7%) metropolitan city residents. A total of 5,150 participants (42.3%) rated their overall health as good, and 1,511 (12.4%) rated their health as

TABLE 2 | Baseline sample characteristics by food insecurity (Korean Welfare Panel Study, South Korea, 2008).

Variables	No. of respondents (%) or mean (SD)			All (*n* = 12,166)
	Food secure (*n* = 11,427)	Moderately food insecure (*n* = 609)	Severely food insecure (*n* = 130)	
Outpatient visits	15.0 (26.7)	21.3 (31.1)	21.9 (31.0)	15.4 (27.1)
Inpatient days	2.79 (16.5)	3.75 (16.1)	4.23 (13.1)	2.85 (16.5)
Inpatient admissions	0.16 (0.63)	0.24 (0.75)	0.22 (0.57)	0.17 (0.64)
Healthcare expenditures (monthly)[a]	16.5 (27.0)	11.1 (23.8)	6.8 (9.8)	16.1 (26.8)
Age (yrs)	50.4 (17.7)	54.7 (17.7)	57.7 (17.0)	50.7 (17.7)
Sex				
Female	6,207 (54.3)	349 (57.1)	75 (58.4)	6,631 (54.5)
Male	5,220 (45.7)	260 (42.9)	55 (41.6)	5,535 (45.5)
Educational level				
Middle school or less	4,902 (42.9)	368 (60.7)	88 (65.8)	5,358 (44.0)
High school graduate	3,334 (29.2)	166 (26.8)	32 (26.8)	3,532 (29.0)
College graduate	3,191 (27.9)	75 (12.5)	10 (7.4)	3,276 (26.9)
Marital status				
Not in marital relationship[b]	3,758 (32.9)	321 (52.4)	80 (61.7)	4,159 (34.2)
Currently married	7,669 (67.1)	288 (47.6)	50 (38.3)	8,007 (65.8)
Number of household members	3.05 (1.28)	2.63 (1.38)	2.15 (1.34)	3.02 (1.29)
Region of residence				
Rural area	2,844 (24.9)	115 (18.9)	26 (20.0)	2,985 (24.5)
Urban area	3,669 (32.1)	159 (26.1)	42 (32.3)	3,870 (31.8)
Metropolitan city	4,914 (43.0)	335 (55.0)	62 (47.7)	5,311 (43.7)
Chronic conditions				
High blood pressure	1,398 (12.2)	81 (13.3)	27 (20.8)	1,506 (12.4)
Diabetes	523 (4.6)	46 (7.6)	10 (7.7)	579 (4.8)
Cancer	134 (1.2)	12 (2.0)	0 (0)	146 (1.2)
Heart disease	218 (1.9)	13 (2.1)	3 (2.3)	234 (1.9)
Stroke	169 (1.5)	17 (2.8)	5 (3.8)	191 (1.6)
Arthritis	1,253 (11.0)	95 (15.6)	21 (16.2)	1,369 (11.3)
Self-rated health				
Very poor	352 (3.1)	65 (10.7)	27 (20.8)	444 (3.6)
Poor	2,293 (20.1)	212 (34.8)	52 (40.0)	2,557 (21.0)
Fair	2,348 (20.5)	130 (21.3)	26 (20.0)	2,504 (20.6)
Good	4,970 (43.5)	161 (26.4)	19 (14.6)	5,150 (42.3)
Very good	1,464 (12.8)	41 (6.7)	6 (4.6)	1,511 (12.4)
Disability	1,094 (9.6)	114 (18.7)	31 (23.8)	1,239 (10.2)
Employment status				
Employed	4,208 (36.8)	178 (29.2)	28 (21.5)	4,414 (36.3)
Self employed	1,812 (15.9)	59 (9.7)	12 (9.2)	1,883 (15.5)
Retired	5,407 (47.3)	372 (61.1)	90 (69.2)	5,869 (48.2)
Household income (yearly)	4,445 (4,317)	1,910 (1,472)	1,101 (1,131)	4,282 (4,247)
Household consumption (monthly)	329 (267)	171 (123)	123 (78)	319 (263)

Abbreviations: SD, standard deviation; n, number of observations.

[a]*Monetary values expressed in 10k KRW.*

[b]*Includes separated, divorced, widowed, and never married.*

great. Overall, 739 participants (6.0%) lived in food insecure households; of these, 609 (5.0%) households were moderately and 130 (1.1%) were severely food insecure. The mean number of outpatient visits was 15.4 (27.1%), and the mean numbers of days spent hospitalized and inpatient admissions were 2.85 (16.5%) and 0.17 (0.64%), respectively. Comparing healthcare variables by food insecurity shows that households with food insecurity reported more outpatient visits, days spent hospitalized, and inpatient admissions but were less inclined to spend on healthcare.

Table 3 presents the results of random effects Poisson and linear regression analyses for healthcare utilization and expenditure (full results in **Supplementary Tables S2–S5**). The baseline models indicate that severe food insecurity was associated with increased incidence rates of outpatient visits (IRR, 1.16; 95% CI, 1.14–1.18), days of hospitalization (IRR, 1.16; 95% CI, 1.11–1.20), inpatient admissions (IRR, 1.52; 95% CI, 1.28–1.80), and lower healthcare expenditure (β = −0.09; 95% CI, −0.18–0.00). Moderate food insecurity was associated with higher inpatient admission incidence rates (IRR, 1.12; 95% CI, 1.03–1.21) and lower healthcare expenditure (β = −0.15; 95% CI, −0.19 to −0.11). Upon controlling for demographic factors, severe food insecurity exhibited positive associations with increased outpatient visits (IRR, 1.15; 95% CI, 1.13–1.17), inpatient visits (IRR, 1.12; 95% CI, 1.08–1.17), and inpatient admissions (IRR, 1.41; 95% CI, 1.19–1.67). The health status-adjusted models show estimated IRRs of 1.15 (95% CI, 1.13–1.17), 1.12 (95% CI, 1.08–1.16), and 1.30 (95% CI, 1.10–1.54) for the associations between severe food insecurity and healthcare utilization variables.

When accounting for all covariates, severe food insecurity was associated with higher incidence rates of outpatient visits (IRR, 1.14; 95% CI, 1.12–1.17), days of hospitalization (IRR, 1.18; 95% CI, 1.13–1.22), and inpatient admissions (IRR, 1.40; 95% CI, 1.18–1.65). Furthermore, moderate food insecurity was associated with a 10.4% (β = −0.11; 95% CI, −0.14 to −0.07) or 238,276 KRW reduction in healthcare expenditure. However, moderate food insecurity exhibited no association with outpatient visits (IRR, 0.99; 95% CI, 0.98–1.00), days of hospitalization (IRR, 0.99; 95% CI, 0.98–1.01), or inpatient admissions (IRR, 1.02; 95% CI, 0.94–1.11). Controlling for all covariates shows that moderate food insecurity is not a significant predictor of healthcare utilization at the 5% level. These insignificant results suggest that, in the partially adjusted models moderate food insecurity may capture the effects of food insecurity as well as participants' sociodemographic characteristics and underlying health status.

TABLE 3 | Association of food insecurity at *t*–1 with healthcare utilization and expenditures at *t*, random effects Poisson and linear regression results (Korean Welfare Panel Study, South Korea, 2008–2019, 2021).

	Outpatient visits	*P* val.	Inpatient days	*P* val.	Inpatient admissions	*P* val.	Healthcare expenditures	*P* val.
	IRR (95% CI)[a]		IRR (95% CI)[a]		IRR (95% CI)[a]		Adjusted β (95% CI)[b]	
Baseline model[c]								
Severe food insecurity (*t*–1)	1.16 (1.14, 1.18)	<0.001	1.16 (1.11, 1.20)	<0.001	1.52 (1.28, 1.80)	<0.001	−0.09 (−0.18, 0.00)	0.05
Moderate food insecurity (*t*–1)	1.00 (0.99, 1.01)	0.67	1.01 (0.99, 1.03)	0.25	1.12 (1.03, 1.21)	0.006	−0.15 (−0.19, −0.11)	<0.001
Food security (*t*–1)	Referent		Referent		Referent		Referent	
Demographic factors adjusted model[d]								
Severe food insecurity (*t*–1)	1.15 (1.13, 1.17)	<0.001	1.12 (1.08, 1.17)	<0.001	1.41 (1.19, 1.67)	<0.001	−0.05 (−0.14, 0.04)	0.27
Moderate food insecurity (*t*–1)	1.00 (0.99, 1.01)	0.68	1.01 (0.99, 1.03)	0.25	1.06 (0.98, 1.14)	0.16	−0.13 (−0.17, −0.10)	<0.001
Food security (*t*–1)	Referent		Referent		Referent		Referent	
Health status adjusted model[e]								
Severe food insecurity (*t*–1)	1.15 (1.13, 1.17)	<0.001	1.12 (1.08, 1.16)	<0.001	1.30 (1.10, 1.54)	0.002	−0.14 (−0.23, −0.05)	0.003
Moderate food insecurity (*t*–1)	0.99 (0.98, 1.00)	0.02	0.96 (0.94, 0.98)	<0.001	0.97 (0.90, 1.05)	0.50	−0.18 (−0.22, −0.15)	<0.001
Food security (*t*–1)	Referent		Referent		Referent		Referent	
SES adjusted model[f]								
Severe food insecurity (*t*–1)	1.16 (1.14, 1.18)	<0.001	1.24 (1.19, 1.29)	<0.001	1.48 (1.25, 1.75)	<0.001	0.02 (−0.07, 0.11)	0.69
Moderate food insecurity (*t*–1)	1.00 (0.99, 1.01)	0.81	1.04 (1.02, 1.06)	<0.001	1.07 (0.99, 1.16)	0.09	−0.08 (−0.12, −0.05)	<0.001
Food security (*t*–1)	Referent		Referent		Referent		Referent	
Fully adjusted model[g]								
Severe food insecurity (*t*–1)	1.14 (1.12, 1.17)	<0.001	1.18 (1.13, 1.22)	<0.001	1.40 (1.18, 1.65)	<0.001	−0.02 (−0.11, 0.07)	0.67
Moderate food insecurity (*t*–1)	0.99 (0.98, 1.00)	0.02	0.99 (0.98, 1.01)	0.56	1.02 (0.94, 1.11)	0.60	−0.11 (−0.14, −0.07)	<0.001
Food security (*t*–1)	Referent		Referent		Referent		Referent	

Abbreviations: IRR, incidence rate ratio; CI, confidence interval.

[a]*Estimated by random effects Poisson regression.*

[b]*Estimated by linear regression.*

[c]*Adjusted for year fixed effects.*

[d]*Adjusted for age, sex, educational level, marital status, number of household members, region of residence, and year fixed effects.*

[e]*Adjusted for chronic conditions (high blood pressure, diabetes, cancer, heart disease, stroke, arthritis), self-rated health, disability, and year fixed effects.*

[f]*Adjusted for employment status, household income, and household consumption, and year fixed effects.*

[g]*Adjusted for age, sex, educational level, marital status, number of household members, region of residence, chronic conditions (high blood pressure, diabetes, cancer, heart disease, stroke, arthritis), self-rated health, employment status, household income, household consumption, and year fixed effects.*

DISCUSSION

In this longitudinal study of representative Korean adults, we found that severe food insecurity was associated with greater subsequent healthcare utilization, including outpatient visits, hospitalizations, and days spent hospitalized. Moderate food insecurity was not associated with healthcare utilization related to hospitalization, indicating a dose-response relationship. The results further showed that moderate food insecurity was associated with 10.4% or 238,276 KRW reductions in personal healthcare expenditures in the subsequent year. The difference between the unadjusted and adjusted models suggests that the unadjusted results were likely confounded by socioeconomic and health variables, and the adjusted results more accurately reflect the true relationship between household food insecurity and healthcare outcomes. Our results support the conceptual frameworks of Andersen and Newman [30] and Becker [29], and replicate previous research showing the complex relationships of household food insecurity with healthcare utilization and expenditure [17, 20, 23, 52, 53].

The findings of this study align with previous research that connects food insecurity to increased healthcare utilization in various contexts. Food insecurity has been associated with greater use of acute healthcare, including emergency department visits, same day surgery, and longer hospital stays in samples of Canadian and American adults [31, 32, 35]. Additionally, food insecure adults seem to use outpatient medical services and pharmaceutical products more frequently than their food secure counterparts [31, 33, 37]. Our analyses contribute to this literature by demonstrating that food insecurity is longitudinally related to outpatient and inpatient medical services, and severe food insecurity leads to greater healthcare utilization in a dose graded manner. Collectively, our results and prior research suggest that food insecure households have a heightened health risk and thus greater needs for medical services [35]. The findings presented here emphasize the importance of considering food insecurity in healthcare reform and interventions.

The negative association between moderate food insecurity and healthcare expenditure could be explained by cost-related underuse of healthcare [27, 28]. Food insecure adults might have switched to more affordable care sources or compromised care quality to reduce the associated financial burden [17]. As a result, they miss opportunities for timely treatment and are more likely to be seen in acute care than their food secure counterparts [54, 55]. The unique healthcare environment in Korea could also contribute to this finding. The NHI program distributes health insurance coverage thinly over a large segment of the population, leading to high out-of-pocket expenses for certain treatments [25]. This co-payment structure can cause vulnerable populations to rely more on primary care and limit the use of specialty medical services for treating severe health conditions. The reform of the national health insurance program to reduce co-payment burdens, currently under consideration by policymakers, may encourage food insecure households to utilize more specialized medical services and thus improve the quality of care received.

It should be noted that the KoWePS targets Korean citizens aged 19 years or older, and therefore food insecurity during childhood and adolescence is not accounted for in this study. Previous research indicates that food insecurity in early life has significant implications for health outcomes and behaviors in adulthood [56–58]. Inadequate nutrition during these critical developmental stages can prompt adaptive bodily responses to food scarcity, which in turn increase the risk of chronic diseases like obesity, diabetes, and heart disease in adulthood [56]. Furthermore, children who grow up in food scarce environments may be more likely to adopt unhealthy eating habits, such as overeating and emotional eating [58]. Those who experienced food insecurity earlier in life are likely to have lower income and unstable job in adulthood, thereby perpetuating the cycle of food insecurity and adverse health outcomes [57]. Collectively, these effects contribute to poor health and an increased demand for healthcare in adulthood. Readers need to be cautious that our results do not fully represent this relationship between food insecurity in adolescence, health outcomes, and health behaviors, and should be interpreted in a restricted context of concurrent health changes that occur when an individual falls into food insecurity during the study period.

The results of this study will contribute to the design of policies and interventions to address food insecurity and healthcare burden among Korean adults. Our findings and prior evidence suggest that the healthcare needs of food-insecure adults may remain unmet [16, 59]. Improving healthcare access requires measures to enhance the income adequacy of vulnerable populations. Policies and programs offering cash assistance have been associated with a lower prevalence of food insecurity [60, 61] and increased use of health services [62]. In Korea, income supplements for working-age adults have been provided by the National Basic Livelihood Security (NBLS), a federal welfare program for citizens below the absolute poverty line. Considering food insecurity in the screening for program qualification may expand the NBLS to food-insecure households and effectively increase their health care-related budgets. Further research is needed to evaluate the effects of income supplementation on healthcare utilization and expenditure among food-insecure Korean adults.

Strengths and Limitations

Our findings should be interpreted in light of several limitations. The 1-year time gap between surveys may be too short to observe meaningful changes in health status and thus in healthcare utilization and expenditure. If food insecurity alters healthcare use through diet-related diseases or other chronic conditions, it may take longer to observe any relevant changes. Second, sample attrition over time raises the concern that a particular socioeconomic group is over-represented in the study sample. Considering that unhealthy participants are more likely to drop out, it's plausible to assume that our study sample includes more food secure individuals and those less likely to seek medical services. This non-random attrition could lead to an underestimated coefficient estimate for food insecurity, limiting the representativeness of the regression results in later years. Moreover, a smaller sample size reduces statistical power, thereby increasing the likelihood of Type II errors. Correcting the problem of non-random attrition could result in a larger sample

size and stronger associations between food insecurity and healthcare access, which would be identified with lower standard errors. Third, our empirical models could not control for a measure of multimorbidity. The co-existence of multiple chronic conditions can interact with other socioeconomic variables in complex ways, influencing healthcare expenditures non-linearly or modifying the effects of food insecurity. Although our regression models factored in self-rated health, chronic conditions, and disability indicators, the inclusion of multimorbidity could yield a more accurate estimate of the food insecurity effect. Finally, this study lacks data on the quality of care, and thus could not investigate whether and to what extent food insecure households switch to more affordable treatment alternatives. A potential avenue for future research is to explore potential substitution between care options among marginalized populations.

The strength of this study lies in the use of multi-wave, longitudinal, and population-based data. The cohort participating in the baseline survey is sufficiently representative of the working-age population in Korea after the application of sampling weights. The survey design of the KoWePS reduces selection bias and leads to generalizable findings regarding healthcare utilization and expenditure of food-insecure households in Korea. The longitudinal nature of this study is another noteworthy strength as it limits the potential of reverse causality in which excessive healthcare spending leads to food insecurity among low-income households [34]. By lagging the food insecurity indicator, we sought to identify changes in healthcare utilization and expenditure attributable to food insecurity and observe dynamic relationships over 12 years of follow-up. Furthermore, our measure of food insecurity was based on reported experiences of food shortage over the past 12 months, as the USDA guidelines recommend [63]. Most previous studies on healthcare use relied on food insecurity assessments in a 30-day window [20, 21, 23, 32–34, 53, 64], and thus could not disentangle persistent food insecurity from transient disruptions in food supply. This study improves upon the existing literature by linking persistent and chronic experiences of food insecurity to healthcare use in subsequent periods. Lastly, this study was conducted in Korea, where medical services incur large out-of-pocket expenses even for those covered by national health insurance [25]. Our findings might be comparable to studies conducted in the United States and Europe, where food-insecure households with insufficient health insurance coverage are examined.

Conclusion

This study expands upon prior research by demonstrating the complex relationship between household food insecurity and healthcare utilization and expenditure in working-age adults. Using population-based longitudinal data from Korea and a validated measure of food insecurity, we showed that severe food insecurity was associated with more outpatient visits, hospitalizations, and days spent hospitalized in a dose-response manner. We also found that moderate food insecurity was associated with reductions in personal healthcare expenditure. While the nature of this complex relationship remains unclear, it is evident that food-insecure households constitute a high-risk group. Integrating information on food insecurity status into routine care may help physicians better assess patients' risk profiles beyond what clinical assessments and diagnoses reveal. Furthermore, policies and programs promoting healthcare access among vulnerable populations need to consider food insecurity when determining priority target groups.

ETHICS STATEMENT

The KoWePS is the publicly released dataset that is available at the website of the Korea Welfare Panel Study (http://koweps.re.kr/). Informed consent was not required to use this dataset. This research received IRB exemption from the Bioethics Committee at the Sungkyunkwan University.

AUTHOR CONTRIBUTIONS

HC: conceptualization, data curation, formal analysis, writing—review and editing. T-YP: conceptualization, methodology, formal analysis, writing—original draft, writing—review and editing, funding acquisition, project administration, and supervision. All authors contributed to the article and approved the submitted version.

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CONFLICT OF INTEREST

The authors declare that they do not have any conflicts of interest.

SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.ssph-journal.org/articles/10.3389/ijph.2023.1605360/full#supplementary-material

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Hunger, Food Security, and Sovereignty: A Need for Evidence-Based Public Health Approaches to Meet Sustainable Development Goals

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Keywords: hunger, food insecurity, evidence-based public health, sustainable development goals (SDGs), Sub-Saharan Africa (SSA)

Hunger remains one of the twenty-first century's most critical public health concerns and only worsens. About 800 million people worldwide suffer from hunger and food insecurity, and 1 in 9 people sleep hungry because of food insecurity, inadequate finances to purchase food or a lack of equitable access to food [1]—more than 110 million people need food and nutrition [1]. In particular, hunger and food insecurity are associated with poor academic and behavioral performance in children and are responsible for more than 50% of all fatalities in children under five [2]. Without adequate public health methods, the Sustainable Development Goals (SDGs) to abolish global hunger by 2030 seem impossible. Theoretical concepts can slowly eradicate hunger, but evidence-based public health (EBPH) will prove efficient and guarantee food security.

The continued hunger, food insecurity, and food sovereignty syndemic propose measures to mitigate their impacts, particularly among vulnerable people in low- and middle-income countries (LMICs). Food insecurity is difficulty obtaining sufficient, nutritious, and culturally appropriate food for active and healthy living [2]. Before the coronavirus disease 2019 (COVID-19) pandemic, global populations suffer from varying degrees of food insecurity and hunger, necessitating immediate intervention [2]. However, hunger and food shortages worsened in the preceding 3 years due to COVID-19 [2] and put global health at risk. Undoubtedly, hunger and food insecurity are global challenges that disproportionately affect young and low-income children, unemployed, and people with disabilities, among others, especially those living in LMICs in Sub-Saharan Africa (SSA) and South Asia regions (**Figure 1**) [2–3]. In addition, the consequences of hunger and food insecurity substantially impact the global health system, increasing the likelihood of poor health outcomes such as cancer, obesity, anxiety, depression, memory loss, and other infectious and chronic diseases [3]. For instance, obesity, a global problem that doubled in prevalence rates between 1975 and 2016, and causes about 2.8 million deaths yearly, is linked to food insecurity [3]. The global distribution of hunger and food insecurity-related mortality is disheartening, signaling the need for immediate public health intervention.

EBPH combines public health initiatives and science-based approaches with an informed, precise, and conscientious use of evidence to improve population health using evidence-based decisions [4]. Because EBPH provides access to excellent information on proven methods that work and an increased likelihood of improved outcomes if the appropriate policies are enacted, the current global

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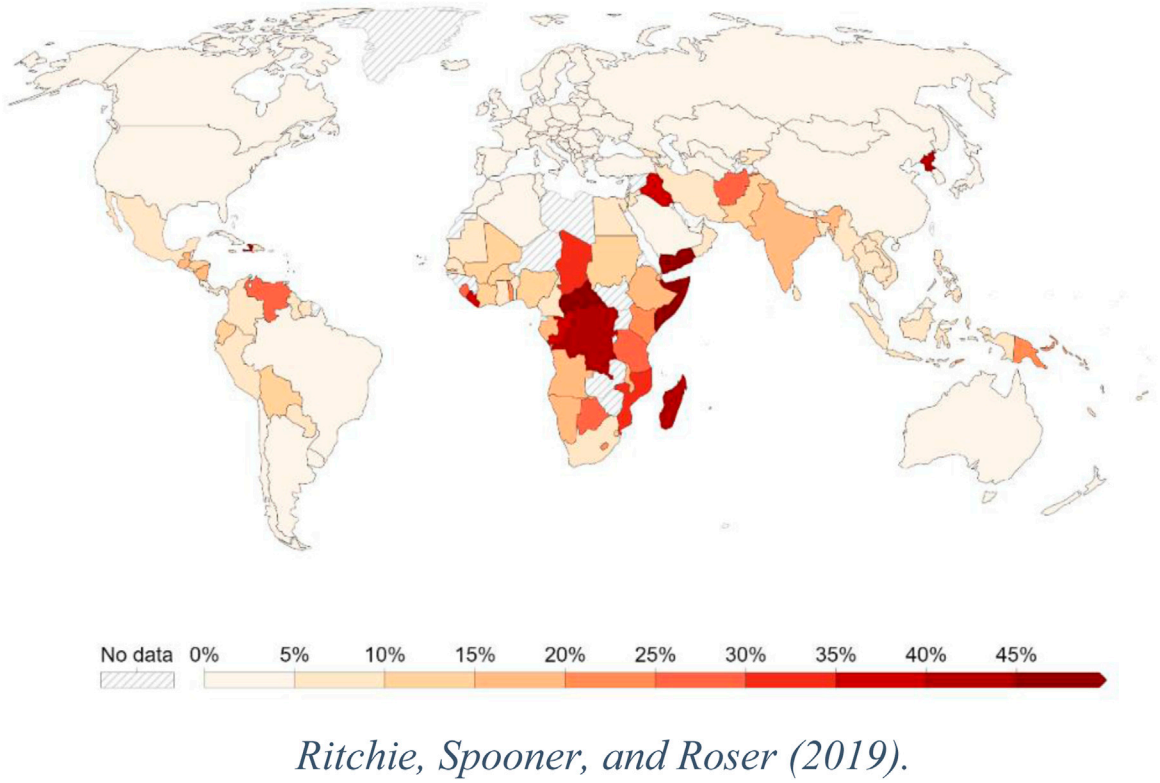

FIGURE 1 | Global distribution of undernourished population (Oxford, England. 2019).

frameworks for food security and nutrition to combat hunger and ensure food availability, access, utilization, and stability will function well using EBPH [4].

EBPH strategies can be beneficial to abolishing hunger as discussed hereto: 1) Investing in education and food security programs is crucial to combat food insecurity and hunger. When developing the SDGs, the United Nations recognized the importance of education in achieving all goals, including eliminating hunger and food insecurity [5]. Research by the UTSA Urban Education Institute further highlights the strong association between education and food insecurity [6]. By investing in food security initiatives, vulnerable populations can be empowered; as a result, food access and availability will improve. Food security initiatives such as participating in during-school, after-school, and summer meal programs that provide meals at no cost or a discount to qualifying pupils, as well as creating school food pantries programs that supply fresh food to students and their families [5–6], can improve access to education, eliminate hunger, and enhance academic engagement, particularly among school-aged children [5]. In addition, adequate dietary education, such as accurately labeling food packages in grams and calories, can aid in the alleviation of food insecurity [7] and hence, improve healthy food choices; 2) Developing a reliable and accurate food surveillance system is a critical tool to alleviate food insecurity and hunger by providing real-time information on food production, availability, distribution, and consumption. This information can detect regions where food is limited, keep track of food costs, predict hunger surges among vulnerable populations, and more effectively prioritize nutritional initiatives. In the United States (US), for example, hospitals and health systems can screen patients for food insecurity and collaborate with a coalition of community groups to offer initiatives and amenities that promote access to nutritious foods and create community awareness [8]. A food surveillance system can also promote research that fosters food security through policy review. Finally, a reliable surveillance system can help in the efficient administration of food and nutrition assistance programs, such as the Supplemental Nutrition Assistance Program (SNAP), targeted at eliminating food insecurity [2] and preventing foodborne disease outbreaks so that people have access to nutritious and healthy food; 3) Strengthening of sociopolitical systems can be achieved through improving food system management, making inclusive and accountability-driven investments in rural communities, empowering small-scale farmers, and strengthening social protection measures for risk management. Some examples include boosting agricultural productivity, supplementing foods to provide undernourished populations with specific micronutrients, and protecting the human rights of populations susceptible to hunger and malnutrition [6]. Effective governments should serve as the pillars of good governance that promote equitable food systems for communities, reducing food security disparities; 4) Improving fresh produce availability and accessibility

can eradicate food insecurity by boosting the availability, accessibility, and affordability of healthful dietary alternatives. In many situations, food insecurity—lack of access to excess healthy food for active well-being [2] is closely linked to poverty and constrained access to healthy foods [6]. People can access healthier food alternatives by boosting the availability and accessibility of fresh produce, which can help them maintain a balanced diet and lower the risk of chronic conditions, malnutrition, and other health problems [9]. Strategies to increase the availability and accessibility of fresh produce include community farms, farmers' markets, roadside shopping trolleys, and federal programs like SNAP and Women, Infants, and Children (WIC) nutrition programs. These initiatives promote healthy diets, create green spaces, and provide fresh produce to those without access to grocery stores or supermarkets [2, 10]; and 5) Tackling structural problems through evidence-based government intervention and transparency will end food insecurity and hunger by encouraging justice and providing integrity through equitable access to food [10]. According to Miller and Thomas (2020), behind forward-thinking governance principles, a view of structural factors as fundamental causes of food insecurity and hunger and the notion that access to food is an ethical issue requiring government attention are critical to reducing food insecurity [10]. The US can completely restructure all affiliated institutions that manage hunger and food insecurity by employing a cross-sectoral strategy to eliminate hunger. However, evidence-based structural measures can be difficult to translate into improved health or reduced health disparities because improving the importance, utilization, and delivery of evidence-based strategies in real-world settings requires time, resources, and collaboration among experts [4]. The Evidence-Based Policymaking Act of 2018 (Evidence Act) recognizes that federal decision-makers require evidence, including performance data, program assessment, and research, to determine whether government programs achieve the desired outcomes [11].

Understanding the systemic and fundamental factors contributing to food insecurity and malnutrition is critical for identifying and prioritizing activities to enhance food security and nutrition. Furthermore, as a public health issue, the solution to accomplishing the second goal of the 17 2030 SDGs, to eradicate hunger [9], rests in appropriating EBPH approaches. In conclusion, EBPH interventions can fully address and provide proven solutions to eradicate hunger and food insecurity.

AUTHOR CONTRIBUTIONS

Conceptualization, OA; Conception or design of the work, OA, OK, OJA, and OM; Drafting the original article, OA, OK, OJA, and OM; Critical revision of the article, OA, OK, OJA, and OM; Supervision, OA and OM. The published version of the work has been reviewed and approved by all authors. In addition, the authors have agreed to accept responsibility for all parts of the work, including ensuring that any issues about the accuracy or integrity of any portion of the work are thoroughly examined and addressed. All authors contributed to the article and approved the submitted version.

CONFLICT OF INTEREST

The authors declare that they do not have any conflicts of interest.

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Barriers to Overcoming Child Hunger and Malnutrition: Applying a Human Rights Approach to Improve Policy and Action

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Objective: Analyze key barriers to achieving children's right to food under Colombia's food and nutrition security policies and programs.

Methods: A literature review was conducted along with 17 semi-structured expert interviews. The law framework on the right to food was applied to analyze findings.

Results: Four key barriers were found. First, a reductionist approach prevails in the political narrative. This focuses on ensuring personal food access overlooking societal and environmental impacts. Second, the implementation of policies and programs is passed on to third parties, preventing civic participation and accountability. Third, there are insufficient national data sources and indicators to monitor the impact of interventions and funding. Fourth, program implementation is unequal and inadequate, which inadvertently supports illicit economies that thrive on conditions of hunger and poverty.

Conclusion: Children's food and nutrition are reliant on organizations that focus on personal food supply without strengthening civic participation. Strengthening participation requires a human rights approach. International organizations can help the government to engage communities in policy and program improvement and oversight.

Keywords: policies, child, hunger, malnutrition, food security

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INTRODUCTION

A large body of evidence shows that hunger and malnutrition, mainly during early stages of life, increase the overall risk of disease and cause irreversible cognitive, psychological, growth, and immunological impairments [1–6]. These effects are intergenerational and create disadvantages compared with nourished peers in terms of access to opportunities and equal outcomes [1–3, 6, 7]. The Food and Agriculture Organization of the United Nations (FAO) defines hunger as an uncomfortable or painful sensation caused by insufficient consumption of dietary energy [8], and malnutrition as the result of deficiencies or imbalances in energy and nutrients consumption. Malnutrition can result from the lack of regular access to sufficient, safe and nutritious food for normal growth, development, and an

active healthy life, or from inappropriate childcare practices, insufficient health services and unhealthy environments [8].

To combat these issues, governments and international organizations have adopted policies and programs aimed at promoting food security [9–12]. Food security is the condition where every person has permanent access to sufficient, safe and nutritious food to meet their dietary needs and preferences for an active and healthy life [8]. To promote food security, governments have adopted policies that seek to improve a population's access to food [8–13] by increasing market staples through intensive agriculture, manufacturing, and imports [10–12]. Parallelly, government and international non-governmental organizations (INGOs) distribute handouts to households that cannot economically access sufficient staples [10–13]. However, these efforts seem insufficient. Although total food production is enough to feed everyone [14], 29.3% of the global population cannot access a healthy diet, including 8.9% of children under five suffering from hunger and 3.8% impacted from some type of malnutrition [8, 15].

Recognizing limitations in food security-focused approaches, scholars and law experts have proposed grounding food and nutrition policy and programs on human rights, rather than on a food security aim [10–13, 16–18]. This is because international human rights law recognizes adequate food as a human right essential for the enjoyment of all human rights and establishes clear correlated obligations [16–23]. The right to adequate food (RtAF) is enshrined in the Universal Declaration on Human Rights (UDHR) Article 25 [19], the International Covenant on Economic, Social and Cultural Rights (ICESCR) Article 11 [20], the Convention on the Rights of the Child (CRC) Article 24 [21], and several other legal instruments [22]. Moreover, General Comment No. 12 of the United Nations Committee on Economic, Social and Cultural Rights (CESCR) (GC12 hereafter) defines the RtAF as the right of every person, alone and in community with others, to have permanent physical and economic access to adequate food or means for its procurement [22]. GC12 establishes correlative state obligations to respect, protect, and fulfill the RtAF, which are not about charity, but about ensuring that everyone can feed themselves in dignity [18, 22]. Conversely, no international law instrument defines food security or establishes correlated state obligations [23]. Nonetheless, evidence shows that legal recognition alone is not enough to ensure the RtAF [10–17] so states must take every necessary action to bring formal recognition into practice [22].

The Latin America and the Caribbean (LAC) region is one of the worst regions in terms of hunger and malnutrition figures that involve the insufficiency of ongoing food security measures to ensure the RtAF [12]. In LAC, 40.6% of people of all ages do not have the means to follow a healthy diet, while the global average is 29.3%. Moreover, 56.6 million people suffer from hunger, which increased 30% between 2020 and 2021, the highest increase globally [8, 24, 25]. Within LAC, Colombia has the highest rate of hunger and malnutrition in the region, where 54.2% of people are unable to access a healthy diet and 20.6% of children under five suffer from some form of malnutrition [24–27].

The Colombian rates of child hunger and malnutrition are especially striking [26–28] although the Colombian regulatory framework provides special protection to children and their RtAF [29, 30]. The 1991 Colombian Political Constitution Article 44 establishes the RtAF as a fundamental right of children and upholds UDHR, ICESCR, and CRC [29]. Accordingly, the Colombian government has established policies and programs to protect the RtAF [17, 30]. However, previous research has identified barriers that impede their efficacy, including: 1) inconsistencies between national food and nutrition policies and the rest of the social, economic, agrarian, and foreign policies [12, 31]; 2) lack of coordination between the institutions in charge of implementing food and nutrition policies and the bodies in charge of national and subnational budget administration [31–35]; 3) impact of the armed conflict and insecurity [10, 31]; 4) inequity in the distribution of land and production means and [11, 31] 5) lack of continuity in the political commitments from one mandate to another [31, 35]. Still, little research has explored why despite having policies and programs framed under the RtAF and children protections, Colombia is not ensuring children's RtAF, and addressing child hunger and malnutrition relief in practice.

This article aims to fill that gap by identifying and analyzing key barriers to achieving children's RtAF under Colombia's existing food security and nutrition policies and programs. Using ICESCR Article 11 and G12 as a framework to analyze our results, we explore how barriers materialize due to a lack of mechanisms that ensure civic participation and monitor the resources and outcomes of policies and interventions. Understanding these barriers can strengthen Colombia's food and nutrition decision-making and further inform other countries.

METHODS

Literature Review

Between May and August 2021, we conducted a literature review that included peer-reviewed and non-peer-reviewed articles. We used Google, Google Scholar and searched Ebsco, Elsevier, and PubMed databases using key search terms: "hunger OR malnutrition AND human rights," "state of the right to food," "right to food AND policy AND Colombia." For the first two combinations of search terms, we did not include the key word Colombia to allow search results related to both international and Colombian peer-reviewed articles, INGO reports, government documents, human rights law, academic reports, and international law handbooks. For the third combination, we included the key word Colombia to focus on Colombian documentation. We did this considering the international context exerts influence on Colombia's food and nutrition status and legislation, but the focus of the study was Colombia's national policy framework. We found 138 documents, of which 77 were relevant to our study. Twenty-eight of them were peer-reviewed articles, 15 INGO reports, 12 government documents, 12 legislations on human rights, 7 university reports, and 3 international law handbooks. We included only publications in English and Spanish. Furthermore, we did not use an exclusion criterion for

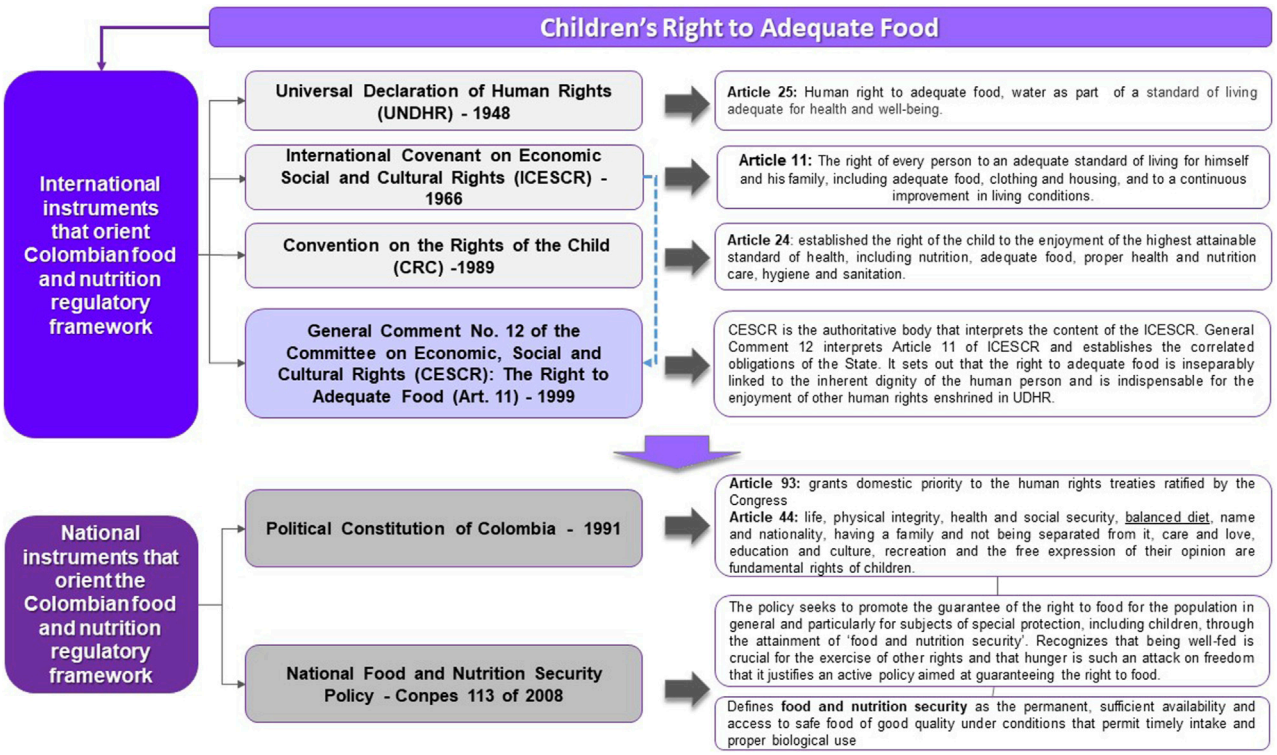

FIGURE 1 | Analysis framework of the right to adequate food for children (Policy Solutions to Realize the Right to Food of Children in Colombia: An Integrative Approach, Colombia, Italy, 2021–2022).

publication dates, considering that relevant reports, law, and policy documents would probably have been published or adopted on different dates, even with notable differences between them. Moreover, documents which could be considered old or out-of-date, could be key to understanding more recent documentation.

Semi-Structured Interviews

Between June and August 2021, we sent email invitations to 18 experts in food and nutrition law and policy. The purpose of the interviews was to identify barriers that prevent food and nutrition policies and programs from effectively addressing child hunger and malnutrition. We conducted expert semi-structured interviews to collect insights of people with first-hand knowledge on the topic. This allowed us to further explore the main limitations and strengths of the policymaking that are minimally reflected in policy documents or in public data [36]. Participants were identified through peer-reviewed articles, using standard snowball sampling [37]. In total, 17 participants agreed to be interviewed, including two government officials, six international organization experts, three civil society actors, and six academics. Interviews were conducted in Spanish [16] and English [1]. Interviews lasted between 30 and 120 min and were based on a semi-structured interview guide (see **Supplementary File S1**). Each interviewee signed an informed consent form following the European Standards of Ethics in social science research. Conversations were recorded, transcribed, and analyzed through thematic analysis [38]. Transcription and analysis were done in MAXQDA®, a software for qualitative and mixed methods data analysis.

Analytical Framework

We analyzed the interviews through deductive and iterative analysis, using the legal framework on the RtAF [19–22]. Findings are presented as a narrative synthesis of the key barriers identified.

The Right to Food

We approached the RtAF as enshrined in Article 11 of ICESCR [20] and interpreted by GC12 [22]. G12 establishes that ICESCR member states are bound to undertake all necessary measures for the progressive realization of the RtAF without discrimination, including international cooperation [24]. Having ratified ICESCR, Colombia is a member state and abides to GC12 [29, 39]. To comply with its obligations towards the RtAF, Colombia established the National Policy on Food and Nutrition Security Conpes 113/2008, which promotes "food and nutrition security" as the way to guarantee the RtAF [30] (see **Figure 1**). Applying this framework, we examined the documents and interviews to understand key barriers to achieving children's RtAF under Colombia's food security and nutrition policy and programs.

TABLE 1 | Assessment of the four main barriers to achieving children's right to adequate food under Colombia's existing food security and nutrition policy and programs (Policy Solutions to Realize the Right to Food of Children in Colombia: An Integrative Approach, Colombia, Italy, 2021–2022).

ICESCR Article 11 and GC12 standards	Application of ICESCR Article 11 and GC12 to Colombia food policies	Barriers to guaranteeing children's right to adequate food according to ICESCR Article 11 and GC12
Barrier 1. Reductionist approach to improving nutrition		
Focus on food security • No legal definition of food security • No mention of food security as a means to achieve the right to adequate food • No clear state obligations on food security	• Conpes 113/2008 guides all food and nutrition public policies in Colombia • WFS 1996 food security definition orients Conpes 113/2008 and the majority of INGO programs • Food security is approached as equivalent to the right to adequate food or the path to achieve it	• Food security is not a human right protected under international law • Food security concept lacks clear correlated legal obligations • Food security remains open to interpretation and is susceptible to manipulation and instability
Barrier 1. Reductionist approach to improving nutrition		
Focus on personal food access • State obligation to *Respect:* refraining from any measures that impede the right to adequate food for any person or human group • State obligation to *Protect:* taking measures to ensure that no entity deprives people of adequate food or the means to access it (e.g., land, ecosystems)	• Conpes 113/2008 and WFS 1996 focus on ensuring food access at personal level • Focus on individual persons overlooks possible impact on communities and ecosystems • Attempt to ensure personal food access through - Augmenting market staples by means of mass production and imports - Handouts for people unable to obtain sufficient food from the market	• Intensive farming, manufacturing and imports endanger small economies and ecosystems • Results in national food dependance from foreign suppliers and corporations • Small entrepreneurs, peasants, and Indigenous communities are deprived of means to access adequate foods • They fall into poverty and depend on handouts • State failure to *protect* and *respect*
Barrier 1. Reductionist approach to improving nutrition		
Resolution as charity The right to adequate food should not be interpreted in a narrow sense as handouts or packages of calories or nutrients	• Government and international organizations approach the resolution of hunger and malnutrition as increasing food supplies at the personal level • To mitigate access constraints, they distribute handouts • Handouts do not address the structural causes of food shortage and malnutrition	• Handouts and supplementation may provide calories and nutrients that reduce hunger and malnutrition rates • However, the causes of hunger and malnutrition remain unsolved
Barrier 2. Policy and program implementation passed on to third parties		
Outsourcing favors corruption States should provide an environment where private businesses functions, in respect to the right to adequate food and compliance with the principles of accountability and transparency	• Government and international organizations hand program implementation over to third parties • Most implementing parties are private food, beverage and healthcare companies • Outsourcing program implementation increases the risk of: politically favorable and corrupt contracts to tenders, misappropriation of public resources, embellishment of public figures, and delivery of low-quality, ultra-processed, rotten, or expired foods	Passing implementation to third parties impedes accountability and transparency: • By creating distance between responsible organizations and recipients, impeding social accountability • Because suppliers are motivated by profit over compliance with human rights • The state is not ensuring conditions for suppliers to operate with accountability, transparency, and respect for the right to adequate food
Barrier 2. Implementation of policies passed on to third parties		
Outsourcing hinders civic participation The State must guarantee the principles of people's participation and decentralization in every food and nutrition policy and program	• Program implementation shifts from supplier to supplier and tender to tender, creating miscommunication between organizations and program recipients • Recipients cannot communicate problems and propose solutions • Communities develop functional solutions to their food and nutrition problems • Miscommunication impedes solutions to be known outside the communities • Reduced opportunities of investment to upscale solutions and divulge as best practices • Hindered understanding of citizens as right holders instead of aid beneficiaries	• State has not planned programs in a way that ensures participation throughout the full policy and program cycle (formulation, implementation, monitoring, evaluation) • Resolving this is essential to comply with the principles of participation and decentralization • Supporting community solutions can complement the efforts of the state and the international community

(Continued on following page)

TABLE 1 | (*Continued*) Assessment of the four main barriers to achieving children's right to adequate food under Colombia's existing food security and nutrition policy and programs (Policy Solutions to Realize the Right to Food of Children in Colombia: An Integrative Approach, Colombia, Italy, 2021–2022).

ICESCR Article 11 and GC12 standards	Application of ICESCR Article 11 and GC12 to Colombia food policies	Barriers to guaranteeing children's right to adequate food according to ICESCR Article 11 and GC12
Barrier 3. Insufficiency of national source data		
The State must comply with the principles of accountability, transparency and people's participation	• ENSIN has inconsistent indicators from one survey to the following • ENSIN is only conducted every 5 years and is often delayed • ENSIN lacks specific indicators to measure the impact of food and nutrition policies and programs • No system to collect national data by asking recipients about their experiences, problems, and suggestions	• Lack of timely food and nutrition data to oversee and evaluate the implementation and impact of policies and programs • Lack of information hinders transparency and accountability • Integrating mechanisms for citizen participation and oversight is needed to - Identify functional and dysfunctional interventions and avoid repeating mistakes - Derive evidence-based strategies - Achieve accountability and transparency
Barrier 4: Uneven and inadequate program implementation		
• State obligation to *Respect:* refraining from any measures that impede the right to adequate food for any person or human group. • State obligation to *Protect:* taking measures to ensure that no entity deprives people of adequate food or the means to access it (e.g., land, ecosystems)	• Unequal, inadequate distribution of handouts • Handouts do not reach many remote territories, most of which are affected by armed conflict and state absence • Uneven distribution reinforces pre-existing inequities • Some handouts consist of expired, culturally inadequate, highly processed, energy-dense foods, manufactured by multinational corporations, threatening public health and local economies • People in territories affected by poverty, hunger, malnutrition and state absence are vulnerable to engage in illicit economies • Other than the inadequate handouts, the state has not taken measures to intervene	• The inequality and inadequacy of aid distribution violates the state's obligation to *respect* the right to adequate food • Handouts do not solve the causes of poverty, hunger, malnutrition, and the links with illicit economies • Lack of forceful measures shows a clear violation to the obligations to respect and protect the right to adequate food

RESULTS

Barriers

We identified four key barriers to achieving children's RtAF under Colombia's food security and nutrition policy and programs; 1) a reductionist approach to improving nutrition; 2) policy and program implementation passed on to third parties; 3) insufficiency of national source data; 4) uneven and inadequate program implementation.

Barrier 1: Reductionist Approach to Improve Nutrition

National and International Focus on Food Security

As of February 2023, all food and nutrition policies in Colombia were based on Conpes 113/2008 [33]. Conpes 113/2008 coined the term "food and nutrition security," drawing on the 1996 World Food Summit (WFS) definition of food security [9, 33]. The 1996 WFS definition has oriented food and nutrition programs of many governments and INGOs and, as all interviewees reported, guided the initiatives for hunger and malnutrition in Colombia. However, neither Article 11 of ICESCR nor GC12 mentions food security as equal to or part of the RtAF, nor does it establish state obligations correlated with food security [20, 22, 23]. Several interviewees saw this as an important barrier and a law expert stated, "because food security is not a legal concept, it does not imply clear obligations to the state or stakeholders, leaving its interpretation and implementation to the discretion of politicians and organizations" (see **Table 1**).

Focus on Personal Food Access

GC12, paragraph 15, establishes that ICESCR state parties are obliged to: 1) *respect* the RtAF by refraining from any measures that impede this right to any person or human group; 2) *protect* the RtAF by taking measures to ensure that organizations, companies, or individuals do not deprive people of adequate food or the means to access it (e.g., land, ecosystems) [22]. All interviewees reported that food security and food and nutrition security focus on guaranteeing personal food access. Some interviewees commented that this individualized focus does not consider whether the ways to supply individuals with food may negatively impact communities and ecosystems. For example, the Colombian government attempts to augment food access by increasing mass food production and imports. Parallelly, the government and INGOs distribute handouts to individuals considered the most vulnerable in society. These approaches increase food supplies. Yet, they disregard that intensive farming and imports favor corporations, big landowners and manufacturers while endangering ecosystems, small-scale farms and businesses, producing food dependency. Furthermore, assistance programs are not coupled with strategies

to ensure that people have the means to decide and access to adequate food on their own. According to one interviewee, this reveals that the State is not taking measures to prevent corporations and organizations from depriving certain vulnerable groups (i.e., indigenous groups, remote communities, areas affected by the armed conflict) of the means to procure adequate food and cause food dependency on industrial production and assistance programs.

Resolution as Charity

GC12, paragraph 6, underlines that RtAF should not be interpreted in a narrow sense as packages of calories or nutrients. All interviewees aligned with GC12, underscoring that a prominent barrier to having efficient food and nutrition policies is the "frequent interpretation by government and international actors of the resolution of hunger and malnutrition as charity" or "nutrition supplementation" focused on disproportionally affected individuals. These observations suggest a widespread paradigm that reduces action on food and nutrition to handouts for specific populations, instead of understanding adequate food as a human right and an obligation of the state under international law. According to one interviewee, "While handouts may reduce malnutrition rates, handouts cannot solve the causes, so malnutrition persists."

Barrier 2: Program and Policy Implementation Passed to Third Parties

Outsourcing Favors Corruption

GC 12, paragraphs 20 and 23, respectively, establish that states should provide an environment where private business pursues its activities within a code of conduct conducive to respecting the RtAF, and compliance with the principles of accountability and transparency. In this regard, all of the interviews revealed that government organizations and a majority of INGOs implementing food security and nutrition aid programs, hand their implementation over to third parties, most notably to food, beverage and healthcare providers. According to the interviewees, outsourcing program implementation impedes compliance with the principles of accountability and transparency by increasing the probability of corruption. This includes politically favorable and corrupt contracts to tenders, misappropriation of public resources, embellishment of public figures, and suppliers cutting costs by delivering low-quality, ultra-processed, rotten, or expired foods, despite being paid enough for adequate food. Some interviewees revealed that, in order to continue receiving international cooperation funds for food and nutrition, which represent important funding resources, the government must justify the allocation of these resources by providing evidence to donors on how they are invested. As evidence, the Colombian government shows reductions in national child malnutrition figures from the National Food and Nutrition Status Survey (ENSIN) [26]. One interviewee revealed that "to make food and nutrition programs appear to have a positive impact on ENSIN, government officials command hospitals in remote areas not to report malnutrition as a cause of death, when death can be attributable to other causes." Another recurring practice to enhance ENSIN results is to "modify its indicators from survey to survey." By modifying indicators, ENSIN results vary, thereby embellishing the numbers.

Outsourcing Hinders Civic Participation

GC12, paragraph 23 and ICESCR, Article 13 establish the obligation of states to guarantee civic participation. Several interviewees explained that outsourcing the implementation of food and nutrition aid creates distance between the responsible organizations and the recipients, as program implementation shifts from supplier to supplier. This prevents recipients from reporting problems and proposing solutions to decision-makers who develop and implement the policies and programs. Interviewees observed that this distance impedes the perception of citizens as right holders rather than aid beneficiaries. This perception is essential to achieve community participation and people's sovereignty to decide on the food system [10, 11].

Four interviewees highlighted that despite these adverse circumstances, numerous communities across the country develop functional solutions to their food and nutrition problems (i.e., peasant networks, seed networks, and family markets). Nonetheless, due to the lack of communication between citizens and decisionmakers, many community solutions remain unknown to stakeholders who could mobilize resources to help grow and spread best practices in other communities. Experts agreed that INGOs can call upon the government to ensure participation in all policies and programs and attract resources toward functional community solutions.

Barrier 3: Insufficiency of National Source Data

Applying GC12 and ICESCR principles of accountability, transparency, and participation helps to identify the limitations of available national source data on food and nutrition in Colombia. As of February 2023, ENSIN, last updated in 2015, remains the only national source data on food and nutrition in Colombia [25]. The interviewees agree that ENSIN has inconsistent indicators from survey to survey, is only conducted every 5 years, is often delayed, and lacks specific indicators to measure the impact of food and nutrition policies and programs. In fact, Colombia has no system to periodically collect national data on policy and program outcomes by asking recipients about their experiences, problems, and suggestions [33–35]. All interviewees observed that ensuring civic participation in data collection and program monitoring is the most efficient way to improve the quality and transparency of national data sources and to enhance program accountability. As one government official put it, "coordination between organizations and civil society at the national and subnational levels is essential to identify the initiatives perceived as functional and dysfunctional by the recipients, develop efficient evidence-based strategies, and

avoid repeating mistakes." These primary data converge with the results of comparative analyses of food and nutrition policies in Colombia [34]. The analyses found insufficient timely food and nutrition data to monitor and evaluate the impact of policies and programs. These studies reiterate the need for civil society, especially the recipients of interventions, to participate in decision-making, data collection, and oversight. Such participation requires a system of data dissemination that allows the government, involved organizations, and citizens (including civil society and oversight organizations, media, academia) to know the data, provide policy and program implementation feedback, and monitor resource allocation and use.

Barrier 4: Uneven and Inadequate Program Implementation

In line with the content of GC12, paragraph 15, several interviewees reported that the distribution of food aid in remote territories is unequal and inadequate, thus violating the state's obligation to *respect* the RtAF. The interviewees agreed that the assistance from national and international organizations does not reach many remote territories, which have experienced a history of armed conflict and state absence. These results align with previous research [35] that reveals an unequal implementation of food and nutrition policies and interventions between territories, without coordination with national and subnational development programs. The unequal distribution of aid ends up reinforcing pre-existing inequities between territories. Moreover, the interviews reveal that the aid that reaches some of the remote territories often consists of low quality, expired, and culturally inadequate foods that are often highly processed, energy-dense, and manufactured by transnational corporations. As a result, weak state intervention threatens public health and local economies, and makes public programs more prone to looting.

Simultaneously, as some interviewees reported, state absence combined with the high levels of poverty, hunger, and malnutrition in most remote areas in Colombia, often trigger people to resort to illicit activities. An interviewee exemplified that the government invests massive resources to combat narcotics. However, many production centers and transport routes are known, yet no forceful measures are taken. Decision makers "are aware that people in neglected territories affected by poverty, hunger, and malnutrition are vulnerable to engaging in illicit economies, such as narcotics, in search of survival. They are pressured by armed groups." However, "in these territories it is not convenient to solve state absence with structural measures to address poverty, hunger, and malnutrition. . . Handouts serve to keep things as they are while pretending that something is done. . . Resources can be looted and allow the perpetuation of profitable illicit activities that benefit some people of the political elite while keeping their implication unclear and unpunished." These results suggest that investments meant for food and nutrition handouts, may inadvertently support illicit economies that thrive in hunger, malnutrition and poverty, hampering the obligation to respect the RtAF.

DISCUSSION

This study provides important insights into what barriers impede the attainment of children's RtAF under Colombia's current food security and nutrition policy and programs. We describe the importance of designing, implementing, monitoring, and evaluating policies and programs in compliance with the obligations of the state toward the RtAF, acquired through ratification of ICESCR and CRC. In doing so, our findings reveal four critical barriers: 1) a reductionist approach to improving nutrition prevailing in the national political narrative; 2) policy and program implementation is passed to third parties, creating distance between the responsible organizations and the recipients; 3) insufficiency of national source data to assess the results of interventions' outcomes and 4) uneven and inadequate implementation of aid interventions in remote communities, which inadvertently reinforces preexisting inequities and supports illicit economies that thrive in conditions of hunger and poverty. Although our study focused on children, findings suggest that these barriers affect both children and the entire community around them, including adult women and men. However, the implications of the barriers on human rights are greater for children, since childhood is a critical developmental window that defines, to a critical extent, lifetime access to opportunities and results, with effects on future generations [1–7]. This raises important implications for policy and program development when seeking to reduce child hunger and malnutrition, a problem that remains critical in Colombia, LAC, and most low- and middle-income countries [8, 24].

The way in which food and nutrition policies are framed is crucial to their success [40]. As other research has shown, food and nutrition security is the methodological and theoretical approach to food and nutrition policies and programs in Colombia since 2000 [11, 33]. Nonetheless, such an approach is reductionist as it is not supported by a research agenda that examines the legal, epistemological, and methodological limitations of using food security as the axis of food and nutrition programs and the discrepancies between food security-based approaches and the law framework on the RtAF [33]. Moreover, since food and nutrition security focuses on individual food access, it is ambiguous, as it does not indicate how to guarantee food access without harming the livelihoods of citizens, communities, and ecosystems [11, 41]. Our findings show two other ways by which this approach is reductionist. First, food and nutrition security is not a legal concept with correlative obligations, so it can be interpreted and implemented at the discretion of the organizations in charge. Second, food and nutrition security tends to be interpreted as the distribution of handouts to vulnerable individuals [10], which does not solve the structural causes of hunger and nutrition inequalities.

A handout-based approach to promote food and nutrition security prevails in multilateral agencies and national institutions [10–13]. The implementation of handout and nutritional supplementation programs is usually outsourced to tertiary providers of goods and services [12, 42]. Previous literature

showed that outsourcing the implementation of government childhood programs creates a communication gap between the responsible organization and recipient families [32]. Our findings show that this gap can also occur in programs of multilateral agencies which are implemented by third parties. The gap impedes program accountability as program recipients cannot report problems, propose solutions, or output information to measure the impact of interventions [13, 17]. Furthermore, this and similar studies show insufficiency and obsolescence in food and nutrition information systems in Colombia [33–35], making it difficult to understand whether existing policies and programs serve to ensure the RtAF in all national territories.

This study also found that outsourcing the implementation of programs raises the risk of corruption. Previous literature identified corruption as a cause of inefficiency of food and nutritional policies in Colombia [31]. Our study sheds light on frequent forms of corruption related to outsourcing program implementation. Moreover, suppliers contracted to distribute food aid often exclude remote territories or send them inadequate aid, which inadvertently triggers illicit economies that thrive in conditions of hunger and poverty. These findings mirror studies in British Colonial Asia [43] and Brazil [44], showing that loss of agricultural income, food shortages, and unequal distribution of resources in areas of weak state presence are drivers of poverty, while poverty triggers different forms of crime [45, 46]. The problems described above reveal important gaps in food-security-assistance-based approaches to hunger and malnutrition relief. These approaches have characterized food and nutrition policies and programs in Colombia and many low- and middle-income countries [10–12, 23]. Our research suggests that formulating more effective food and nutrition programs requires a paradigm shift from seeing recipients as beneficiaries to understanding them as human rights holders and policy allies. This understanding implies generating participation mechanisms that integrate their voices in policy and program formulation, implementation, monitoring, and evaluation, including the design of indicators to longitudinally assess their impact and mobilization of resources to upscale community solutions to hunger and malnutrition.

No specific models were found for Colombia to prevent outsourcing policy and program implementation from hindering civic participation and to mobilize resources towards community solutions. However, a 2022 study systematically reviewed community-based participatory interventions to improve food and nutrition, finding that community-based participatory interventions have been applied in several low- and are middle-income countries and associated with improved nutritional, health, and food security outcomes. Furthermore, agricultural practices were improved, mainly after participatory models based on agroecology. Nonetheless, the review found insufficient evidence to support a specific type of participatory model to improve food and nutrition [47]. In addition, a recent study in Peru showed a high relevance of citizen participation in planning public strategies to reduce undernutrition [48], and in the United Kingdom, a model was developed to integrate children's voices in research to design national food policies [49].

Peru and UK models are human rights based. Although a human rights-based policy approach has several advantages [50–52], there are potential limitations of this approach to address child hunger and malnutrition, including the potential for governments to claim economic and infrastructure difficulties to advancing economic development while simultaneously complying with their human rights obligations [50, 53]. Moreover, decision makers and influential actors who benefit directly or indirectly from current food-security-orientated measures and/or related outsourcing may not want to support or may even oppose a change of approaches, including initiatives to prevent corruption through citizen oversight. Recognizing this, the exploration of participatory models that adapt documented international best practices to the country context, identifying and addressing the potential limitations of human rights-based participatory approaches could be an opportunity for future research.

Conclusion

This study canvassed the issue of policy and program adequacy to achieve the RtAF through a case study in Colombia, a review of the legal framework on the RtAF and a thematic analysis of 17 semi-structured interviews with experts. Findings from this research show that Colombia's food-security-assistance-based policies and programs are failing to provide the RtAF for children. Given the importance of food for the attainment of all human rights, the need for an integrative approach to ensure children's RtAF is urgent. This requires mechanisms to guarantee full citizen participation and accountability in policies and programs of government and international agencies. Like Colombia, many countries have food-security-assistance-based policies. Therefore, models to integrate citizen voices in food and nutrition decision making are an opportunity for future application and research insights from this study can serve as a baseline.

AUTHOR CONTRIBUTIONS

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CONFLICT OF INTEREST

The authors declare that they do not have any conflicts of interest.

SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.ssph-journal.org/articles/10.3389/ijph.2023.1605969/full#supplementary-material

Supplementary File S1 | Guide for the semi-structured interviews (Colombia, 2022).

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Predictors of Suboptimal Adherence Among Children on Antiretroviral Therapy in Southern Ethiopia: A Multicenter Retrospective Follow-Up Study

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Objectives: Despite increased access to and availability of antiretroviral therapy, the program's effectiveness is primarily affected by treatment adherence. Therefore, this study aimed to determine the magnitude and predictors of suboptimal adherence among children on ART in Southern Ethiopia.

Methods: A multicenter retrospective study was conducted among human immunodeficiency virus (HIV) infected children in Gamo and South Omo zone public health facilities. To identify factors associated with suboptimal adherence, a binary logistic regression model was fitted. Variables with a p-value ≤0.25 in bivariable logistic regression analysis were included in multivariable logistic regression analysis. p-value <0.05 was used to declare statistical significance.

Results: The suboptimal adherence was determined to be 30.3% (95% CI: 25.5%, 35.6%). Advanced clinical stage, hemoglobin level <10 mg/dL, unchanged initial regimen, and non-disclosure of HIV sero-status were significant predictors of suboptimal adherence.

Conclusion: Suboptimal adherence is a significant public health problem in the study setting. Therefore, designing interventions towards improving adherence is needed especially for children with poor clinical characteristics.

Keywords: antiretroviral therapy, children, HIV, suboptimal adherence, Ethiopia

INTRODUCTION

Human immunodeficiency virus (HIV) remains a major global public health problem, having claimed 40.1 million lives so far with ongoing transmission in all countries globally. It is an infection that attacks the body's immune system, and acquired immunodeficiency syndrome (AIDS) is the most advanced stage of the disease [1]. By the year 2020, about 1.7 million children under 15 years old were living with Human Immunodeficiency Virus (HIV) [2], and about 99,000 died of AIDS-related mortality worldwide [3]. Sub-Saharan Africa is the region most affected by HIV and about 90% of all adolescents and children living with HIV were living in the region [4]. Ethiopia is one of the Sub-Saharan African countries with a total of 43,400 children living with HIV, out of which 2,000 AIDS-related mortalities occurred by the year 2020 [5].

Adherence is described as "the extent to which a person's behavior, such as taking medication, sticking to a diet, and/or implementing lifestyle changes, corresponds with agreed-upon recommendations from a healthcare provider" [6]. Any child who misses more than three dosages throughout a 1 month treatment term is considered to have less than 95% adherence, which is suboptimal adherence, and a child who misses a dose of fewer than three is considered to have optimal adherence [7]. The success and duration of ART drug regimens are mostly influenced by treatment adherence, which needs near-perfect adherence of up to 95% [8–10]. Suboptimal adherence among children remains a significant challenge for ART programs in both developed and developing countries [11]. According to evidence from studies conducted in numerous countries throughout the world, the extent of suboptimal adherence among HIV-positive children was expected to be substantial. In a systematic review conducted in low- and middle-income countries among children living with HIV, the level of adherence ranges from 49% to 100% [12]. Studies conducted in Sub-Saharan African countries showed that the adherence level was reported to be from 29% to 98% among children on ART [13–15]. Evidence from previous studies conducted in different parts of Ethiopia revealed that the magnitude of suboptimal adherence to ART ranged from 9.3% in Hossana [16] to 34% in Southwest Ethiopia [17].

Suboptimal treatment adherence is linked with an increase in the risk of unfavorable treatment outcomes like treatment failure and antiretroviral drug resistance, immunological decline resulting in opportunistic infections, and advanced HIV disease progression [18–22]. This in turn leads to preventable morbidity and mortality, increased expenditure for care, and avoidable forward transmission of HIV [23]. Poor adherence to ART reduces the effectiveness of viral suppression, increases viral resistance, and puts people living with HIV (PLHIV) at risk of hospital admission, and opportunistic infection [24]. Moreover, the effect of suboptimal adherence was also revealed by the outcome of the ambitious 90–90–90 targets, which aimed to attain 90% viral suppression. Due to this effect, only 40% of under-fifteen-year-old children living with HIV were virally suppressed [25].

Evidence from previous studies identified different factors associated with suboptimal treatment adherence of HIV-positive children on ART. These include the child's age, the caregiver's age, TB co-infection, advanced clinical stage, non-disclosure of children's sero-status, and treatment failure [14, 26, 27].

Several strategies have been implemented to improve treatment adherence in children on ART, and they have shown benefits in improving adherence. Mobile phone text messages, behavioral skills training/medication adherence training for caregivers, fixed-dose combinations, and once-daily regimens are among the approaches [28]. Despite these efforts, poor adherence remains a significant hurdle to the efficacy of ART programs. The degree of suboptimal adherence level and factors associated with it can vary from place to place, so it is necessary to assess the problem in order to design effective strategies. However, there is limited evidence regarding suboptimal adherence to care among children on ART in Ethiopia, and no evidence in a study setting. Therefore, this study aimed to assess suboptimal adherence and associated factors among children receiving ART.

METHODS

Study Design, Period, and Setting

An institution-based retrospective follow-up study was conducted from 12 April to 10 May 2022. The study was conducted in public health facilities found in Gamo, and South Omo zones, Southern Ethiopia. Arba Minch town is 505 Kilometers (KM) Southwest far from the capital city, Addis Ababa. Jinka town is about 563 KM far from Addis Ababa and 399 Kilometers from Hawassa. In these two zones, there are about 23 health facilities (2 general hospitals, 5 primary hospitals, and 16 health centers) that are currently providing pediatric ART services. These health facilities provide different services to the community in their catchment area and nearby woredas and zones. In these two zones currently, there are about 256 HIV-positive children on active ART follow-up. The follow-up schedule was based on the national ART guideline of Ethiopia; children beginning their follow-up returned for their first follow-up after 2 weeks of initiation of ART then monthly for the first 6 months, followed by every 3 months for drug refill, clinical assessment, and adherence support [23].

Population

All HIV-positive children (<15 years) who were on ART in public health facilities of Gamo and South Omo Zones made up the source population. All HIV-positive children (<15 years) who were on ART in Jinka General Hospital, Arba Minch General Hospital, Gazer Primary Hospital, Chencha Primary Hospital, Birbir Health Center, Gerese Health Center, Jinka Millennium Health Center, Kamba Health Center, and Shele Health Center, from 1 January 2012 to 31 December 2021 made up the study population. All HIV-positive children (<15 years) who were on ART and had completed at least one follow-up visit were included in the study. Children on ART with incomplete records were excluded from the study.

Sample Size Determination and Sampling Technique

Sample Size Determination

The sample size was determined by using a single population proportion formula [$n = [(Z_{a/2})^2 * P(1-P)]/d^2$] and by considering a 95% confidence interval with a confidence level of $Z_{a/2} = 1.96$, the proportion of sub-optimal adherence of 21.8% taken from a study conducted in south Gondar public hospitals, Northwest Ethiopia [26], a margin of error (d) 5%. Using the above assumptions, the calculated sample size was 262 and after adding a 10% incompleteness rate, the final sample size was 289.

Sampling Technique and Procedure

The public health facilities in Gamo and South Omo Zones were stratified based on their type of health facility into General

Hospitals, Primary Hospitals, and Health Centers. Then by simple random sampling (lottery method) two Primary Hospitals and five Health Centers were selected. Both of the General Hospitals were included. The children <15 years of age were identified in each of the health facilities using medical record numbers (MRN) that were obtained from electronic databases. Patients' charts were drawn using the MRN. In these health facilities 349 children (age < 15) on ART from 01 January 2012 to 31 December 2021 were identified and 323 of the children who fulfilled the eligibility criteria within the follow-up period were included in the study.

Data Collection Tools and Procedures

Data were collected by using a data extraction checklist developed in English from the standardized ART intake and follow-up forms from national HIV guideline [23], and by reviewing related literatures. The tool contains socio-demographic, clinical, and treatment-related characteristics of participants. The lists of study participants were taken from the ART data clerk by using children's MRN or unique ART numbers. Charts of the children were taken from card rooms. Then data were collected by reviewing the patient follow-up charts by fourteen data collectors and three supervisors.

Operational Definitions

Suboptimal adherence: If HIV-positive children on ART experienced fair or poor adherence (drug adherence of ≤94% or ≥3 doses missed monthly) [23].

CD4 count for severe immunodeficiency: The classification was based on children's age. For children < 5 years CD4 < 200 cells/mm^3, and CD4 < 100 cells/mm^3 children ≥ 5 years [29].

Nutritional status: Was measured by weight for age (WFA) and body mass index (BMI) for Age. Categorized as; underweight (WFA or BMI for age <−z-score) and normal (z-score > −2) [23].

Data Quality Assurance

The data collection process was conducted by 14 data collectors (9 BSc in Nursing and 5 BSc in Public Health), who were trained on comprehensive HIV care and providing follow-up care services, and three supervisors (BSc in Public Health) after receiving 1 day of training. To check the relevance, consistency, and adequacy of the checklist, a pretest was conducted before the actual data collection in the same setting. The data collection tool was properly numbered and coded. The principal investigator and supervisors carried out daily monitoring of the data collection process by reviewing and checking the filled-out checklists to ensure accuracy, completeness, and consistency.

Data Processing and Statistical Analysis

The collected data were entered into Epi-Data version 3.1 and then exported to STATA version 14.0 for management and analysis. Exploratory data analysis was done to check the presence of potential outliers, normality, and level of missing values. Z-scores, to assess nutritional status, were generated by using WHO Anthro-Plus software. Descriptive statistics were found using mean, median, standard deviation, interquartile range, frequencies, and percentages. A bivariable logistic regression model was fitted to assess the association between each independent variable and the dependent variable, variables with a p-value ≤ 0.25 in bivariable logistic regression were candidates for multivariable analysis. A multivariable logistic regression model with a backward likelihood ratio method was fitted to identify factors significantly associated with suboptimal adherence. Multicollinearity was checked by using variance inflation factor (VIF) and tolerance, the mean VIF = 1.08, indicating no threat of collinearity. The goodness of fit of the model was checked by the Hosmer-Lemeshow chi-square test (Prob > X^2 = 0.2309). AOR with a 95% CI and corresponding p-value was used to identify statistically significant variables. p-value <0.05 was used to declare statistical significance.

RESULT

From a total of 349 children (age <15 years) who were receiving ART from 1st January 2012 to 31st December 2021, about 323 have fulfilled the inclusion criteria and are included in the analysis with a 92.6% completeness rate of charts.

Sociodemographic Characteristics of Children Receiving ART

The median age of the study participants was 5 (IQR: 2–9) years, 118 (36.5%) children were in the age group of ≤3 years, and approximately a quarter (91 (28.2%)) of the participants were in the age group of ≥9 years. Among the study participants, 167 (51.7%) were male and forty-five children (13.9%) had lost both of their parents. For the majority of the children, 277 (85.8%) caregivers were their biological families. Three percent of the caregivers were in the age range of ≤24 years and 135 (41.8%) of the caregivers were in the age group of 35–44 years. Regarding the place of residence, more than half (50.8%) of the HIV-positive children were urban residents. Half of the caregivers [165 (51.1%)] had not attended formal education and 28 (8.6%) attained a tertiary and above educational level. One-third of the caregivers [112 (34.6%)] were daily laborers and 42 (13%) were government employees (**Table 1**).

Clinical and Treatment-Related Characteristics of Children on ART

Among the 323 HIV-positive children who participated in the study, more than three-quarters (78.0%) were from hospitals, and the remaining 71 (22.0%) were from health centers. One hundred sixty-four (50.8%) HIV-positive children were enrolled with a test-and-treat approach. Regarding the BMI for age z-score, 222 (68.7%) of the study participants had a BMI for age z-score of ≥−2. Regarding baseline weight for age and height for age z-scores, 33.6% and 32.5% of children had a z-score of <−2, respectively. Among the under-five children who participated in the study, 99 (65.1%) had reached a developmental milestone that was appropriate for their age, whereas 53 (34.8%) had a delayed or regressed developmental milestone. The functional status of the HIV-positive children aged above 5 years was identified to be 49.1%, 45.6%, and 5.3%, labeled as working, ambulatory, and bedridden,

TABLE 1 | Socio-demographic characteristics of children on antiretroviral therapy in public health facilities of Gamo and South Omo zones, southern Ethiopia, 2022 (n = 323) (Predictors of Suboptimal Adherence Among Children on Antiretroviral Therapy in Southern Ethiopia, 2022: A Multicenter Retrospective Follow-Up Study).

Characteristics	Categories	Frequency (n)	Percent (%)
Age (in years)	≤3	118	36.5
	4–8	114	35.2
	≥9	91	28.2
Sex	Male	156	48.3
	Female	167	51.7
Residence	Urban	164	50.8
	Rural	159	49.2
Parent status	Both alive	144	44.6
	Either died	134	41.4
	Both died	45	13.9
Caregiver-child relationship	Biological family	277	85.8
	Others[a]	46	14.2
Age of caregiver	≤24 years	12	3.7
	25–34 years	112	34.6
	35–44 years	135	41.8
	≥45 years	64	19.8
Educational status of caregiver	No formal education	165	51.1
	Primary	105	32.5
	Secondary	25	7.7
	Tertiary and above	28	8.6
Occupational status of caregiver	Farmer	87	26.9
	Merchant	51	15.8
	Gov't employee	42	13
	Daily laborer	112	34.6
	Others[b]	31	9.6

Abbreviation: ART, antiretroviral therapy.
Note: [a]Other: relative, not relative.
[b]Others: Housewife, Gospel preacher.

respectively. More than eighty percent of the participants had a hemoglobin level of ≥10 mg/dL and the mean hemoglobin level was 12.5 mg/dL (2.45 mg/dL SD). Concerning the WHO clinical stage, of the total children who participated in the study, 209 (64.7%) were in clinical stage I or II. The study reported that 45 (13.9%) HIV-positive children had a history of TB/HIV co-infection. In addition, 68 (21.1%) of the participants had a history of opportunistic infections other than TB. For the prevention of common opportunistic infections, 157 (48.6%) of the children on ART took both CPT and IPT. The median baseline CD4 count was determined to be 473 (IQR: 288–783) cells/mm^3. Regarding ART regimens initiated during enrollment, 172 (53.3%) were started on Zidovudine, Lamivudine, and Nevirapine (AZT+3TC+NVP)-containing regimens, and only 21 (6.5%) were initiated on Dolutegravir (DTG)-containing regimens. The HIV sero-status of 72 (22.3%) children on ART was disclosed to the children themselves. The initial ART regimen of 149 (46.1%) children was not changed, and the children were taking their old ART regimen. Availability of new drugs was the main reason for regimen change, but other reasons, such as treatment failure, drug stockouts, and other unknown reasons, were also responsible. Only four children on ART experienced side effects.

Predictors of Suboptimal Treatment Adherence

This study identified that the magnitude of suboptimal adherence was 30.3% (95% CI: 25.5%, 35.6%) (**Figure 1**).

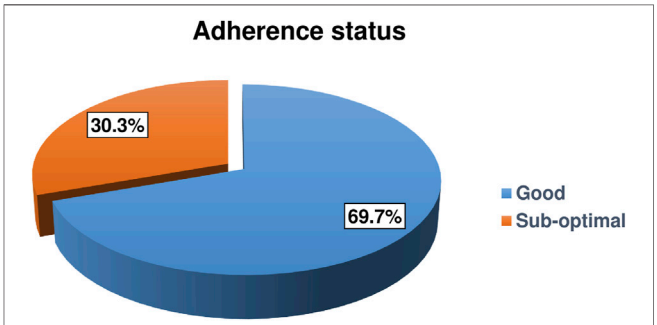

FIGURE 1 | Adherence status of HIV-positive children on antiretroviral therapy in Gamo and South Omo zones public health facilities, Southern Ethiopia, 2022 (n = 323) (Predictors of Suboptimal Adherence Among Children on Antiretroviral Therapy in Southern Ethiopia, 2022: A Multicenter Retrospective Follow-Up Study).

In bivariable logistic regression analysis, suboptimal adherence was significantly associated with; sex of the child, parent status, educational status of caregiver, type of health facility, BMI for age, WHO clinical stage, history of tuberculosis infection, CPT prophylaxis, IPT prophylaxis, hemoglobin level, CD4 count, regiment change, and disclosure status at p-value of <0.25. In multivariable logistic regression analysis, WHO clinical stage, hemoglobin level, regimen change, and disclosure status of the children showed statistically significant association with suboptimal adherence at p-value <0.05.

TABLE 2 | Bivariable and multivariable analysis for predictors of suboptimal adherence among children on antiretroviral therapy in public health facilities of Gamo and South Omo zones, Southern Ethiopia, 2022 (n = 323) (Predictors of Suboptimal Adherence Among Children on Antiretroviral Therapy in Southern Ethiopia, 2022: A Multicenter Retrospective Follow-Up Study).

Variables	Categories	Suboptimal adherence		COR (95% CI)	AOR (95% CI)	*p*-value
		Yes (%)	No (%)			
Sex	Male	41 (12.7)	115 (35.6)	1	1	
	Female	57 (17.7)	110 (34.1)	1.45 (0.90, 2.35)	1.68 (0.99, 2.88)	0.06
Parent status	Both alive	39 (12.1)	105 (32.5)	1	1	
	Either died	48 (14.9)	86 (26.6)	1.50 (0.90, 2.50)	1.35 (0.75, 2.42)	0.32
	Both died	11 (3.4)	34 (10.5)	0.87 (0.40, 1.89)	1.03 (0.43, 2.48)	0.95
Educational status of the caregiver	No formal education	64 (19.8)	101 (31.3)	2.72 (1.28, 5.80)	2.06 (0.90, 4.74)	0.09
	Primary	24 (7.4)	81 (25.1)	1.27 (0.56, 2.91)	1.16 (0.47, 2.83)	0.75
	Secondary and above	10 (3.1)	43 (13.3)	1	1	
Type of health facility	Hospital	82 (25.4)	170 (52.6)	1	1	
	Health center	16 (5.0)	55 (17.0)	0.60 (0.33, 1.12)	1.04 (0.46, 2.35)	0.92
BMI for age	z-score < −2	36 (11.2)	65 (20.1)	1.43 (0.87, 2.36)	1.08 (0.60, 1.93)	0.80
	z-score ≥ −2	62 (19.2)	160 (49.5)	1	1	
WHO clinical stage	I or II	47 (14.6)	162 (50.2)	1	1	
	III or IV	51 (15.8)	63 (19.5)	2.79 (1.71, 4.56)	2.29 (1.31, 3.98)	0.003
Presence of TB	Yes	24 (7.4)	21 (6.5)	3.15 (1.66, 5.99)	1.75 (0.80, 3.83)	0.16
	No	74 (22.9)	204 (63.2)	1	1	
CPT Prophylaxis	Yes	86 (26.6)	167 (51.7)	1	1	
	No	12 (3.7)	58 (18.0)	0.40 (0.20, 0.79)	0.98 (0.43, 2.22)	0.96
IPT Prophylaxis	Yes	56 (17.3)	158 (48.9)	1	1	
	No	42 (13.0)	67 (20.7)	1.77 (1.08, 2.89)	1.21 (0.62, 2.37)	0.58
Hemoglobin level	<10 mg/dL	34 (10.5)	18 (5.6)	6.11 (3.23, 11.54)	3.62 (1.82, 7.19)	<0.001
	≥10 mg/dL	64 (19.8)	207 (64.1)	1	1	
CD4 count	≤200 cells/mm^3	30 (9.3)	31 (9.6)	3.35 (1.84, 6.07)	1.49 (0.70, 3.17)	0.30
	200–350 cells/mm^3	20 (6.2)	28 (8.7)	2.47 (1.28, 4.77)	1.76 (0.81, 3.82)	0.15
	≥350 cells/mm^3	48 (14.9)	166 (51.4)	1	1	
Regimen change	Yes	37 (11.5)	137 (42.4)	1	1	
	No	61 (18.9)	88 (27.2)	2.57 (1.57, 4.18)	2.69 (1.55, 4.67)	<0.001
Disclosure status	Disclosed	11 (3.4)	61 (18.9)	1	1	
	Not disclosed	87 (26.9)	164 (50.8)	2.94 (1.47, 5.88)	2.46 (1.17, 5.19)	0.018

Abbreviations: ART, antiretroviral therapy; BMI, body mass index; CD4, cluster of differentiation 4; CPT, cotrimoxazole preventive therapy; IPT, isoniazid preventive therapy; WHO, world health organization.

The odds of suboptimal adherence was doubled (AOR = 2.29; 95% CI: 1.13, 3.98) among children with a WHO clinical stage of III or IV when compared to those with a WHO clinical stage of I or II. Children receiving ART with hemoglobin levels below 10 mg/dL had 3.62 times increased odds of suboptimal adherence when compared to their counterparts (AOR = 3.62; 95% CI: 1.82, 7.19). The odds of suboptimal adherence was nearly three times higher among children whose initial regimen was not changed when compared to those children whose initial regimen was changed (AOR = 2.69; 95% CI: 1.55, 4.67). Children whose HIV sero-status was disclosed had 2.46 times increased odds of suboptimal adherence when compared to their counterparts (AOR = 2.46; 95% CI: 1.17, 5.19) (**Table 2**).

DISCUSSION

This retrospective follow-up study was conducted to identify the predictors of suboptimal adherence among children on ART. As a result, advanced clinical stage (III or IV), low hemoglobin level, unchanged regime, and non-disclosure of HIV sero-status of the children were identified to be the independent predictors of suboptimal adherence.

This study revealed that the magnitude of suboptimal adherence was found to be 30.3%. This finding is lower than studies conducted in Dar es Salaam [14] and Northern Tanzania [30] which reported a magnitude of 40% and 75.4%, respectively. The result of this study is in line with the studies conducted in New Delhi [31] (34.4%) Uganda [32] (28.05%) Gondar in Ethiopia [33] (31.9%) and Ambo in Ethiopia [34] (33.3%). On the contrary, the magnitude of suboptimal adherence determined by this study was reported to be higher than previous studies conducted in South India [35] (9.1%) and Nigeria [36] (14%). Likewise, it was higher than studies previously conducted in different parts of Ethiopia which reported a magnitude of suboptimal adherence ranging from 5.16% to 21.8% among HIV-positive children who are on ART [26, 37–40].

The disparity could be attributed to differences in the adherence level diagnosis technique, the socio-demographic and cultural backgrounds of study participants, and patient-healthcare provider relationships in various settings. Socioeconomic status, study design, adherence assessment approaches, sample size, and setting differences may also be factors. Furthermore, under or over-reporting is more likely in low-income nations than in middle-income countries due to a shortage of expertise among healthcare personnel or caregivers. The consistency may be due to similarity

in data recording formats and follow-up charts in the ART program for pediatric HIV Care and treatment in Ethiopia which was prepared by the Federal Minister of Health of Ethiopia [41].

In this study, the WHO clinical stage was associated with suboptimal treatment adherence among HIV-positive children on ART. Children with advanced clinical stage (stage III or IV) had twice the increased risk of suboptimal adherence when compared to those with a WHO clinical stage I or II. This is consistent with a study conducted in Dar es Salaam, Tanzania [14]. However, this result of the current studies is inconsistent with studies conducted in Ethiopia [34, 37, 42] which stated that children with advanced clinical stages (III/IV) were more likely to adhere. This may be due to the fact that children at advanced WHO clinical stages of the disease may be hopeless for their survival and hence may give little attention or even be ignorant of their medication as compared to their counterparts that are at stage I or II.

The current study reported that children receiving ART with hemoglobin levels below 10 mg/dL had 3.62 times increased odds of suboptimal adherence when compared to their counterparts. This is likely because of the exacerbation of previously existing anemia among children who started on a Zidovudine (AZT)-containing regimen, which can further lead to additional opportunistic infections and in turn reduce adherence due to the tension of the concurrent illness. In addition, it can also be because of the reduction in ART tolerance due to decreased absorption and the effect of immune defense from anemia.

Moreover, regimen change was another factor associated with suboptimal adherence, as identified by this study. The odds of suboptimal adherence was nearly three times higher among children whose initial regimen was not changed when compared to those children whose initial regimen was changed. This is consistent with a study done in Northwest Ethiopia [26] that states that children enrolled in the Zidovudine-containing ART regimen were more likely to be poor adherents. This regimen is the oldest one and is currently replaced with a Dolutegravir-containing regimen; hence, children on this old regimen have not had their regimen changed. This may be due to the fact that the majority of the old ART regimens have side effects that enhance the progression of the disease and result in subsequent complications. The Zidovudine-containing ART regimen was associated with anemia that imposed additional effects on the immune system.

Furthermore, the disclosure status of HIV-positive children on ART was found to be associated with suboptimal adherence, which is controversial. Therefore, children whose HIV sero-status was disclosed had 2.46 times higher odds of suboptimal adherence when compared to their counterparts. This is consistent with studies conducted in Uganda [32], Ethiopia [27, 33], and on the other hand, the report from the current study contradicts a study done in Tikur Anbessa Hospital, Ethiopia [42] that states that HIV-positive children who were not aware of their HIV sero-status were more likely to adhere. Children who are not aware of their HIV status may not grasp the rationale for taking drugs and may become resistant to them since they do not understand why they take medicine while appearing to be well. Children who are aware of their HIV sero-status may feel doomed, refuse, and intentionally miss the treatment doses until they accept their HIV sero-status, and the observed variation between studies may be associated with the extent and duration of counseling provided to children.

The study used a long year of data to identify predictors of suboptimal adherence among the children receiving ART. It is a retrospective study and used secondary data, the effect of some variables (like socioeconomic status and viral load) was not assessed because of incomplete recoding. Since the data were collected at a point in time retrospectively; it was difficult to ascertain potential cause-effect or temporal relationship.

Conclusion

The magnitude of suboptimal adherence was found to be high in the study settings. Advanced clinical stage, low hemoglobin level, unchanged regimen, and non-disclosure of HIV sero-status were the identified predictors of suboptimal adherence. To improve treatment adherence, special attention should be given to adherence counseling and training of adherence supports, especially for children with poor baseline clinical characteristics, those who are taking old regimens, and children with non-disclosed HIV sero-status. Researchers should conduct a longitudinal prospective study to address further clinical and Sociodemographic predictors of suboptimal adherence.

ETHICS STATEMENT

The Institutional Research Ethics Review Board (IRB) of Arba Minch University's College of Medicine and Health Sciences granted ethical permission with the reference number IRB/123/2022. The study was carried out in line with the Helsinki Declaration on Health Research. Arba Minch University's School of Public Health provided official support in the form of a letter. After explaining the purpose of the study, a letter of cooperation was submitted to administrators of public health facilities, and formal official permission was obtained for full access to the history and medical data of ART patients. Because the study was retrospective and was completed through record review, the IRB waived the requirement for informed consent from each participant so that the research could be carried out without contacting patients. The identification (name and unique ART number) of the study participants and healthcare providers who examined each study participant were not included in the data collection instrument to ensure confidentiality. To ensure confidentiality, the data were password-protected after the completion of data entry.

AUTHOR CONTRIBUTIONS

TGG and FM were responsible for the design of the study. TGG, FM, and TMT conducted the research. TGG and FM supervised

data collection. TGG and TMT completed the statistical analyses and drafted the manuscript. TGG and FM contributed to the writing of the manuscript. All authors contributed to the article and approved the submitted version.

CONFLICT OF INTEREST

The authors declare that they do not have any conflicts of interest.

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Hunger, Food Sovereignty and COVID-19 Pandemic: Food Risks During Lockdown

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Objective: This article focuses on describing the food scenario of families in Cali (Colombia), where almost half of the city's population could not guarantee their access to adequate feeding during COVID-19 crisis.

Methods: Involved 1. Analyze laws to understand their relationship with access to food in Cali during lockdown; and 2. Identify changes in the eating practices of families from different socioeconomic levels and the strategies used by the city's public institutions during lockdown.

Results: Feeding was not considered from the beginning of the lockdown, which generated a food crisis. Institutional responses were insufficient in quality and coverage, since feeding aid focused on calories and logistic aspects. The solutions implemented by households were guided by collective action and social organization around the community pots.

Conclusion: The contrast between food security strategies (focused on availability and access) and food sovereignty (with an emphasis on the collective) shows the need for structural transformations in food policies and in the collective imagination that allow for designing new food models focused on community wellbeing and not on economic growth to future emergencies.

Keywords: pandemic, lockdown, food, eating behavior, hunger

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INTRODUCTION

In Colombia, the population remained under different lockdown schemes for 162 days between 22 March and 31 August 2020, due to the COVID-19 pandemic [1]. Food, an aspect of life that had become almost mechanical, became one of the central themes during this period to be addressed, both by families and public institutions. For the former, concerns ranged from "what are we going to eat" to "how do we make it enough for everyone" because their incomes decreased or disappeared; and for the latter, the questions revolved around "how to prevent a crisis during the lockdown."

This research was conducted in Cali, the third most densely populated city in Colombia with 2,280,907 inhabitants with a significant Afro-Colombian population [2], located in the southwest of the country, and the main recipient of the migrant population in this area of the country. It also exhibits significant socioeconomic inequality with a GINI index of 0.523, reflected in socio-spatial and racial segregation [3]. **Figure 1** is a map of the political division of the city which provides a glimpse of the differences in the spatial distribution according to socioeconomic stratum.

The question that led the research was related to how the food security approach influenced the responses to the food needs of the population of Cali, particularly during the period of lockdown by

COVID-19. The answer to this question highlights the need to make a paradigm shift and enable food sovereignty to guide food policies.

This article demonstrated how the government's strategies to address the demand for food, favored large distribution platforms that market processed and ultra-processed food products, to the detriment of local and grassroots initiatives. To a significant extent, this happened because the local food system has traditionally emphasized in the availability of food (food security), while neglecting other aspects related to food sovereignty such as the origin of the food, the traditions around it, the way of cultivating it, and the social relationships that make it possible [4].

Additionally, local and national food regulations do not provide guidance on how to act during times of crisis. As a contrast, community initiatives emerged that helped counteract the hunger experienced during the lockdown, while also fostering dynamics of solidarity and leadership within communities.

METHODS

To address the research question, a case study was conducted between March and August 2020, months when the lockdown period took place. The study involved: a systematic review of news, policies, and articles focused on the lockdown period; and semi-structured interviews.

Regarding the selection of policies, emphasis was placed on the Decree-laws issued by the national and local governments and published on their official websites, which were related to food, food supply chain, and the lockdown period. As for the news, a search was conducted in two newspapers, one national and one local, using the keywords "food," "markets," and "pandemic," and those news articles related to the food situation in Cali during the study period were selected. A total of 228 documents were selected from the 9.459 found in the initial search. The selection process followed the scheme proposed by [5] which is summarized in **Figures 2**, **3** and for both, regulations and news, articles the selection were related to their relevance to food during the lockdown.

The interviews were semi-structured, conducted virtually and had two prioritized groups: on the one hand, families and, on the other hand, food system actors. Families were identified using the snowball sampling technique, prioritizing different family compositions (nuclear, single-parent, extended, single-person) and different socioeconomic strata (considering the impact of the lockdown based on the number of people in the household and their income-generating possibilities). Within the families, the person responsible for food purchases was identified to ask them questions related to changes experienced in food purchase and consumption due to the lockdown. The food system actors, were contacted based on their involvement with food (public officials, NGO members, and retailers). All interviews began with obtaining informed consent, were recorded, and had an average duration of 1 hour. In total, 26 interviews were conducted, 15 with families and 9 with the food system actors.

For the analysis, both interviews (interviews were transcribed) and documents underwent information coding using ATLAS.ti. The codes (constructed following the parameters of [6]) were constructed

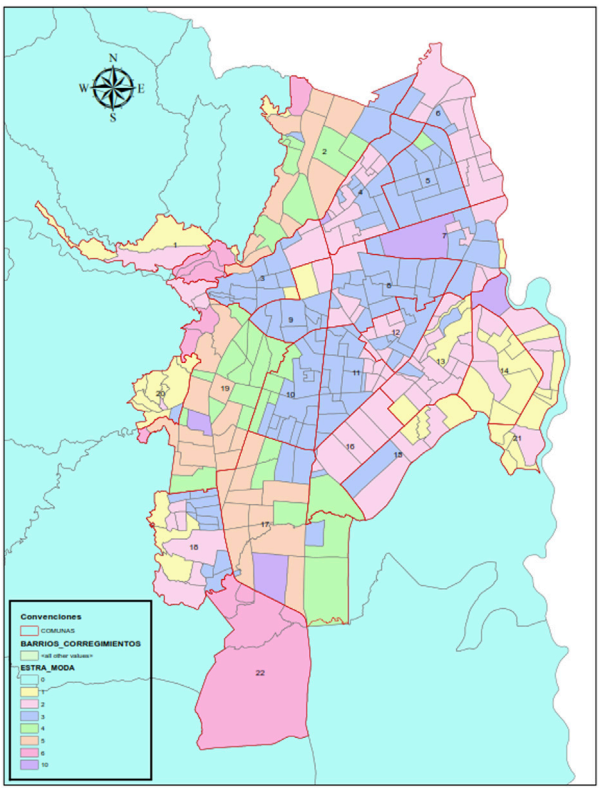

FIGURE 1 | Map of Political division of Santiago de Cali by socioeconomic strata (Food social space in times of pandemic, Cali, Colombia. 2020).

based on the theory of the Food Social Space [7], (a concept from the socioanthropology of food that places diners and their communities at the center of analysis, emphasizing the interactions between dietary patterns, the social, the psychological, the biological, and the ecological, and integrating the multiple dimensions that give rise to the discourses, imaginaries, and representations intrinsic to the circulation of food, food products, and their meanings) and corresponded to the dimensions it encompasses: space of the edible, food social space, culinary space, space of consumption habits, food temporality, and space of social differentiation, **Figure 4** shows a representation of them.

RESULTS

The analysis of the decree-laws made it possible to identify the strategies proposed by the institutions, which included restrictions on mobility, permits to make purchases and guidelines for food aid provided to families that had lost their income. The news, on the other hand, made it possible to identify the application of the provisions of the decree-laws, as well as the situations that arose, and the strategies that families implemented during this period to guarantee their food. Regarding the interviews, they made it possible to approach the details of what happened within the households: distribution or overload

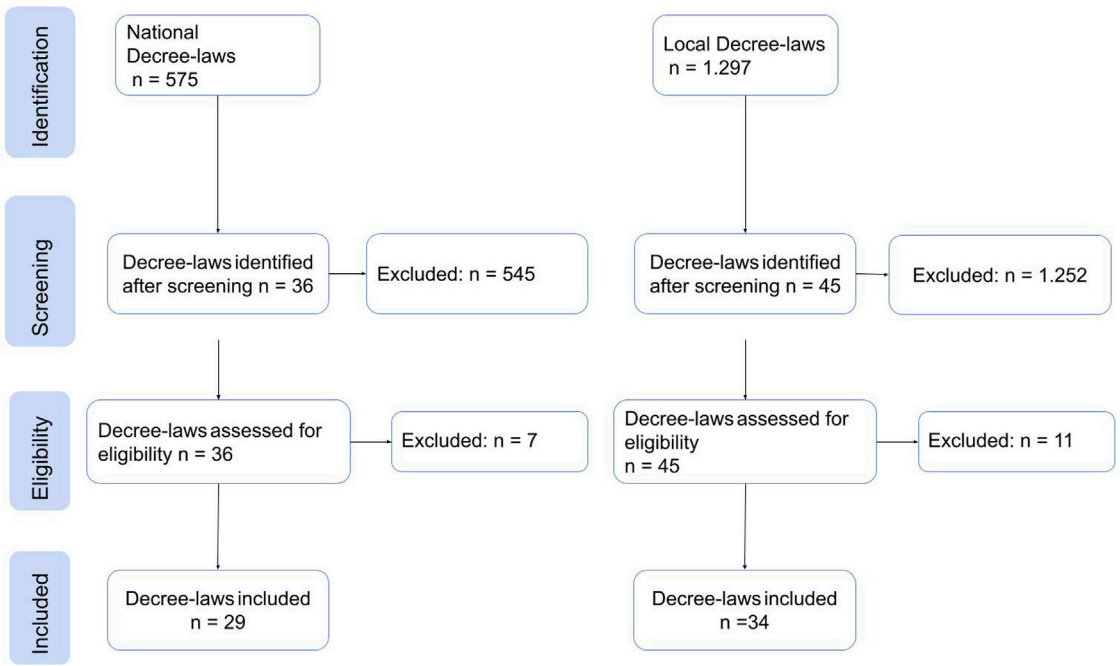

FIGURE 2 | Flowchart Decree-laws selection process (Food social space in times of pandemic, Cali, Colombia. 2020).

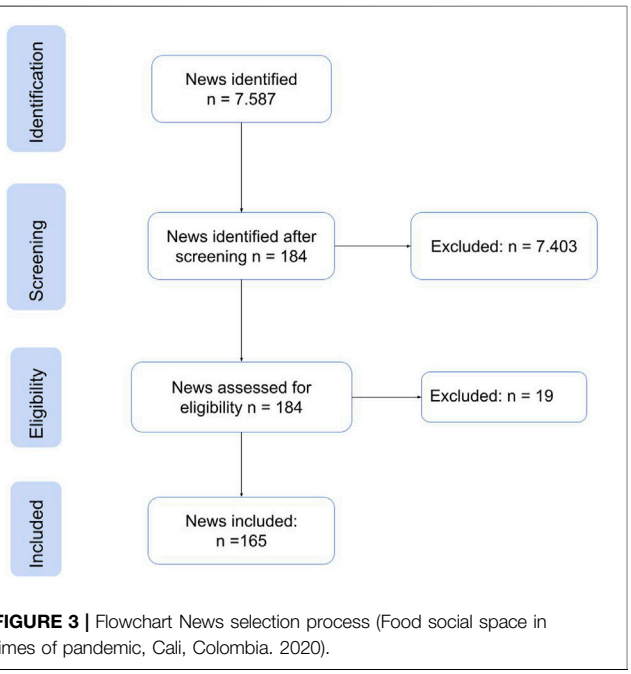

FIGURE 3 | Flowchart News selection process (Food social space in times of pandemic, Cali, Colombia. 2020).

of tasks, food preparation and food acquisition. **Tables 1**, **2** describe the people interviewed, their socio-demographic characteristics (in the case of families) and their political affiliation (in the case of food system actors).

With the analysis carried out, a narrative was elaborated using direct quotations from interviews, news, and decree-laws, looking to, a) show how food was guaranteed to vulnerable people before confinement in Cali and, b) show the dynamics, situations and strategies that were experienced and implemented by institutions and families during the confinement period. Two sections are presented below, one for each aspect mentioned.

Cali's Food Security Strategy Pre-Pandemic

Before the pandemic, there was already a situation of food insecurity in the city, which was addressed through developing different programs: i) the school feeding program (PAE by its Spanish initials), for children and adolescents attending educational institutions; ii) the community kitchens, located in strategic areas of the city to cover the most vulnerable population (in conditions of poverty and extreme poverty), and iii) efforts made by the social service providers and food banks, whose main beneficiaries are legally-constituted social organizations, community kitchens, foster homes, kindergartens and educational institutions [A2. Personal interview. February 22, 2021].

The PAE is the oldest of these programs, having its origins in 1941 [8] and operated through the delivery of snacks and lunches to students in public institutions, seeking to guarantee a daily minimum individual provision of calories and with the certainty, that the food the beneficiaries eat there may be the only food they receive during the day. The community kitchens, originated in 1990, when institutional support began to be given to community pots, (initiatives where food is prepared in large quantities and are led by people who organize themselves in solidarity to prevent their own or others' hunger) created by civil society, which later became the first community kitchens, and their operation was guaranteed through agreements with established companies with

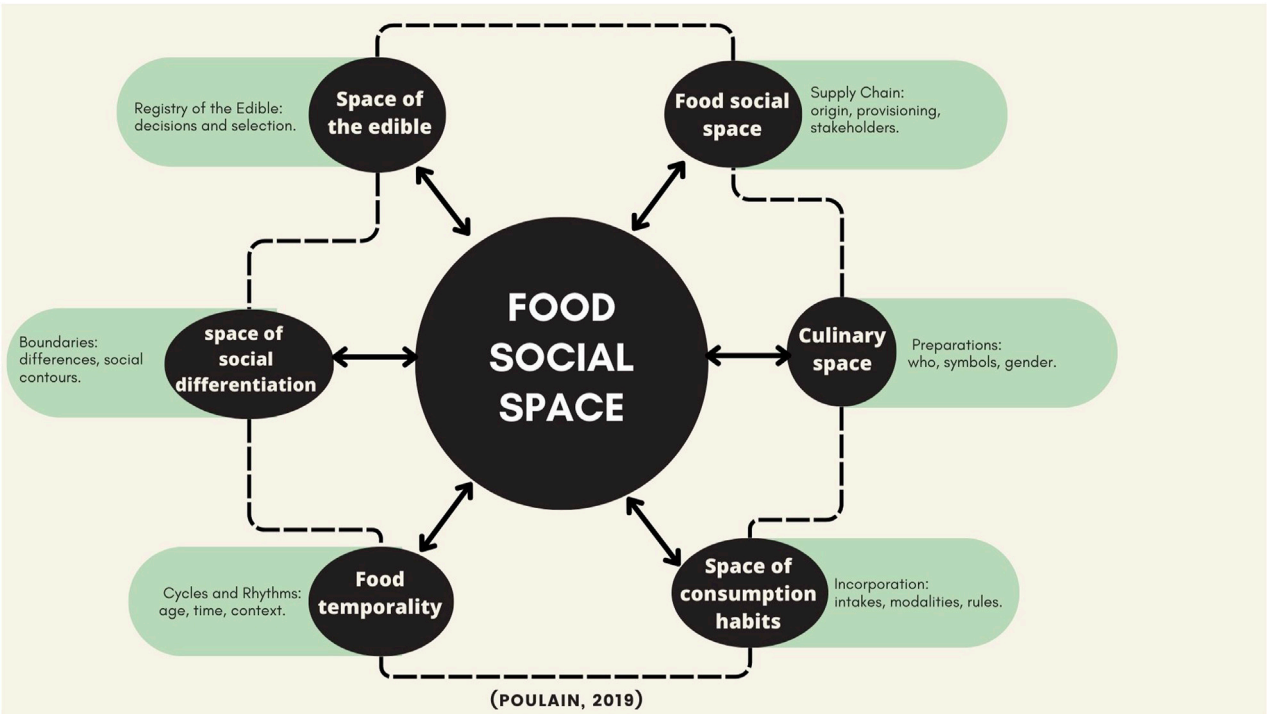

FIGURE 4 | Diagram of the food social space (Poulain, 2019) (Food social space in times of pandemic, Cali, Colombia. 2020).

TABLE 1 | Characterization of the families interviewed (Food social space in times of pandemic, Cali, Colombia. 2020).

Name	Sex	Age	Commune	Socioeconomic strata	Occupation	Conformation	Persons in the home
Dilia	F	61	21	1	Domestic employee	Unipersonal	1
Jennifer	F	33	1	1	Entrepreneur	Single-parent (mother and child)	2
Diego	M	33	14	2	Economist	Nuclear (father, mother, and child)	3
Juana	F	48	15	2	Domestic employee	Nuclear (father, mother, and child)	4
Lucila	F	72	13	2	Homemaker	Extensive (grandmother, children, grandchildren, great-granddaughter)	6
Landa	F	48	11	3	Secretary	Nuclear (father, mother, and child)	4
Nelly	F	66	7	3	Seller	Nuclear (father, mother, and child)	3
Nelson	M	59	8	3	Architect	Extensive (spouse and wife's sister)	3
Nubia	F	67	5	3	Homemaker	Extensive (grandmother, children and grandchildren)	6
Oliva	F	54	7	3	Homemaker	Nuclear with a visiting mother-in-law	3
Esperanza	F	70	17	4	Retired	Unipersonal	1
Leonilde	F	67	2	4	Homemaker	Single-parent (mother and child)	2
Constanza	F	50	17	4	Manager	Nuclear (father, mother, and child)	4
Alejandro	M	40	19	6	Lessor	Unipersonal	1
Laura	F	65	22	6	Occupational therapist	Nuclear with son and daughter-in-law	4

the economic capacity to accept the difference in payment times and who also have the capacity to deliver everything on the food menu. "I have a supplier who is able to organize everything in a single market and in a single trip I get everything at the canteen" [R. Personal interview. February 18, 2021].

Finally, the food bank formally began its operation in 2000 and its operating structure is based on receiving donations of either money or food that for some reason does not meet market quality standards (presentation, labelling) or that due to its high state of maturity must be used before it is lost and delivered to the beneficiary population. As for the cash donations, they are used to buy food in large distribution platforms "with the cash donations, what we do is automatically buy, because we have suppliers that give us very good prices, so we buy, bring, pack, balance the markets and go out to deliver" [A2. Personal interview. February 22, 2021].

TABLE 2 | Characterization of Food Social Space actors interviewed (Food social space in times of pandemic, Cali, Colombia, 2020).

Id dentification	Sex	Organization	Job title
A1	M	Secretariat of Economic Development	Ex Secretary of Economic Development
S	F	Secretariat of Economic Development	Food Safety Team Leader
R	M	Social Welfare Secretariat	Community Kitchens program coordinator
A2	F	Food Bank	Coordinator
F	F	Social Welfare Secretariat	Ex Secretary of Social Welfare
F1y	M	FENALCO	Telephone sales platform supervisor
L	F	Market place	Salesperson
A3s	M	Market place	Salesperson
F2	F	Market place	Salesperson

Considering that both the community kitchens and the PAE are among the beneficiaries of the Food Bank and that a large amount of the Bank's food comes from the large platforms, we can affirm that Cali's food strategy before the pandemic was highly dependent on the large distribution platforms for its functioning. This situation, far from changing during the pandemic, increased during the period of lockdown.

Cali's Food Strategy During Lockdown

The city's food strategy began with the prioritization of street dwellers and public nursing homes because the confinement was initially planned as a 3 days pilot [9]. Later, with the national declaration of the confinement period for a period of almost 20 days, the approach was modified to respond to a vulnerable population prioritized according to socio-demographic variables (socioeconomic stratum, spatial location, age group and informal jobs).

The mayor's office designed a strategy that consisted of delivering food aid to families that could not guarantee access to food; this aid was built on the basis of the basic minimum calorie requirement for an adult, with a caloric intake of 1959.62 kilocalories, which was enough for 4 days for a household of four people and did not include all food groups, as it did not include neither fruits nor vegetables in its composition [A1. Personal interview. February 15, 2021].

The implementation of the strategy was based on the previously described experience of the mayor's office in food procurement, according to which the almost exclusive source of supply was the large distribution platforms: customers with an infrastructure large enough to offer the food demanded and with the financial capacity to wait for months for payments, but who did not have the supply of perishable food, thus reaffirming the decision to maintain food aid without these food packages.

However, there were other actors within the city's food system that could have provided fruit and vegetables to the food aids, such as the central supply center, marketplaces, and producers in the surrounding rural area. Each of these was ruled out for logistical, legal, or economic reasons, respectively. In the first case, the central supply center required greater logistics for the mayor's office [A1. Personal interview. February 15, 2021]; in the second, the marketplaces had legal entities that were not designed to contract with the State such as, foundations that are not authorized to receive funds [S. Personal interview. February 19, 2021]; and in the third, the producers did not have the economic capacity to defer payments for months at a time.

Once the delivery of food aid and its composition had been defined, the idea was to expand coverage through complements: the PAE, unable to deliver prepared food in institutions, also delivered food rations in educational institutions [10]; the operation of community kitchens was enabled so that one person per family could claim a daily ration for their family unit; and the food bank adapted its model to begin to respond to organized civil society groups that were formed as the hunger situation worsened.

The worsening of the situation occurred for two main reasons: a) the underestimation of the population impacted by the lockdown, since the considered variables excluded those many people with formal jobs who could no longer work and who therefore lost the capacity to generate income to access food on their own "of course, all the containment measures forced many people to lose their jobs or their income and need support or food assistance from the government" [R. Personal interview. February 18, 2021]. And b) the high demand experienced by the large distribution platforms, exercised by families who made panic purchases [11] and by institutions seeking to deliver food aid to the vulnerable population. Faced with this situation, the response of the large platforms was to prioritize their usual clients (families), leaving the institutions with many commitments and no capacity to respond, both for market deliveries and for delivery of rations to community pots [A1. Personal interview. February 15, 2021].

The lack of compliance triggered different community responses as the lockdown progressed. The first of these was the use of red rags, by means of which families signaled the hunger they were experiencing, without leaving their homes, with the idea of receiving help from the authorities or neighbors. "There is not a house here that does not have a red rag in its window, a sign of help to be able to feed themselves... we are hungry, and we need help" [12].

> "*We have a very serious problem because the mayor's office is not able to deliver to all the people who were at that time taking out red rags, and you could see red rags all over the city in April and May*" [A1. Personal interview. February 15, 2021]

Faced with the mayor's office's inability to respond to this first call, many people took to the streets, some to demonstrate and protest [13] and others to tour the city, especially in the residential units of the higher socio-economic strata "... they do it in the doorways of the units... with megaphones and then they say: 'look, I live in such, and such a place and we don't have enough to eat... the situation is difficult, help us with money, with food, with whatever" [Constanza. Personal interview. August 29, 2020], and many others began to organize around community pots.

Of these strategies, the ones that most served the families were community pots, as they were platforms for social interaction and articulation [14]. Community pots were identified by the institutions as an opportunity to deliver food with far fewer logistical demands, while allowing the delivery of a wider range of food to a larger number of people.

> [...] The community pots allowed us to deliver, not food aids, but rice, potatoes [...] eggs, chicken and people also put in their work..... and meals were made [A1. Personal interview. February 15, 2021].

The mayor's office delivered food aids to the community pots and identified points in the city where new community pots could be established and had them functioning for 2 months [R. Personal interview. February 18, 2021]. Additionally, they complemented their food strategy with the delivery of exchangeable vouchers in large distribution platforms and in some neighborhood shops, with which families could decide what to buy as long as it was food or cleaning supplies [15].

Finally, both national and local institutions focused on extending exceptions so that people could gradually resume their work and once again secure access to food on their own. This strategy was identified as "economic reactivation" and eased the burden:

> "We served about 100 community pots, and we were serving them weekly, until they themselves were deactivated, because they emerged and multiplied at the time of the closure, but when the opening started it started to go down. And they remain because there have always been community pots and we have always attended to them, but the usual ones remain" [A2. Personal interview. February 22, 2021].

In summary, the 162 days of lockdown brought the city, its families, and its institutions to a standstill. No one was adequately prepared for the challenges that arose, and there were no suitable food policies in place to address the situations experienced. Moreover, the decisions that were taken failed to respond to the reality unleashed by the lockdown and led to constantly changing strategies in search of the most suitable one, which, considering scope and quality, ended up being the one focused on the community kitchens.

DISCUSSION

The food strategy built in Cali during the lockdown period by the institutions, from a food security approach, was insufficient to solve the pandemic problems, as it did not respond effectively to the food needs of the population. This can be explained by the economic orientation that prioritized large distribution platforms, the lack of flexibility regarding possible alternatives that would allow for variety and quantity in the aid delivered, and the lack of knowledge of the heterogeneity of the population living in the city.

Prior to the lockdown, the city had a food context in which the large distribution platforms were the main suppliers of food, which led to the prioritization of processed and ultra-processed food products, to the detriment of other food groups, and long supply/value chains to the detriment of shorter ones. This phenomenon increased during the period of lockdown with the delivery of food aid that was insufficient in coverage and quality, as it did not reach all the households in need and did not have adequate nutritional intake.

Regarding coverage, priority was given to the individual delivery of aid, which is explained by the characteristics of the COVID-19 contingency, during which the aim was to prevent contagion by means of social distancing. However, as it did not manage to cover the entire population, nor guarantee the frequency of delivery, collective responses such as marches and protests were triggered, which contravened social distancing rules.

The second problem had to do with food supply, since the aid was structured prioritizing non-perishable foods, thus depriving families of the possibility of consuming fruit, vegetables, and dairy products. The argument for this food scheme was that there were no logistical, legal, or economic options for contracting other suppliers. This argument showed a lack of flexibility in the regulations to respond to vital issues such as food and was manifested in the limitation of not being able to buy perishable foods from the marketplaces that would have more effectively responded to the nutritional and cultural characteristics of the consumers.

However, successful experiences in other countries show that it was possible to buy directly from small producer families, ensuring economic stability in rural areas and healthy food supply for urban families. This is the case in Brazil and Costa Rica, where, despite facing the same legal, logistical and financial challenges [16, 17], they managed to implement a strategy that consisted of purchasing food produced by family farming to supply school feeding programs, which promoted the economic dynamism of producer families and guaranteed the supply of fresh and nutritious food for vulnerable families [18–20].

These examples show that alternatives did exist when designing strategies and that what was required was a stronger political will to make the necessary adjustments to guarantee supplies of quality food for urban families and adequate income for rural families. They also highlight the lack of tools in the public policies that guide food and their implementation mechanisms (PSAN, PNSAN, OSAN, CISAN), which do not have guiding components for times of crisis and did not participate in the construction of food strategies at the national or local level.

This lack of functional public policies is reinforced by the high degree of ignorance of the vulnerability of the city's households,

since the population and its food conditions are not clear to the institutions, which meant that the vulnerable population expanded over time, transcending economic and spatial variables.

The heterogeneity of the population is an extremely important factor, not only in atypical contexts, but above all in the design of food policies and programs, in such a way that they allow for the inclusion of cultural characteristics from food production to consumption.

On the other hand, the dependence on a single supplier and the pressure that both the aids and the markets carried out by families exerted on the supply of large platforms generated a shortage that made it impossible to continue with the delivery of food aid, triggering a series of community reactions that culminated in the community pots.

These community demonstrations, built from a solidarity and collective approach, achieved in a very short time what the institutional system had failed to achieve in months: guaranteeing at least a daily ration of nutritious and varied food for many families who not only benefited, but also participated actively in their management and existence.

It is precisely this new approach that the community cooking pots bring to the social panorama, which is part of any proposal for food sovereignty, for which the construction of networks, the prioritization of aspects beyond economic ones and the recognition of the heterogeneity of the population, are necessary pillars to be considered to achieve fair food that prioritizes life over profitability.

The contrast between food security strategies (focused on availability and access) and food sovereignty (with an emphasis on the collective) shows the need for structural transformations in food policies and in the collective imagination that allow for designing and implementing new food models focused on community wellbeing and not on economic growth.

ETHICS STATEMENT

The studies involving humans were approved by Ethics committee of the University of Valle. The studies were conducted in accordance with the local legislation and institutional requirements. The ethics committee/institutional review board waived the requirement of written informed consent for participation from the participants or the participants' legal guardians/next of kin because all the interviews were virtual, and a verbal consent was obtained. Written informed consent was not obtained from the individual(s) for the publication of any potentially identifiable images or data included in this article because all the interviews were virtual, and verbal consent was obtained.

AUTHOR CONTRIBUTIONS

MC Study conception and design, data collection, analysis and interpretation of results, and manuscript preparation. JB Revised the article critically for important intellectual content; approved the version to be published.

CONFLICT OF INTEREST

The authors declare that they do not have any conflicts of interest.

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Financial Hardship on Food Security in Ageing Populations

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Objective: This study investigated the prevalence of food security, and the association of food security with financial hardship and socio-demographic characteristics among the ageing population in Thailand.

Methods: The study extracted data on 1,197 persons age 60 years or older from a nationally-representative sample survey of Thai households. The food security data were collected using the Food Insecurity Experience Scale (FIES), developed by the Food and Agriculture Organization. Multiple regression analysis was used to investigate the association between financial hardship, socio-demographic characteristics, and food security.

Results: Of the total sample, 71% had food security. The least probability of having food security was observed in the respondents who sometimes and often had income problems ($p < 0.001$), and felt dissatisfied with their financial situation ($p < 0.001$). The respondents who were female, at oldest-old age, with lower than primary school education and in the Northeast were less likely to have food security.

Conclusion: These findings suggest the need for government assistance for those who are experiencing financial hardship to help them manage their finances and food security more effectively, taking into account different socio-demographic characteristics.

Keywords: financial hardship, socio-demographic characteristics, food security, ageing population, Thailand

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INTRODUCTION

Many countries in the world are experiencing a faster pace of population ageing than in the past. In 2020, the global population age 60 years or older outnumbered the population under age 5 years [1]. It is expected that, by 2050, the older population will have almost doubled compared to 2015, and the majority of this population is expected to live in lower- and middle-income countries.

Ageing is the gradual decline of physical and mental capacity, and is a driver of various age-related diseases such as cardiovascular disease, cancer, immune system disorders, and musculoskeletal disorders [2]. Access to safe, nutritious and sufficient food is a fundamental human right for all people [3], and can contribute to improving long-term population, health, and national security. Secure access to food can produce wide-ranging positive impacts such as improved health and healthcare, poverty reduction, economic growth, job creation, and trade opportunities [4–6].

A longer, healthy life offers the promise of a healthy future for not only for older persons and their families, but also for societies as a whole. However, previous evidence suggests that food insecurity,

particularly in older persons, still exists in many places of the world. In Portugal, 23% of older persons lived in a food-insecure household [7]. In the United States, food insecurity in older persons increased from 5.5% to 12.4% between 2007 and 2016 [8]. In Ethiopia, about 83% of households with older persons who receive pension beneficiaries experienced food insecurity [9, 10]. In South Africa, 30.2% of older persons lived with food insecurity [9–11]. In Tehran and Malaysia, 39.1% and 10.4% of older persons faced food insecurity, respectively [12, 13].

Various studies have shown that socio-economic and demographic characteristics of seniors are the main factors that support or threaten food security of the older population. Lack of food security or presence of food insecurity was more prevalent in lower-income, youngest-old age, less education, and unemployed groups [7, 8, 13]. There is also a significant relationship between financial difficulty and food security. Straining to make ends meet was associated with increased likelihood of an older person to be living in a food-insecure household [7]. Lobl et al. [14] found an association between having more financial stressors and increased risk of food insecurity in older persons in the United Kingdom, Germany, and the Netherlands. It has been also reported that the older persons with material hardship (e.g., debt) in the United States was linked to food insecurity [15].

Thailand is one of many ASEAN countries that has already become an "aged society" [16]. Almost 20% of total population were at age 60 years or older in 2021. This made Thailand the second most aged population in ASEAN after Singapore (22%) [17]. It is expected that in the next two decades the proportion of the Thai population that is older persons will exceed 31% of total population. The speed of ageing is projected to be highest in the oldest-old group (80+ years) [17]. Old-age dependency ratio (65+ per 15–59) of Thailand increased overtime, from 10.7 ratio in 1994 to 30.5 ratio in 2021 [18]. Consumption of healthy food is a crucial part of maintaining healthy behavior throughout life. Good nutrition will contribute to reduced risk of non-communicable diseases (NCD), better physiological wellbeing, and delayed care dependency [1]. However, unhealthy diets among Thai older persons have been observed. For example, nearly 70% of Thai older persons had insufficient intake of fruits and vegetables, and lived with chronic NCD and debilitating conditions [19].

The COVID-19 pandemic has been tremendous challenge for societies around the world, and has exposed the fragility of older persons' health and livelihoods. Eleven percent of the total population infected with COVID-19, and 70% of COVID-19 deaths from among persons age 60 years or older [17]. In Thailand, the COVID-19 epidemic has disrupted food supply, and resulted in sudden loss of income and mounting debt among most households [20]. Thai household income declined significantly in the wake of COVID-19 [21]. The debt service rate increased from 29% in 2019 to 34% in 2021, and this is probably a direct cause of the decline in household consumption including food consumption in 2021. Over half (53%) of Thai older persons reported still working to earn income for feeding their family, paying debts, and supporting other household members [18]. This is presenting a major challenge for Thailand to meet the needs of an ageing society and, in particular, promotion of active and healthy ageing through financial resources and food security, for which older persons are always vulnerable.

As far as we know, there are no data in the literature regarding food security and financial hardship, or the association between these two in the ageing population in Thailand. Understanding the association between food security, financial hardship, and other socio-demographic factors is fundamental for improvement of geriatric health promotion policies and successful promotion of an active and healthy ageing population. Thus, the aim of this cross-sectional study was to investigate the association between food security, financial hardship, and other socio-demographic factors among older persons in Thailand.

METHODS

Sampling and Study Design

This study used secondary data from a Cross-sectional Study on Fruit and Vegetable Eating Behaviors [22]. This nationally representative data was collected in 2021. The study selected a subsample of the dataset of people age 60 years or older for analysis. A multi-stage sampling design was conducted by the National Statistical Office to select the sample. The sampling process was undertaken sequentially across several hierarchical levels, first at the regional level, second at the provincial level, third at the district level, and last at enumeration area (EA). In total, nine provinces and one district were sampled. Within each district, EAs were randomly selected using a nationally-representative sampling frame of the national Population and Housing Census. Within each selected EA, 20 households were selected.

The survey included households in the four geographic regions of Thailand (central, north, northeast, and south) and Bangkok. In each region urban and rural localities were included. In total, 1,197 older persons were selected for this study.

Data Collection

Data collection of the survey was done during June–December 2021 via face-to-face interviews using Qualtrics offline survey application. The survey was administered by trained research staff. Prior to the interview all respondents learned about the purpose of the study and overview of the survey process. Individual consent to participate was obtained before the interview started. The survey questionnaire included modules on socio-demographic characteristics, perceived financial hardship (debt burden, income problem, financial dissatisfaction), and food security.

Outcome Variables

Individual food security was measured using the eight-question Food Insecurity Experience Scale (FIES), developed by the Food and Agriculture Organization (FAO) [23]. Eight questions (**Supplementary Table S1**) pertained to stages about individual's experiences or behaviour related to insufficient resources to access food over the past 12 months. Each

question refers to a different experience or behaviour, and thus a different level of severity of food insecurity—from mild to severe food insecurity. Food security is defined as 0 affirmative responses, meaning that an individual had sufficient resources for food at all times. Each respondent was asked to answer each question in order. If a respondent answered "no" for any question, then the respondent was instructed to immediately skip to the end of the FIES survey. The FIES score ranges from 0 (food secure) to 8 (severely food insecure). However, the purpose of this study was to measure prevalence of food security among older persons. Thus, researchers performed reverse scoring by re-coding the responses so that a high score is transformed into the corresponding low score on the scale. The reverse score therefore ranges from 0 (severely food insecure) to 8 (food secure).

This study used the validated Thai version of FIES by FAO and pretested it before actual data collection. Reliability of the Thai FIES questions were assessed using Cronbach's alpha. The results for the assessment indicated good reliability of the questions, with alpha value of 0.89.

Independent Variables

Socio-Demographic Characteristics

Sex was coded as male/female. Age was grouped as youngest-old (60–69 years), old-old (70–79 years), and oldest-old (80 years or over). Marital status includes married, single, or widowed/divorced/separated. Place of residence was classified into rural and urban areas. Regions of Thailand were divided into Central, North, Northeast and South. Educational attainment includes lower than primary school, primary school, secondary school, and bachelor's degree or higher. Employment status was grouped as unemployed (people who are not in the labour force, jobless, actively seeking work, available to take a job), and employed (such as government employee, company-hired worker, business owner, wage labourer, and farmer).

Financial Hardship

The respondents were asked for their perception of their situation regarding the following financial constraints: debt burden, income problem, financial dissatisfaction. Debt burden was coded as "having no debt/having debt but not feeling burdened," "having low debt burden" and "having high debt burden." Income problem was coded as "no income problem," "sometimes have an income problem" and "often have an income problem." Financial dissatisfaction was coded as "dissatisfied," "moderately satisfied" and "highly satisfied."

Statistical Analysis

This study first estimated the prevalence of food security among Thai older persons using descriptive statistics (i.e., frequencies and percentages). Next, the study examined differences in socio-demographic characteristics and financial hardship by an individual's food security status using *t*-test. To examine the associations between an individual's food security and other variables, multiple regression models were performed. All statistical tests were 2-sided, and statistical significance was considered at $p < 0.05$. Statistical analyses were performed using SPSS version 22.

TABLE 1 | Food security score (*N* = 1,197) (Thailand, 2021).

Food security score	Severity scale	*N*	%	Mean score
0	Severe food insecurity	15	1.3	7.0
1		28	2.3	
2		42	3.5	
3		18	1.5	
4		9	0.7	
5		100	8.4	
6		34	2.9	
7		102	8.5	
8	Food security	850	71.0	

TABLE 2 | Responses of older persons to each of the eight questions of the food insecurity experience scale (*N* = 1,197) (Thailand, 2021).

Question	*N*	%
Q1. You were worried you would not have enough food to eat?	347	29.0
Q2. You were unable to eat healthy and nutritious food?	245	20.5
Q3. You ate only a few kinds of foods?	211	17.6
Q4. You had to skip a meal?	111	9.3
Q5. You ate less than you thought you should?	102	8.5
Q6. Your household ran out of food?	84	7.1
Q7. You were hungry but did not eat?	43	3.6
Q8. You went without eating for a whole day?	15	1.3

Due to the fact that the economic factors in this study (i.e., employment status, debt burden, income problems, and financial dissatisfaction) may be highly correlated, the correlations between these variables were tested. The results in **Supplementary Table S2** showed that their correlation coefficients were low (less than 0.7). Therefore, these variables were included in the final model.

RESULTS

Prevalence of Food Security

The study found a mean score of food security of 7.0. Of total 1,197 older persons, 71% scored 8, meaning that they had food security. Almost one-third of the respondents had food insecurity and, of these, 1.3% had severe food insecurity (0 score). **Table 1** shows the percentage of respondents by food security score from 0 to 8. **Supplementary Table S3** provides an overview of characteristics of the sample by food security score.

For persons who were experiencing food insecurity, the study found that 29% of respondents felt worried about not having enough food to eat, and 21% reported being unable to eat healthy and nutritious food in the past 12 months (**Table 2**). It is shown that 17.6% or slightly more than half of the respondents who experienced food insecurity ate only a few kinds of foods. Almost 9.3% of the respondents skipped their meal.

Table 3 shows the distribution of the mean score of food security of respondents based on socio-demographic characteristics and financial hardship. Respondents who are male (7.21), at old-old age (7.26), single (7.15), and unemployed (7.05), live in urban area (7.07), and have bachelor's or higher degree (7.83) had higher scores than other respondents in the same

TABLE 3 | Characteristics of the sample and mean scores of their food security (Thailand, 2021).

Variables	N	%	Mean score	*t*-test (*p*-value)
Total	1,197	100.0	7.03	
Sex				***
Male	535	44.7	7.21	
Female	662	55.3	6.89	
Age group (years)				
60–69	716	59.8	6.93	
70–79	398	33.3	7.26	
80 or over	83	7.0	6.78	
Marital status				
Single	40	3.3	7.15	
Married	812	67.9	7.08	
Widowed/divorced/separated	345	28.8	6.91	
Place of residence				
Urban	498	41.6	7.07	
Rural	699	58.4	7.00	
Region				***
Bangkok	91	7.6	7.86	
Central	222	18.5	7.48	
North	374	31.3	6.75	
Northeast	225	18.8	6.32	
South	285	23.8	7.35	
Education attainment				***
Lower than primary school	199	16.6	6.55	
Primary school	872	72.9	7.06	
Secondary school	82	6.9	7.45	
Bachelor's degree or higher	44	3.7	7.83	
Employment status				
Unemployed	688	57.5	7.05	
Employed	509	42.5	7.01	
Debt burden				***
No debt/having debt but not feeling burdened	860	71.8	7.23	
Low debt burden	101	8.5	6.95	
High debt burden	236	19.7	6.34	
Have an income problem				***
No problem	923	77.1	7.33	
Sometimes have an income problem	184	15.3	6.24	
Often have an income problem	90	7.5	5.57	
Financial dissatisfaction				***
Dissatisfied	285	23.8	6.08	
Moderately satisfied	559	46.7	7.24	
Highly satisfied	354	29.5	7.47	

*Note(s): ***p ≤ 0.001.*

variable category. Respondents who reported having no debt (7.23), having no income problem (7.33) and feeling highly satisfied with their financial status (7.47) scored highest compared to other respondents in the same category.

There was an association between socio-demographic variables, in particular sex and education, and food security ($p \leq 0.001$). All financial hardship-related variables had significant effects on the older persons' food security status ($p \leq 0.001$).

Regression of Food Security on Financial Hardship and Socio-Demographic Factors

Table 4 shows results of the regression analysis that found statistically significant associations between all financial hardship variables, some socio-demographic characteristics and food security among the older persons.

The socio-demographic characteristics—sex, age, region, education—were found to relate to food security. Food security score was higher for being male, age 70–79 years and having at least primary education. Male respondents were more likely to have 0.282 (B = 0.282; $p \leq 0.05$) greater food security scores than female. Respondents age 70–79 years had greater scores than those at age 80 years or over (B = 0.607; $p \leq 0.01$). Respondents who live in the North, Northeast and South regions were more likely to have lower scores than those in Bangkok, especially people in the Northeast (B = −1.267; $p \leq 0.001$). Respondents with at least primary school education had greater scores than those with less than primary school education. People who had at least a bachelor's degree were

TABLE 4 | Multiple regression of food security score by financial hardship and socio-demographic characteristics (*N* = 1,197) (Thailand, 2021).

Variables	B	Std. Error	β	*p*-value
Sex (Reference group = Female)	0.282	0.112	0.073	*
Male				
Age group (Reference group = 80+ years)				
60–69 years	0.369	0.215	0.094	
70–79 years	0.607	0.214	0.149	**
Marital status (Reference group = Single)				
Married	0.210	0.293	0.051	
Widowed/divorced/separated	0.215	0.299	0.051	
Place of residence (Reference group = Urban)				
Rural	0.140	0.110	0.036	
Region (Reference = Bangkok)				
Central	−0.298	0.231	−0.060	
North	−0.841	0.222	−0.203	***
Northeast	−1.267	0.232	−0.257	***
South	−0.525	0.225	−0.116	*
Education (Reference group = Lower primary school)				
Primary school	0.504	0.141	0.117	***
Secondary school	0.616	0.235	0.081	**
Bachelor's or higher degree	0.767	0.305	0.075	*
Work (Reference group = No)				
Yes	0.018	0.113	0.005	
Debt burden (Reference group = No debt/No burden)				
Low debt burden	−0.077	0.189	−0.011	
High debt burden	−0.264	0.143	−0.055	
Having income problem (Reference group = No problem)				
Sometimes having income problem	−0.730	0.152	−0.137	***
Often having income problem	−1.129	0.207	−0.155	***
Financial satisfaction (Reference group = Highly satisfied)				
Moderately satisfied	−0.093	0.122	−0.024	
Dissatisfied	−0.790	0.157	−0.175	***
Constant		6.920		
Adjusted R squared		0.174		

Note(s): *p ≤ *0.05*, **p ≤ *0.01*, ***p ≤ *0.001*.
B, Unstandardized coefficient; β, Standardized beta coefficient.

more likely to have greater scores than other education groups (B = 0.767; $p \leq 0.05$).

A statistically significant association of financial hardship was found with food security. Respondents reporting sometimes or often having an income problem were more likely to have lower scores than those with no income problem (B = −0.730; $p \leq 0.001$ and B = −1.129; $p \leq 0.001$, respectively). Financial dissatisfaction had statistically significant association with food security scores (B = −0.790; $p \leq 0.001$, respectively).

DISCUSSION

Food security among older persons has become an important issue in improving health outcomes and geriatric care [7, 24]. The results of the present study show that, although many Thai older persons had food security, almost one-third of older persons still lived with food insecurity, and 1.3% experienced severe food insecurity. The study reported that food security was affected by various factors, in particular, financial vulnerability and certain socio-demographic characteristics, consistent with previous studies [7, 8, 24–27].

Food security in this sample was significantly higher among those who were male. This finding is consistent with several other reports that food security was more prevalent in male older persons than females [12–14, 27]. Traditionally, in Thai family culture, Thai men or fathers were expected to be leaders and providers of the family and were more involved in outdoor chores, whereas Thai women or mothers were expected to provide care and perform most of housework including procuring and preparing meals to promote overall family life and health, even at the expense of their own needs [28]. For example, the men in the traditional Thai household would eat first, followed by children and the adult women. Thus, even though women were expected to prepare the meals for the family, they were given lower priority for consumption.

Furthermore, this study found that food security tended to be more pronounced among older persons age 70–79 years than those at age 80 years or above. This may be explained by the impact of ageing which is "*a state of progressive functional decline accompanied by an increase in mortality* [29]." This state can lead to gradually functional decline in physical and mental capacities at greater age [30], and that affects the advanced older person's ability to access to and eat various types of healthy and nutritious

foods. This study also revealed that Thai older persons with low education tended to be the most vulnerable group for low food security. Previous studies found a significant association of the low levels of education (or the absence of formal education) of older persons with their cognitive performance, functional disability, and frailty [31]. This can limit their ability to manage food quantity and dietary quality which require more complex knowledge, skills, and behaviours for healthy eating, and thus become barriers to improved food security.

The lowest probability of having food security was found among older persons in the Northeast region. This was not surprising as the Northeast is the lowest with poverty line and highest with poor people among geographic regions in Thailand [32, 33]. This is consistent with previous studies that show that Thai people in the Northeast were most at risk of food security [34, 35]. This suggests special attention to the poorest and most vulnerable geographic region. The government needs to focus on small and specific strategies that work on improving food security, with full participation of key stakeholder in decision-making and policy development. This action is critical to reducing poverty in the region.

According the findings, income-related financial hardship were associated with food security among Thai older persons. These findings are comparable with studies conducted in other countries [14]. Financial hardship can push older persons further away from meeting standard living needs like buying food. This could limit their access to and impose financial constraints in consuming a healthy diet. Hardship would impact their ability to purchase enough food or nutritious food, which could result in risk of undernutrition and cardiometabolic disease if it occurs over a long period [36]. In addition, economic hardship or financial difficulties are important sources of financial stress which might increase the risk of experiencing depression [37]. Previous studies found that subjective financial measures are more direct indicators of financial stress than objective measures such as amount of debt or income [37]. This is because despite facing a similar objective financial situation, people may perceive or respond to their objective financial situation differently due to different experiences, personality and attitudes, resource management skills, and perceived financial-related sufficiency.

This study has some limitations. First, this was a cross-sectional study and, thus, causal inferences about the relationship between food security and other variables cannot be drawn. Future research which analyses the causal relationship between food security outcome and other factors over a period of time is needed. Second, the study focused on measuring food security rather than severity level of food insecurity, and that may limit a comprehensive understanding of food and diets of Thai older persons and thus limit for policy implications on the groups most vulnerable for low food security. Additional research specific to severity level of food insecurity is important in the future. Third, despite the significant relationship between food security and financial fragility, the effect of financial fragility on food insecurity in different socio-demographic characteristics of older persons (such as sex, age, marital status, place of residence, and education attainment) may differ. The study did not investigate the interactions between financial fragility and other independent variables. Therefore, further analysis is needed to test the interaction of these variables. Fourth, in addition to the analysis of debt and income related financial hardship in this study, other potential aspects should be analysed further, such as housing, health and family aspects that were found to be associated with food security in older age [14], and access to government's welfare support to the older persons. This will help policymakers and other stakeholders to make decisions that are informed by a more comprehensive understanding and balanced view point in food security among financially fragile older persons.

Policy Implications

This study has a number of implications for public policy around food security and financial circumstances among Thai older persons. *First*, the prevalence of food security is significantly lower in specific groups (e.g., female, oldest-old age, low level of education and Northeast residence). Government attention needs to be focused on development of specific actions or targeted interventions at older persons who are the most vulnerable groups for low food security, such as older women's self-care and full participation in rural development and food security strategies, and social and community service provision addressing food security. It is also important for local governments to consult with different groups of older persons separately to understand their needs, and the degree to which they are able to access financial and non-financial resources, food and assistance. *Second*, the study highlights influence of income-related financial hardship on food security. This financial hardship could be used as a measure in improving food security and nutrition. In particular, the finding on the strong association of financial dissatisfaction and food security points to the importance of subjective financial measures in order to monitor and identify solutions for food security in older age. Other government's support such as providing financial counselling services and financial education to those who are experiencing financial hardship should be implemented to help the fragile older persons manage with their financial problems including their concern and anxieties and associated food security more effectively. *Third*, factors contributing to food security are complex, interrelated, and operate beyond the individual level. Thus, improving food security among older persons requires cross-cutting strategies that all policy actors from various sectors need to address in their activities. This requires an interdisciplinary collaboration of policy actors from food, health, societal, and economic sectors and at the national and local level.

Conclusion

This study found the association between perceived financial hardship, socio-demographic characteristics, and food security in the Thai ageing population. The results suggest that the presence of income-related financial hardship and anxieties affects low food security. The prevalence of food security in this population was also significantly associated with certain socio-demographic and geographic factors. These findings, in turn, could have important implications for policymakers and other stakeholders, especially the need for government and community support for those who are experiencing financial

hardship and anxieties so that they can improve their economic situation and associated food security more effectively, such as financial counselling services and financial education. The government actions should also take into account the influence of socio-demographic and geographic factors among older persons, especially the most vulnerable groups for low food security. The findings also point out various factors beyond the individual level that contribute to older persons' food security. Accordingly, there is a need for greater collaboration of policy actors across sectors such as health, food, societal, and economic sectors, that will be beneficial to developing targeted interventions either to alleviate financial hardship or improve food security among older persons.

ETHICS STATEMENT

The studies involving humans were approved by the Institutional Review Board of the Institute for Population and Social Research of Mahidol University (COA. No. 2021/02-032). The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

SP: Conceptualization, formal analysis, funding acquisition, investigation, methodology, project administration, writing–original draft preparation, writing–review and editing. ST: Formal analysis, investigation, methodology, writing–review and editing. AC: Conceptualization, methodology, writing–review and editing. RG: Conceptualization, methodology, writing–review and editing. UP: Conceptualization, methodology, writing–review and editing. CU: Writing–review and editing. PS: Writing–review and editing.

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AUTHOR DISCLAIMER

The views and opinions expressed in this paper are those of the authors alone and do not necessarily reflect the funder or any other organization with which they are involved.

CONFLICT OF INTEREST

CU and PS declare that they are serving as the steering committee and the Assistant Chief Executive Officer of the Thai Health Promotion Foundation, respectively.

The remaining authors declare that they do not have any conflicts of interest.

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SUPPLEMENTARY MATERIAL

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Characterizing Trends in the Use of Food Donations and Other Food-Related Community-Based Social Assistance Programs in a Cohort of New Food Bank Users in Quebec, Canada

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Objective: To characterize 12-month trends in the use of food donations and other food-related community-based social assistance programs (CB-SAPs) during the first year following the enrollment of new food bank (FB) users in Quebec, Canada.

Methods: A cohort of 1,001 newly registered FB-users in Quebec from the Pathways Study were followed-up during 12-month following baseline assessment. Outcomes were monthly use of food donations and other food-related CB-SAPs. Main predictors were alternative food source utilization (AFSU) profiles: 1) exclusive-FB-users; 2) FB+fruit/vegetable-market-users; and 3) Multiple/diverse-AFS-users. Covariates included sociodemographic characteristics, health status, and major life events. We fit Bayesian hierarchical mixed-effect models, accounting for spatial clustering, temporal correlation, and censoring.

Results: We observed an overall downward trend of food donation use among study completers (n = 745). Each AFSU profile had a distinctive monthly trend of food donation use, but probabilities of use across the three profiles overlapped, between 44% and 55%. The use of other food-related CB-SAPs was low and not correlated with AFSU profiles.

Conclusion: *De novo* FB-users use food donations in different ways over time according to specific contextual AFSU profiles.

Keywords: alternative food sources, food banks, food assistance, community-based food programs, Canada, food access, Quebec

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INTRODUCTION

The use of food banks (FBs) has been increasing in Canada since their conception in the 1980s [1], illuminating the pressing problem of hunger even among the richest countries [2]. In 2022, in ten Canadian provinces, 4.2% of households (i.e., 1.5 million individuals) experienced severe food insecurity, defined as the reduction in the amount of food consumed due to lack of financial resources [3]. FBs are organizations which collect surplus, wasted, or donated food and distribute it in the form of food baskets. FBs have become an important alternative food source -AFS- (i.e., ways through which people can procure food outside the regular food system) for people who are experiencing or are at risk of experiencing severe food insecurity [4–9]. In Québec, most FBs are integrated in community organizations also offering other food-related community-based social assistance programs (CB-SAPs) (i.e., collective kitchens, collective gardens, collective food-buying groups, food sales service, and community meals) for people in need [10]. Little is known about how FB-users use food donations and other food-related CB-SAPs over time.

FB-users are a heterogenous population with diverse socioeconomic backgrounds and needs [11, 12]. To feed themselves and their household, FB-users take advantage of diverse strategies to exploit their limited resources and overcome structural barriers such as transport limitations, high food prices, and limited food access [9, 11, 13, 14]. These strategies classified into coping and adapting strategies are implemented by people with different capacities and assets in specific contexts [15]. Coping strategies offset shocks that jeopardize food availability [15]. One important coping strategy used by FB-users is the utilization of multiple AFSs (including diverse types of FBs, fruit and vegetable (F&V) markets, domestic food production, etc.) with different frequencies and travel times [16]. Our research group previously identified three profiles of alternative food source utilization (AFSU) among new FB-users that vary across urban, suburban, and rural settings: FB-exclusive-users, FB+F&V-market-users, and multiple/diverse-AFS-users. The study showed that in rural settings, couples with or without children are more likely to be multiple/diverse-AFS-users, whereas in urban settings, more educated households are more likely to belong in this profile [17]. In the long-term, FB-users employ adapting strategies which are coping strategies that become integrated into the normal cycle of households activities [15].

Studies have indicated that some FB-users may use FBs sporadically due to unexpected events or emergencies and others may become long term users [18–23]. Using data from the Greater Vancouver Food Bank from 1992 through 2017, Black et al. (2020) identified three patterns of FB-users that were correlated with sociodemographic and health-related characteristics: transitional-users (91%) who visited FBs on average seven times over 2 months and then stopped; episodic-users (7%) who used FB for an average of 8.6 years with a mean number of visits of 100 over the period; and chronic-users (1.5%) who visited FB at least 200 hundred times over several years (mean > 13 years) [24]. Understanding the link between short- and long-term strategies to cope with food insecurity among FB-users could help to better understand why it is that some food insecure households become food secure, whilst others do not, but it has not yet been documented in quantitative studies [25, 26]. This study aims to characterize 12-month trends in the use of food donations and other food-related CB-SAPs during the first year following enrollment of new FB-users in Quebec, Canada.

METHODS

Design, Sampling, and Data Source

This longitudinal prospective study uses data from the baseline (t_0) and 1-year follow up (t_1) from the *Pathways Study*. Our population consists of newly enrolled FB-users in urban, semiurban, and rural settings of Quebec, Canada. Baseline data were collected from September 2018 to January 2020, from 1,001 newly registered FB-users in 106 community organizations offering food donations in four regions of Quebec (Montréal, Lanaudière, Mauricie-Centre-du-Québec, Estrie). These organizations regularly distribute food baskets to people in need, but they vary in their services (e.g., size and quality of food baskets), structure, and operations depending on their resources and specific context. Some of them also provide other food-related CB-SAPs (e.g., collective kitchens, food-buying groups, food sales service). Follow-up data were collected in a window of 11–13 months after the baseline interview [27]. Inclusion criteria were: 1) FB-users who used food donations for the first time within a maximum of 6 months prior to recruitment, 2) between 18 and 63 years of age, and 3) being able to communicate in French or English. People living with a person who was already enrolled in the study and persons experiencing homelessness were excluded. Details of the Pathways Study are presented elsewhere [27].

Baseline data were collected by trained interviewers via face-to-face interviews conducted at the community organizations where the food donation occurs. COVID-19 related lockdowns were in place in the middle of the second wave of interviews, forcing the second half of follow-up interviews to be conducted over the phone or online.

Variables

Outcome

Trends in the use of food donations and other food-related CB-SAPs during the 12 months following FB enrollment. The use of food donations and other food-related CB-SAPs over 12-month period was ascertained by asking participants whether they used (yes/no) these programs in each of the 12 months prior to the follow-up interview. The use of other food-related CB-SAPs refers to the use of at least one of the following CB-SAPs: including collective kitchens, collective gardens, food buying groups, food sales service, and community meals. We grouped these programs due to the limited usage observed among participants (between 3.4% for community garden and 10% for community meals).

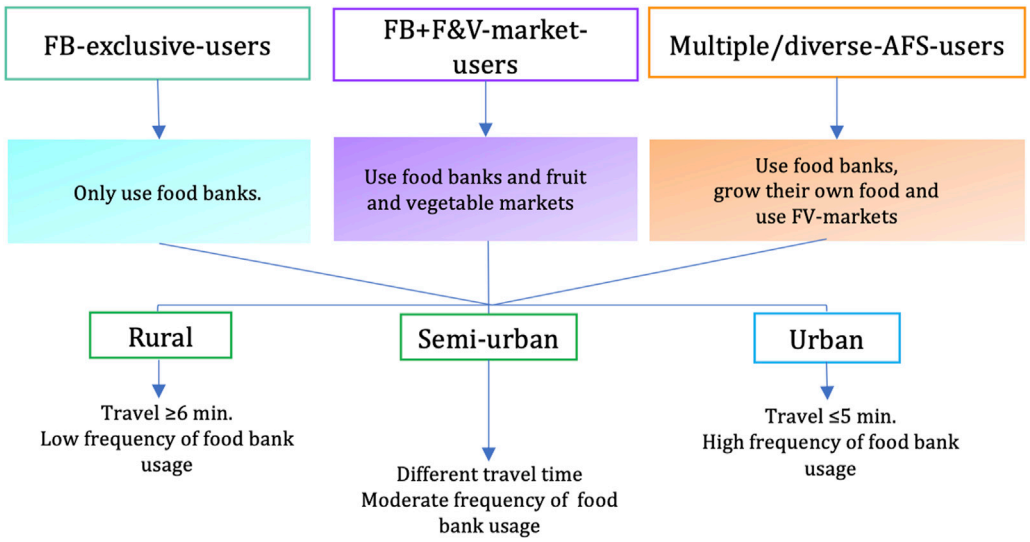

FIGURE 1 | Alternative food source utilization profiles of newly enrolled food bank users in Quebec, Canada (2018–2021).

Main Independent Variable

Alternative food source utilization profiles. At baseline, participants were classified into three distinctive profiles: FB-exclusive-users, FB+F&V-market-users, and multiple/diverse-AFS-users. These profiles were created to reflect on the differential characteristics and food-acquisition practices of participants study, as well as their differences across settings (e.g., urban, semiurban, and rural). AFSU profiles were created using five items related to AFS utilization: 1) Type of food bank used (i.e., Capacity-Building Programs [CBP-FBs] were those community organizations offering food donations and other CB-SAPs, and Food Donations [FD-FBs] were community organizations providing only food) [12]; 2) Use of F&V markets during the summer; 3) Growing one's own food during the summer; 4) Frequency of food donations use; and 5) Travel time to the grocery store. An overview of these profiles is presented in **Figure 1**. Further details about item assessment and profiles computation were summarized in a prior paper [17].

Covariates

To account for the nested and longitudinal structure of the data, as well as to adjust the variance, we included variables related to the setting, size of community organization from which participants were recruited, *COVID-19* measures, and time with the following parameterization: *Setting* indicates the location of the community organisation where participants were recruited. It was defined as urban, semi-urban, and rural using Statistics Canada's Census Metropolitan Areas (CMAs) and Census Agglomerations (CAs) categorization [28], in conjunction with Regional County Municipalities' development plans, used by administrative regions in Quebec. Urban settings are characterized by a large and diverse population, building density and mixed land uses. Semi-urban settings are characterized by a less diverse population and are closer to rural settings than to the urban centres. Rural settings are characterized by low population density and a lack of diversity in land use. Details about the classification of this variable are presented elsewhere [27]. *Size of community organization* is a variable created based on the number of participants recruited from each community organization to account for any deviation from the proportionality of the sampling. *COVID-19 measures* indicates whether the participant completed the follow-up interview before or after COVID-19 lockdown measures in Quebec were in place, because the COVID-19 pandemic could have an impact on follow up of participants, covariates, and the use of CB-SAPs.

The selection of the other covariates was based on prior theoretical and empirical research about AFSU profiles and trends in food donation use [24, 29–32]. Baseline covariates included gender (male, female, or other), age in years (continuous), race/ethnicity, country of birth, household composition, household educational level, and length of FB use time prior to the study. Validated questions from the Canadian Community Health Survey and Canada Census were used to assesses all sociodemographic variables. *Race/ethnicity* was assessed by asking participants to indicate to which racial or cultural group they belong (White, South Asian, Chinese, Black, Filipino, Latin American, Arab, Southeast Asian, Korean, Japanese, or other). This variable was dichotomized into Whites and other due to data sparsity for non-White groups. *Country of birth* as self-reported by the participants, was dichotomized into Canada and other. *Household composition* was determined by asking participants to indicate which of type of household best described the one they lived in. This variable was grouped into three categories: single-parent household, couple with/without children, and single (i.e., individuals living alone or with others but without a child under their care or a marital or common-law relationship). *Household educational level* was determined by the highest educational level achieved by the respondents or their partner.

This variable was dichotomized: secondary studies (11th grade) or less, and post-secondary studies. *Length of FB use time before the study* represents the time in months which had elapsed between the first time the participant visited the community organization offering the FB service and their study entry, determined by asking: "*How long you had been visiting this organization?*". Further, we dichotomized the answers into ≤1 and 2–6 months.

Annual household income, presence of major life events, and physical and mental health were assessed at the baseline (t_0) and at follow-up (t_1). Participants were asked to indicate their *total annual household income from all sources before taxes* in the previous year. It was collected as a categorical variable with twelve levels in Canadian Dollars (CAN$), going from no income to CAN$≥100,000. Given that more than half of the participants reported total annual household income lower than CAN$14,999, this variable was dichotomized into CAN$≤14,999 and CAN$≥15,000.

Major life events during the past 12 months were measured using Brugha and Cragg's list of threatening events LTE-Q [33], which has been used in epidemiological studies and validated among divers populations [34, 35]. This scale includes 12 questions about major negative events such as serious illness, death of a loved one, separation, or loss of a job, that may influence mental health. It varies from 0 to 12. This variable was classified into two-or-less major life events and ≥3 major life events, given that the COVID-19 pandemic can be considered as a major event and increase the probability of experiencing more than one major life event during the study period.

Physical and mental health was measured using the 12-item Short Form Health Survey (SF-12), a valid and reliable tool to assess an individual's perception about their own physical and mental health [36, 37]. The tool's eight domain scores (physical functioning, role physical, role emotional, body pain, general health perceptions, vitality, social functioning, and mental health) were summarized into two components: Physical Component Summary (PCS) and Mental Component Summary (MCS). Both were standardized according to Ware et al. 2002, with scores > 50 indicating better than sample average health [38].

We included an indicator variable, *time,* indicating the month (from 1 to 12) after enrollment in the study for which the participant provided the information.

Statistical Analysis

Descriptive statistics, including median and interquartile ranges (IQRs) for continuous variables and percentage for categorical variables, were calculated for all observations.

We used a Bayesian hierarchical mixed model logistic regression to assess the overall use of food donations and other food-related CB-SAPs trends associated to AFSU profiles over time. AFSU profile, sociodemographic covariates, mental health (centered at the mean), physical health and size of the community organization (as log-transformed variables) were modelled as fixed effects.

To identify the trends of use by the AFSU profiles we included a random effect interaction term of AFSU profiles and time, where time was parameterized as continuous with an autoregressive correlation of a first-order (AR1) structure to account for the repeated measures and autocorrelation within the same profile over time. To account for the nested structure (i.e., each participant had twelve observations, one for each month, T_1 to T_{12}) and any residual autocorrelation between measures over time, we included random effects variables for the *User* (i.e., the ID variable for each participant) and the time variable, both parameterized as independent and identically distributed (i.i.d) random effects. A version of the final model is presented in Eq. **1** and details of explored models are presented in **Supplementary Tables S1, S2**.

$$Y = logit\left(p_{it}\right) = log\left(\frac{p_{it}}{1-p_{it}}\right) = \beta_0 + \boldsymbol{X_i^{'}}\beta_{x1} + \boldsymbol{Z_{it}^{'}}\beta_x + u_i + w_t + z_i^{X*t}, \quad (1)$$

Where p_{it} is the probability of use of food donations or other food-related CB-SAP for an individual i (i_1, i_n) at time t ($t_{1, \ldots} t_{12}$) and the exponentiated beta coefficient is the odds ratio (OR) for the use of food donations or other food-related CB-SAP; β_0 is the model's intercept and $\boldsymbol{X_i^{'}}\beta_1$ is the individual fixed effect for the AFSU profile; $\boldsymbol{Z_{it}^{'}}\beta_x$ is a vector of the individual or setting fixed effects covariates described above; u_i and w_t are the i.i.d random effects for the user (to account for the correlated data between observation of the same individual) and time (to capture any residual temporal effect) respectively; and $z_i^{X'*t}$ is the interaction term between the AFSU profile and time as AR1 to determine the trend of food donations or other food-related CB-SAP use over the study period. Results are transformed using the inverse logit function ($\frac{1}{1+exp(-p_{it})}$) to obtain and present probabilities of food-related CB-SAP use by AFSU profiles over time.

Missing Data

The distribution of missing data is presented in **Supplementary Table S3**. Although the maximum percentage of missing values of any covariate at baseline was low (<3.2%), we imputed missing data on covariables (e.g., annual household income, age, major life events, health status, race, and country of birth) before performing Bayesian hierarchical mixed models, using multiple imputation by chained equations (MICE) (100 sets).

Given that the losses to follow-up in this study may be influenced by participants' sociodemographic characteristics, AFSU profiles, and use of CB-SAPs, we used inverse probability of censoring weighting (IPCW) to account for the potential differential attrition. With the IPCW we upweighted the observations from participants who remained in the study to account for those who were lost to follow-up (i.e., missing at 1 year follow-up), reconstructing the study population that we would have observed without attrition [39]. Thus, IPCW represents the inverse probability of remaining in the study at t_1, which means 12 observations of CB-SAP use before the follow-up. Weights were estimated using logistic regression including all covariates before to be included in the final model. We used stabilized weights and compare the results from the IPCW model with results from the unweighted model.

Model Selection

To assess model fit we specified different model regressions using different setting parameters, including them as random effects and different autoregressive formulations for the time as the residual and the interaction term. Model selection was informed by Deviance Information Criterion (DIC), the Watanabe-Akaike information criterion (WAIC) and the precision of the hyperparameters for the random effects. To obtain the posterior distribution of the estimates and the respective 95% Credible Intervals (95% CrI), all analyses were performed using the Integrated Nested Laplace Approximation (INLA) package with non-informative priors [40] in R-Studio version 4.2.1 (R Core Team. R, 2019).

RESULTS

Among the 1,001 participants enrolled with baseline data, 745 (74.4%) provided data at t_1. Compared to participants with data in the two waves, a higher proportion of those lost-to-follow-up were white Canadian single males, who lived in urban settings and reported lower household education level and income. A complete description of the Pathways Study sample and sociodemographic differences among participants across settings have been previously outlined [41]. FB-exclusive-users presented the highest proportion of lost-to-follow-up going from 35.5% to 29.1%, while the proportion of the other profiles increased (5.2% and 1.2%) at t_1 (**Supplementary Table S4**).

The distribution of AFSU profiles by sociodemographic characteristics is presented in **Table 1**. At t_1, 29.1% of participants were classified as FB-excusive-users (n = 217), 43.9% were FB+F&V-market-users (n = 327), and 27% were multiple/diverse-AFS-users (n = 201). The full description of AFSU profiles and their socioeconomic differences in urban, semi-urban, and rural settings have been presented in a prior paper [17]. In both waves, most of the participants in all AFSU profiles were white Canadian single women, reported an annual household income CAN$≤14,999, and did not have post-secondary education among all profiles. However, the proportion of participants that reported having an annual household income CAN$ ≥15,000 increased in all groups at t_1. More than 81% of participants reported having used food donations at least once after the baseline and the mean use of this program in all AFSU profiles presented a downward trend going from 75% to 50%. In contrast, less than 20% of participants used other food-related CB-SAPs and the mean use of these programs in all AFSU profiles did not change over time (**Figure 2**).

AFSU Profiles and Trends of Food Donation Use

Compared to the overall mean change in food donation use at the end of 12 months of follow-up among FB-exclusive-users, FB+F&V-market-users were more likely to continue using food donations (OR: 1.24; 95% Crl: 0.49, 3.12) and multiple/diverse-AFS-users were less likely to continue using donations (OR: 0.87; 95% Crl: 0.31, 2.42), but the posterior distribution of both estimates included the null value (i.e., one). Although the trends of food donations were influenced by age and setting at baseline, as well as major life events and household income at t_1, only an income ≥ CAN$15.000 at the follow-up showed an indication of decreased likelihood in food donation use.

The mean random effects coefficients of the interaction between AFSU profile and time on the food donation use by month are available in **Supplementary Table S5**. The posterior mean distribution of the interaction between AFSU profile and time, which represents the residual trends of food donation use after accounting for other variables, showed an important temporal autocorrelation of food donation use over the time (Rho: 0.76; 95% Crl: 0.76, 0.87). **Figure 3** shows that the mean trends of food donation use were different across AFSU profiles. While FB-exclusive-users had a rapid downward mean trend of food donation use after 5 months of the study, multiple/diverse-AFS-users had a flatter trend afterwards. In contrast, FB+FV-market-users presented an upward trend during the study period. However, the posterior mean distribution of the monthly probabilities of food donation use overlapped. The results of the unweighted and ICPW-weighted models of food donation use are presented in **Table 2**. Adding ICPW to the unweighted model improved the model fit and decreased some credible intervals but did not change the estimates.

AFSU Profiles and Trends of Other Food-Related CB-SAP Use

Given the small proportion of participants using other food-related CB-SAPs (18% adding up all programs) and the fact that the utilisation of these programs did not change during the study, the models including the interaction between AFSU profiles and time with a first-order autoregressive structure did not result in a good fit. We selected the model without interaction, but still with random effects for user and time with an autoregressive structure because it presented the best fit. The ORs and 95% Cr.Int for the effect of AFSU profiles on other food-related CB-SAPs are shown in **Table 3**. Compared to FB-exclusive-users, the overall mean of the use of other food-related CB-SAPs was more likely to decrease (OR: 0.77; 95% Crl: 0.24, 2.46) among FB-FV-market- users and more likely to increase among multiple/diverse-AFS-users (OR: 2.39; 95% Crl: 0.67, 8.67). However, the posterior distribution of both estimates includes one indicating the absence of differences in the use of other food-related CB-SAPs across profiles. Age, setting, the length of FB use time before the study, and COVID-19 measures gave an indication of decreased likelihood in the use of other food-related CB-SAPs. The IPCW improved the model fit, improving precision for some credible intervals and estimates.

DISCUSSION

Our findings indicate that the trends of food donation use during the first year after FB enrollment varies according to AFSU profiles of *de novo* new FBs users, whereas the average trend of other food-related CB-SAPs use did not vary across profiles. These results These results are in line with studies suggesting that FB-users develop diverse strategies, including

TABLE 1 | Characteristics of participants at baseline and follow-up by alternative food source utilization profiles on monthly use of food donations among newly enrolled food bank users in Quebec, Canada (2018–2021).

Characteristic	Baseline			Follow-up		
	Alternative food source utilization profiles					
	FB-exclusive-users (*n* = 308)	FB = F&V-market-users (*n* = 426)	Multiple/diverse-AFS-users (*n* = 267)	FB-exclusive-users (*n* = 217)	FB = F&V-market-users (*n* = 327)	Multiple/diverse-AFS-users (*n* = 201)
Age, y, median (IQR)	41.0 (31.0, 53.2)	41.0 (32.0, 51.0)	40.0 (32.0, 49.5)	42.0 (31.5, 54.0)	40.0 (32.5, 51.0)	40.0 (32.5, 51.0)
Gender (%)						
Female	172 (55.8)	236 (55.4)	204 (76.4)	132 (60.8)	192 (58.7)	161 (80.1)
Male	136 (44.2)	190 (44.6)	63 (23.6)	85 (39.2)	135 (41.3)	40 (19.9)
Country of birth (%)						
Canada	256 (83.1)	286 (67.1)	233 (87.3)	170 (78.3)	214 (65.4)	175 (87.1)
Other	52 (16.9)	140 (32.9)	34 (12.7)	47 (21.7)	113 (34.6)	26 (12.9)
Race (%)						
White	247 (80.32)	276 (64.8)	227 (85.0)	167 (77.0)	206 (63.0)	172 (86.0)
Other	61 (19.8)	150 (35.2)	40 (15.0)	50 (23.0)	121 (37.0)	28 (14.0)
Mental health, median (IQR)	40.7 (30.5, 48.3)	40.7 (32.6, 50.5)	41.9 (32.6, 49.9)	42.9 (34.4, 51.6)	43.9 (35.1, 52.6)	43.3 (35.8, 52.7)
Physical health, median (IQR)	47.4 (36.1, 55.1)	48.6 (35.4, 56.6)	49.8 (35.6, 57.5)	47.6 (37.3, 54.8)	49.7 (36.1, 56.9)	50.8 (34.4, 57.2)
Major life events, median (IQR)	3.0 (2.0, 5.0)	3.0 (1.0, 4.0)	4.0 (2.0, 5.0)	2.0 (1.0, 3.0)	2.0 (1.0, 3.0)	2.0 (1.0, 4.0)
Household composition (%)						
Couple (with or without children)	70 (22.7)	116 (27.2)	71 (26.6)	56 (25.8)	98 (30.0)	58 (28.9)
Single-parent home	53 (17.2)	85 (20.0)	82 (30.7)	39 (18.0)	68 (20.8)	59 (29.4)
Single (living alone or with others)	185 (60.1)	225 (52.8)	114 (42.7)	122 (56.2)	161 (49.2)	84 (41.8)
Household educational level (%)						
Secondary level or less	241 (78.2)	269 (63.1)	174 (65.2)	161 (74.2)	198 (60.6)	123 (61.2)
Post-secondary studies	67 (21.8)	157 (36.9)	93 (34.8)	56 (25.8)	129 (39.4)	78 (38.8)
Annual household income (%)						
≤CAN14.999	208 (67.5)	298 (70.0)	131 (49.1)	121 (57.1)	193 (61.5)	88 (44.9)
≥CAN15.000	100 (32.5)	128 (30.0)	136 (50.9)	91 (42.9)	121 (38.5)	108 (55.1)
Length of FB use time before the study, median (IQR)	1.0 (1.0, 3.0)	2.0 (1.0, 3.0)	3 (1.0, 4.0)	1.0 (1.0, 3.0)	2.0 (1.0, 3.0)	3.0 (1.0, 4.0)
Community organization size, median (IQR)	14.0 (9.0, 22.0)	14.0 (8.0, 24.0)	15.0 (8.0, 23.0)	13.0 (9.0, 18.0)	14.0 (8.0, 24.0)	15.0 (8.0, 22.0)
Setting (%)						
Urban	113 (36.7)	326 (76.5)	131 (49.1)	66 (30.4)	246 (75.2)	96 (47.8)
Suburban	143 (46.4)	66 (15.5)	41 (15.4)	116 (53.5)	53 (16.2)	30 (14.9)
Rural	52 (16.9)	34 (8.0)	95 (35.6)	35 (16.1)	28 (8.6)	75 (37.3)
COVID-19 measures (%)						
Non	—	—	—	93 (42.9)	156 (47.7)	121 (60.2)
Yes	—	—	—	124 (57.1)	171 (52.3)	80 (39.8)

using different AFSs, to feed themselves and their households [9, 11, 13, 15, 16]. They confirm that new FB-users use food donations in different ways over the time [18–22], which means that this program may have distinct effects on FB-users' lives. Likewise, consistent with a prior study conducted in Montréal showing that newly registered FB-users in Montréal who used other food-related CB-SAPs were different from those who only used food donations [12], Our findings suggest that people who used these programs before the study baseline, mostly multiple/diverse-AFS-users, were those who continued using them during the 12 months of the study. However, we cannot rule out any association between AFSU profiles and the use of other food-related CB-SAPs.

Our research adds to the body of literature suggesting that some coping strategies may become adapting strategies integrated in the activities of food-insecure households [15, 23, 42] by showing that the use of food donations as a short-term coping strategy may contribute to FB-users' adaptability in diverse forms according to their needs and capabilities. For instance, the rapid downward mean trend of food donation use among FB-exclusive-users after 5 months of the study may be

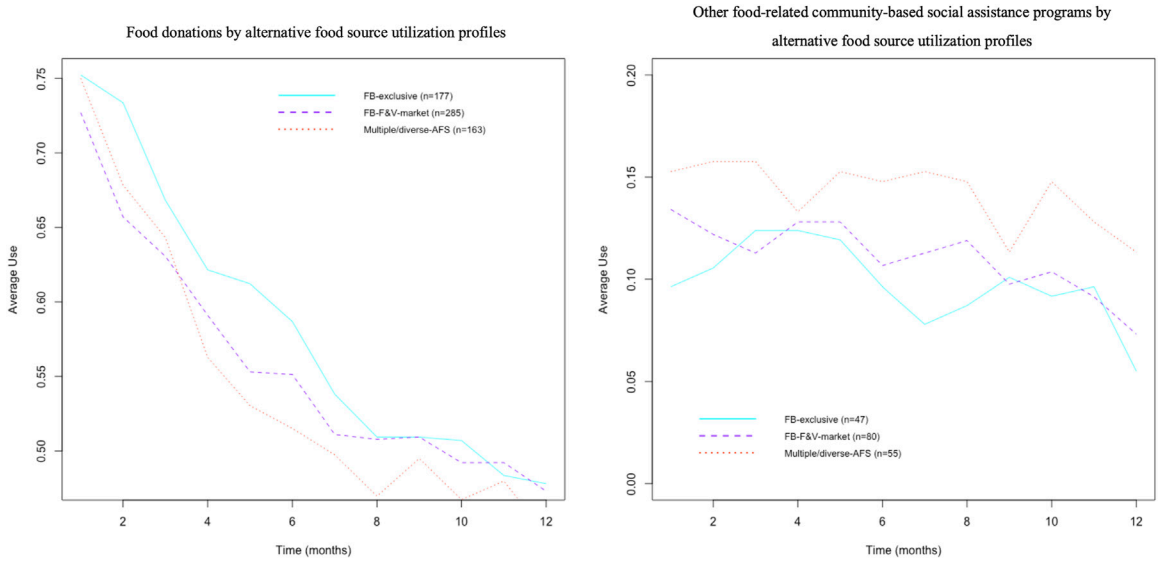

FIGURE 2 | Unadjusted trends (proportion) in the use of food donations and other food-related community-based social assistance programs among newly enrolled food bank users in Quebec, Canada (2018–2021).

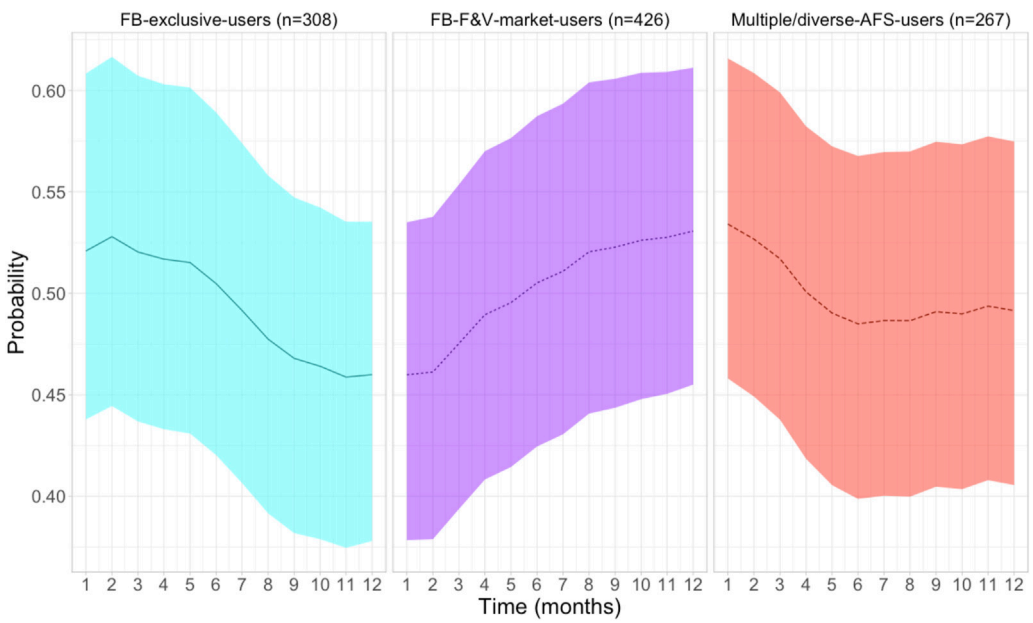

FIGURE 3 | Trends (estimated probabilities and 95% CrIs) of food donation use by alternative food source utilization profiles among newly enrolled food bank users in Quebec, Canada (2018–2021).

explained by the fact that some FB-exclusive-users may start using F&V-markets to cope with the limited supply of fruit and vegetables in FBs [2]. Thus, some FB-exclusive-users became FB+F&V-market or multiple/diverse-AFS users during the study, which may also explain the upward trend of FB+F&V-market-users, although we did not formally test this phenomenon. In contrast, the flat mean trend of food donation use observed (in the second half of the follow-up period) among multiple/diverse-AFS-users may indicate that even if they have more opportunities to access food when they start visiting FBs, and their usage of food donations tends to diminish in the first months, some of them continue using this program to meet some of their needs or to save money. This is in line with qualitative studies suggesting that some FB-users

TABLE 2 | Odds ratios for the effect of alternative food source utilization profiles on monthly use of food donations among newly enrolled food bank users in Quebec, Canada (2018–2021).

	Unweighted		IPCW	
	OR	CrI	OR	CrI
Alternative Food Source Utilization Profiles				
FB-exclusive-users	1.00	Reference	1.00	Reference
FB+F&V-market-users	1.26	0.45; 3.52	1.24	0.48; 3.19
Multiple/diverse-AFS-users	0.84	0.27; 2.64	0.87	0.30; 2.49
Age	1.10	1.07; 1.14	1.09	1.06; 1.13
Gender				
Female	1.00	Reference	1.00	Reference
Male	1.31	0.57; 3.01	1.29	0.60; 2.78
Race				
White	1.00	Reference	1.00	Reference
Non-white	0.92	0.25; 3.30	0.95	0.29; 3.10
Country of birth				
Canadian	1.00	Reference	1.00	Reference
Non-Canadian	1.82	0.46; 7.19	1.76	0.50; 6.22
Mental health				
Baseline	1.04	1.00; 1.08	1.04	1.00; 1.07
T1	0.97	0.93; 1.00	0.97	0.94; 1.00
Physical health				
Baseline	1.56	0.45; 5.40	1.49	0.48; 4.67
T1	1.06	0.58; 1.93	1.06	0.61; 1.83
Major life events				
Two or less events	1.00	Reference	1.00	Reference
Three or more events, baseline	0.94	0.40; 2.20	0.94	0.43; 2.04
Three or more events, T1	3.60	1.58; 8.30	3.23	1.51; 6.96
Household composition				
Couple (with or without children)	1.00	Reference	1.00	Reference
Single parent-family	0.50	0.17; 1.48	0.54	0.20; 1.45
Single	0.43	0.16; 1.16	0.47	0.19; 1.17
Household educational level				
Secondary level or less	1.00	Reference	1.00	Reference
Post-secondary studies	1.22	0.52; 2.87	1.20	0.55; 2.64
Annual household income				
≤CAN14.999	1.00	Reference	1.00	Reference
≥CAN15.000, baseline	0.87	0.36; 2.12	0.89	0.39; 2.01
≥CAN15.000, T1	0.14	0.06; 0.34	0.17	0.08; 0.37
Length of FB use time before the study				
One or less than 1 month	1.00	Reference	1.00	Reference
Two or more months	1.07	0.37; 3.12	1.06	0.40; 2.84
Size of community organization	0.87	0.52; 1.46	0.88	0.54; 1.42
Setting				
Urban	1.00	Reference	1.00	Reference
Suburban	3.06	1.14; 8.31	2.80	1.13; 7.02
Rural	6.38	2.01; 20.65	5.40	1.86; 15.84
COVID measures				
Non	1.00	Reference	1.00	Reference
Yes	1.34	0.49; 3.73	1.33	0.52; 3.41

use food donations not as a means to address short-term hunger, but as a means of freeing up income for other purposes over time [42, 43]. Consistently, although the likelihood of using food donations seems to decrease with income ≥ CAN$15.000 at t_1 (post baseline), we did not find great heterogeneity in income distribution, as most participants reported very low incomes in both waves.

Consequently, it seems that the boundaries between using food donations as coping and adapting strategies blur in a global, complex, and dynamic process. In this process FB-users are constantly changing and bargaining in response to several drivers (e.g., food sources availability and sociocultural differences across settings) interacting with their capacities and adaptability through time and space. Thus, it is highly probable that multiple/diverse-AFS-users improve their food security status quickly than exclusively relying on FBs. However, empirical testing is needed.

Strengths and Limitations

Although our study uses a robust methodology there are some limitations. First, the small sample size can impact the precision of our estimates, especially for rural settings. Likewise, the assessment of AFSU and time interaction could be underpowered. The assessment of statistical interactions requires larger sample sizes and therefore, the lack of statistical significance in this context should not be misunderstood as a lack of effect. Second, given that the *Pathway Study* includes only *de novo* FB-users in four regions of Quebec, interpretation is intended for this province. Further research is needed on this topic to explore differences in trends of food donation and other food-related CB-SAP use among FB-users in other regions of the country. Third, we did not consider the usage frequency, or the quality and size of FB parcels when modeling the trends, although these may influence the use of CB-SAPs. However, the frequency of food donations use is one of the key variables used to identify AFSU profiles and therefore, partially accounted for. Fourth, our results might be affected by recall bias because information related to programs use and time-variant covariates in the previous 12 months was assessed using a self-reported questionnaire at *t*1. Fifth, the COVID-19 pandemic could have affected our study in various ways. For instead, living during the pandemic could have affected the validity of the LTE-Q, potentially considering it as a main stressor, an overall modifier, or an indicator of stressors, thus participants' perception of stress may have changed during this period. It could also have exacerbated the reliance on food donations during this period [44–46]. Even though we included a variable to account for these consequences, we were unable to control for all of them.

Despite these limitations, to the best of our knowledge, this study is the first to assess the influence of AFSU on the use of food donations and other food-related CB-SAPs over time among *de novo* FB users. An important strength of this study relates to use of a well-characterized cohort of new FB-users in urban, semiurban, and rural areas with detailed follow-up information. The advantage of using repeated measures since the beginning of FB enrollment in diverse community organizations located in different settings, allowed the Bayesian modelling of data for within-individual variations in the use of food donations and other food-related CB-SAPs. This permitted considering setting and community organization differences, and potential clustering, while estimating trends of use addressing temporal autocorrelation and accounting for censoring via IPCW ensuring robustness of our estimates.

TABLE 3 | Odds ratios for the effect of alternative food source utilization profiles on monthly use of other food-related community-based social assistance programs among newly enrolled food bank users in Quebec, Canada (2018–2021).

	Unweighted		IPCW	
	OR	**CrI**	**OR**	**CrI**
Alternative Food Source Utilization Profiles				
FB-exclusive-users	1.00	Reference	1.00	Reference
FB+F&V-market-users	0.76	0.21; 2.70	0.77	0.24; 2.46
Multiple/diverse-AFS-users	2.82	0.71; 11.61	2.39	0.67; 8.67
Age	1.12	1.07; 1.18	1.11	1.06; 1.16
Gender				
Female	1.00	Reference	1.00	Reference
Men	0.46	0.16; 1.29	0.50	0.19; 1.30
Race				
White	1.00	Reference	1.00	Reference
Non-white	0.45	0.09; 2.30	0.51	0.11; 2.24
Country of birth				
Canadian	1.00	Reference	1.00	Reference
Non-Canadian	2.57	0.45; 15.23	2.24	0.45; 11.36
Mental health				
Baseline	1.01	0.96; 1.05	1.01	0.97; 1.05
Time1	0.96	0.91; 1.00	0.96	0.92; 1.00
Physical health				
Baseline	1.42	0.30; 6.84	1.36	0.33; 5.74
Time1	1.96	0.95; 4.57	1.78	0.91; 3.87
Major life events				
Two or less events	1.00	Reference	1.00	Reference
Three or more events, baseline	6.72	2.23; 21.67	5.26	1.92; 15.09
Three or more events, T1	1.46	0.51; 4.19	1.36	0.52; 3.56
Household composition				
Couple (with or without children)	1.00	Reference	1.00	Reference
Single parent-family	0.54	0.13; 2.10	0.61	0.17; 2.14
Single	0.66	0.18; 2.32	0.72	0.23; 2.30
Household educational level				
Secondary level or less	1.00	Reference	1.00	Reference
Post-secondary studies	1.40	0.47; 4.15	1.33	0.49; 3.60
Annual household income				
≤CAN14.999	1.00	Reference	1.00	Reference
≥CAN15.000 t0	0.67	0.21; 2.04	0.73	0.26; 2.04
≥CAN15.000 t1	0.80	0.27; 2.36	0.79	0.29; 2.15
Length of FB use time before the study				
One or less than 1 month	1.00	Reference	1.00	Reference
Two or more months	0.17	0.04; 0.68	0.22	0.06; 0.78
Size of community organization	0.83	0.43; 1.59	0.86	0.47; 1.56
Setting				
Urban	1.00	Reference	1.00	Reference
Suburban	0.04	0.01; 0.15	0.06	0.02; 0.19
Rural	0.11	0.02; 0.47	0.14	0.04; 0.55
COVID measures				
Non	1.000	Reference	1.000	Reference
Yes	0.15	0.04; 0.55	0.19	0.05; 0.63

Conclusion

This study highlights the diverse trends of food donation use among new FB-users, indicating that this program has different meaning for FB-users depending on their background and needs. Hence, FB-users' responses to food shortages should be understood as dynamic processes. For some, food donation use serves as a short-term strategy to cope with food insecurity, while for others, the use of this program evolves into a long-term strategy. This transformation is contingent upon their AFS-utilization profile and their adaptability to evolving socioeconomic conditions. Recognizing these processes and documenting changes over time can help to

predict FB-users' pathways and indicate appropriate ways to improve access to food among this population.

ETHICS STATEMENT

The study protocol was reviewed and approved by the Health Research Ethics Committee at the University of Montréal (CERSES-21-020-D). The study was conducted in accordance with the local legislation and institutional requirements. Participants provided written consent at the beginning of the Pathways Study.

AUTHOR CONTRIBUTIONS

EP designed the study, analyzed the data, and wrote the first draft with contributions from MC, M-PS, and LP. All authors contributed to the article and approved the submitted version.

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CONFLICT OF INTEREST

The authors declare that they do not have any conflicts of interest.

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SUPPLEMENTARY MATERIAL

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Bridging the Gap: Parental Supervision as a Mediator Between Home Environment and Unintentional Injuries in Children Under 3 Years

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Objectives: Unintentional home injuries pose a serious risk to children under 3 years. While parental supervision and home environment are key factors influencing these injuries, few studies have explored the correlation between them. This study aimed to examine the relationship between home environment, parental supervision, and unintentional home injuries, and to investigate whether parental supervision mediates this relationship.

Methods: This study, conducted in Shanghai, China from June to August in 2023, using a convenience sample. Paper questionnaires were distributed to 600 parents of children, assessing unintentional injuries, parent supervision (using parent supervision attributes profile questionnaire), in-home environmental risk scale and demographic variables. A bootstrap test was applied to assess the mediating role of parental supervision.

Results: Both in-home environment risks and parental supervision were significantly related to unintentional home injuries in children under 3. Moreover, parental supervision was found to partially mediate the relationship between environmental risks and injuries, explaining 14.2% of the total effect.

Conclusion: Children under 3 were highly vulnerable to unintentional home injuries. Enhancing parental supervision may reduce the impact of environmental risks on injury occurrence. These findings offer practical guidance for health practitioners, underscoring the value of community-based interventions and tailored educational programs for injury prevention. Future research should explore intervention effectiveness and long-term outcomes.

Keywords: health promotion, children, unintentional home injury, parental supervision, home environment

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INTRODUCTION

Unintentional injuries (UI) in childhood represent a significant global public health concern, being the leading cause of mortality in children. According to the Global Burden of Diseases report, more than 200,000 child deaths occur annually as a result of UIs [1], with the majority of these injuries taking place within the home [2]. Unintentional home injuries (UHI) substantially contribute to the global disease burden. In China, the incidence rate of UHI was 65.5%, with mortality rates exceeding those in developed countries by 3–11 times [3]. In 2019, UHIs accounted for 12.49% of all child

deaths in China, with nearly 1.9 million Disability-Adjusted Life Years lost among children and adolescents [4]. Thus, great attention should be paid to the risk factors of UHI so as to develop strategies to reduce the incidence of UHI.

Age is an important predictor of UHI, with younger children at greater risk of UHI [5]. Specifically, children aged 0–3 years are the main age group for UHI compared to other age group [6]. Given the heightened vulnerability of this population, it is essential to examine UHI within this age group. Furthermore, the home environment is subject to frequent changes, and parenting practices play a pivotal role in child safety. Due to their physical and cognitive immaturity, children under the age of 3 are highly dependent on their caregivers for protection from injury [7, 8]. As primary caregivers, parents have a critical role in preventing childhood injuries [7]. According to the Haddon model, which provides a framework for understanding UI, key risk factors include both the physical and social environments, as well as interpersonal interactions [9]. So, we focused on the home environment and parental supervision as key factors influencing UHI.

The home environment encompasses both indoor areas and associated outdoor spaces, such as balconies, rooftops, and gardens [10]. Most studies have identified home environment as a major factor to UHI [6, 10–12]. Each additional injury hazard observed in the home was associated with a 22% increase in the odds of injury [13]. Many home hazards are often overlooked yet can significantly increase the risk of injury. For example, 41% of homes had unsafe water temperatures [14] and only 10% of families with young children securely store toxic substances [15]. Additionally, 97% of families leave prescription medications within reach of children [16]. Therefore, exploring their home surroundings is crucial to children's UHI. Furthermore, the home environment has been shown to correlate with parental supervision [12].

Parental supervision is defined as "the interaction between attentive behaviors and physical proximity over time" [17]. Inadequate supervision of young children is widely recognized as a significant contributing factor to UHI. Children under five who died from UIs were 3.3 times more likely to be unattended than children who were alive [17]. In addition, Schnitzer et al [18] demonstrated a significant association between lower levels of parental supervision and an increased risk of injury, which aligns with the findings of Yang et al [19]. However, research also shows that children may still face injury risks even when closely supervised [20]. It is therefore crucial to explore the complex interactions between parental supervision and UHI.

Despite growing research in this area, few studies have speciafically examined the correlation regarding home environment, parental supervision and UHI, particularly regarding the potential mediating role of supervision. Morrongiello et al. [21] highlighted the need for future research to assess how environmental characteristics interact with caregiver behaviors to influence children's risk of UI. Consequently, this study aims to describe the current state of UHI among children and investigate the relationships between home environment, parental supervision, and UHI.

METHODS

Aim

This study aims to explore in-home environmental risks and parent supervision in relation to UHI and the mediating role of parent supervision between in-home environmental risks and parent supervision among younger children (0–3 years).

Design

A descriptive, cross-sectional design was applied using a convenience sample.

Participants

The study included fathers or mothers aged 18 or older who accompanied their children aged 0–3 to a tertiary children's hospital in Shanghai from June to August 2023. Parents whose children have severe organic disease or were unwilling to sign an informed consent form were excluded.

The hospital was chosen as the site for investigating child injuries because it provides immediate access to injured children and their families, allowing researchers to gather detailed information on the causes, injury specifics, and parental supervision at the time of the incident. As a centralized hub, the hospital offers diverse cases, ensuring a more representative sample. Additionally, parents in this setting are often more open to sharing incident details and seeking guidance, enabling real-time data collection, reduced recall bias, and improved data accuracy.

Measurement Instruments

The Demographic Questionnaire

Demographic information assessed the characteristics children (age, gender, only child, residence et al) and their families (education level of parents, living with grandparents et al.).

Measurements of Unintentional Injury

According to the International Classification of Diseases, 10th edition [22], and the characteristics of children aged 0–3 years, the unintentional injuries criteria were established: (a) children need to visit a medical unit and have a specific type of injury diagnosed, or (b) children need emergency treatment or care by family members, or (c) children have restricted activity more than half a day.

Before asking whether the child had suffered an UHI in the last 12 months, we described what an UHI is. If the child had suffered an UHI, parents answered the number of times and selected the type of unintentional injury. (Question-1 Have your children suffered an unintentional injury in the last 12 months; Question-2- How many unintentional injuries have your children had in the last 12 months; Question-3 Please fill in the type and number of injuries your child has had in the last 12 months) The responses were converted into scores on a 5-point Likert scale, primarily based on the frequency indicated in Question 2.

Parent Supervision Attributes Profile Questionnaire

Parent supervision attributes profile questionnaire (PSAPQ) is a 29-items tool designed to assess various aspects of parental

supervision [23]. It covers four dimensions: protectiveness with 9 items, supervision beliefs with 9 items, tolerance for children's risk-taking with 8 items, and belief in fate with 3 items. Items were rated on a 5-point Likert scale ranging from 1 (never) to 5 (all of the time). The total score varies from 29 to 145 and higher total scores indicated parents had more engagement with supervision for their children. The PSAPQ has good reliability and validity in the Chinese population [19]. In the current study, Cronbach's alpha for the scale was 0.847.

In-Home Environmental Risks Scale

The In-home Environmental Risks Scale, derived from the Knowledge, Attitudes, and Behavior in Unintentional Injuries Questionnaire developed by Ma et al [7], is used to assess the safety of the home environment. It consists of 27 items focusing on various aspects of potential environmental risks within the home, such as hazards that could contribute to unintentional injuries. Each item is rated on a 5-point Likert scale (1 = never, 5 = always), with higher scores indicating a safer home environment as perceived by the parents. In this study, the scale demonstrated strong internal reliability, with a Cronbach's alpha of 0.876.

Data Collection

Prior to initiating data collection, a research team was formed, and primary investigators provided standardized training to all team members. This training encompassed the procedures for completing the questionnaire, study objectives, inclusion and exclusion criteria for participant selection, and key considerations to ensure accurate and consistent questionnaire completion.

Data for the study was collected with paper surveys that were posted in June to August in 2023. Before participation, each potential respondent was informed about the study's purpose, and informed consent was obtained. Participants were also notified of their right to withdraw at any stage of the study. Upon completion of each questionnaire, researchers reviewed responses for completeness and requested clarification on any missing items, ensuring the accuracy and integrity of the data. For parents unable to complete the questionnaire independently due to childcare responsibilities, one-on-one, face-to-face interviews were conducted. Interviewers adhered to a structured, standardized protocol to guide participants through each question. A total of 600 questionnaires were received. After screening the incomplete and visibly unqualified questionnaires, 594 were included in the statistical analysis, with the response rate of 99%.

Data Analysis

After data were collected, the statistical analyses were performed using SPSS version 26 and Mplus 8.3. Descriptive statistics were adopted to analyze the demographic characteristics of all participants, means and standard deviation (SD) of three variables. Pearson's correlation coefficients were calculated to test the correlated relationship among three research variables. Multiple linear regression was used to evaluate whether in-home environment and PSAPQ could significantly affect the UHI. In order to obtain the confidence intervals, bootstrapping was performed for each of the models with 1,000 replications. The mediation effect is significant ($p < 0.05$) if the confidence interval constructed does not include 0.

RESULTS

Characteristics of UHI

The proportion of children who experienced UHI was 53.2% (n = 316). Additionally, 145 children were injured once, 82 children were injured twice, and 61 children were injured three, 28 children were injured forth or more. The prevalence rate of recurrent UIs was 47.3%. The most frequently reported type of UHI was falls, followed by cuts/stabs and burns.

Univariable Analysis Based on the UHI History

There were 594 participants in this study, ageing from 0 to 3 years old, with an average age of 2.01 ± 0.92 years old. The average scores for the In-home Environmental Risk and PSAPQ were 107.91 ± 16.90 and 105.20 ± 13.88, respectively. Specifically, children with UHI had significantly lower scores on both the PSAPQ and the In-home Environmental Risk compared to those without injury, indicating that higher scores in these measures are associated with greater child safety. A significant difference was revealed between the children's age. The participants' demographic characteristics are outlined in **Table 1**.

The Correlated Relationship Among UHI, PSAPQ, and In-Home Environmental Risks

The results of correlational analyses among UHI, PSAPQ, and in-home environmental risks were shown in **Table 2**. UHI were positively associated with age ($r = 0.166$) and negatively associated with in-home environmental risks ($r = -0.261$) and PSAPQ ($r = -0.230$).

Multiple Linear Regression Analysis of UHI

A multiple linear regression model was constructed using UHI as the dependent variable. Age, in-home environmental risks and PSAPQ were used as the independent variables. In-home environmental risks ($\beta = -0.189$, $P < 0.01$) and PSAPQ ($\beta = -0.209$, $P < 0.01$) were negatively correlated with UHI, while age was positively correlated with UHI. Detailed results of the regression analysis are shown in **Table 3**.

The Mediating Effect of PSAPQ Between In-Home Environmental Risks and UHI

As shown in **Table 4**, in-home environmental risks directly influenced UHI and indirectly affected UHI through PSAPQ. The indirect effect accounted for 14.2% (−0.037/−0.261) of the total effect of in-home environmental risks and UHI.

TABLE 1 | The sociodemographic characteristics of participants (Shanghai, China. 2023).

Variables	Total	Without IUIs history	With IUIs history	X^2/F	P
Age	2.01 ± 0.92	1.79 ± 1.0	2.19 ± 0.79	24.66	<0.001
Sex				0.140	0.80
Male	346 (58.2)	160 (46.2)	186 (53.8)		
Female	248 (41.8)	118 (47.6)	130 (52.4)		
Premature				0.39	0.56
Yes	51 (8.6)	26 (51)	25 (49)		
No	543 (91.4)	252 (46.4)	291 (53.6)		
Residence				0.003	1.0
City	508 (85.5)	238 (46.9)	270 (53.1)		
Town	86 (14.5)	40 (46.5)	46 (53.5)		
Only child				0.031	0.928
Yes	421 (70.9)	198 (47)	223 (53)		
No	173 (29.1)	80 (46.2)	93 (29.4)		
Education level of mother				4.94	0.083
Technical secondary school and below	93 (15.7)	36 (38.7)	57 (61.3)		
Junior college	124 (20.9)	53 (42.7)	71 (57.3)		
Bachelor's degree or above	377 (63.5)	189 (50.1)	188 (49.9)		
Education level of father				0.74	0.70
Technical secondary school and below	88 (14.8)	39 (44.3)	49 (55.7)		
Junior college	130 (21.9)	58 (44.6)	72 (55.4)		
Bachelor's degree or above	376 (63.3)	181 (48.1)	195 (51.9)		
Home environment	107.91 ± 16.90	113.74 ± 15.58	102.78 ± 16.36	4.94	<0.001
Protectiveness	34.90 ± 5.37	35.53 ± 5.01	34.36 ± 5.63	4.22	0.008
Tolerance for children's risk taking	29.66 ± 5.31	30.09 ± 5.47	29.28 ± 5.16	2.25	0.062
Belief in fate	6.40 ± 2.89	6.49 ± 3.08	6.33 ± 2.71	2.32	0.49
Supervision beliefs	34.31 ± 5.60	35.24 ± 5.49	33.50 ± 5.57	0.01	<0.001
PSAPQ	105.20 ± 13.88	107.35 ± 14.0	103.31 ± 13,51	1.14	<0.001

Abbreviation: PSAPQ: parent supervision attributes profile questionnaire.

TABLE 2 | Correlations between the study variables (Shanghai, China. 2023).

Variable	1	2	3	4	5	6	7	8
1. Age	-	0.166**	–0.095*	–0.015	0.066	–0.057	–0.026	0.003
2. UHI	0.166**	-	–0.261**	–0.184**	–0.131**	–0.032	–0.231**	–0.230**
3. In-home environmental risks	–0.095*	–0.261**	-	0.217**	0.100*	–0.006	0.181**	0.197**
4. Protectiveness	–0.015	–0.184**	0.217**	-	0.342**	0.045	0.641**	0.775**
5. Tolerance for children's risk taking	0.066	–0.131**	0.100*	0.342**	-	0.117**	0.568**	0.757**
6. Belief in fate	–0.057	–0.032	–0.006	0.045	0.117**	-	0.010	0.265**
7. Supervision beliefs	–0.026	–0.231**	0.181**	0.641**	0.568**	0.010	-	0.863**
8. PSAPQ	0.003	–0.230**	0.197**	0.775**	0.757**	0.265**	0.863**	-

Abbreviation: PSAPQ, parent supervision attributes profile questionnaire.
**: P value < 0.05 **: P value < 0.01.*

TABLE 3 | The multiple linear regression analysis (Shanghai, China. 2023).

Variables	B	SE	Beta	t	p
Age	0.185	0.049	0.146	3.779	0.001
PSAPQ	–0.015	0.003	–0.209	–5.295	<0.001
In-home environmental risks	–0.016	0.003	–0.189	–4.797	<0.001

Abbreviation: PSAPQ: parent supervision attributes profile questionnaire.

TABLE 4 | The results of the mediation analysis (Shanghai, China. 2023).

Path	Estimate	P	BCa 95% CI
Total effect	–0.261	<0.001	–0.025 ~ –0.012
Direct effect	–0.224	<0.001	–0.022 ~ –0.010
Home environment-PSAPQ- UHI	–0.037	0.001	–0.004 ~ –0.001

Abbreviation: BCa 95% CI: the bias-corrected and accelerated 95% confidence interval, PSAPQ, parent supervision attributes profile questionnaire.

DISCUSSION

In this study, around half of children had suffered UHI in the previous year, higher than the results in other studies [12, 24]. It also examined the mediating influence of parental supervision on the association between risks present in the home environment and UHI in young children aged 0–3. To our knowledge, this is the first to explore the connection between parental supervision, home environment risks, and UHI.

Additionally, the model employed evaluates the intricacies of UHI processes which exist in the real world (such as the interactions between caregiver and environmental traits) when studying children's risk of injury.

Age-Related Vulnerabilities: Limited Motor Control and Increased Curiosity Drive Higher UHI Incidence

The incidence of unintentional injuries (UHI) among infants and young children aged 0–3 can reach up to 50% [6], with 53.2% of children in our study experiencing UHI. This high rate likely stems from age-specific physical and cognitive development characteristics. During this period, rapid growth and intense curiosity drive children to explore their surroundings, yet limited motor skills, self-protection awareness, and cognitive abilities leave them vulnerable to injury [25]. Lacking mature motor control and risk awareness, young children are often unable to recognize or avoid dangers effectively [26]. The results of multiple linear regression analysis showed that age plays a crucial role in predicting UHI. Furthermore, compared to children without a history of UHI, we have found that children with an average age of 2.19 ± 0.79 are more prone to suffer from them. This aligns with a previous study conducted in Wenzhou, which showed that children aged between 24 and 47 months were more susceptible to injuries at home [24]. As infants grow, their motor skills at two different stages of motor development (pre-mobile, mobile). However, limited control over these abilities and an underdeveloped sense of risk make them prone to accidents [27]. In addition, the most common injury in our study reported is fall, which is in line with Ma et al [7]. Their relatively large heads and higher center of gravity, however, make them prone to losing balance and falling, often leading to head or other injuries [28]. When developing interventions to reduce UHI, it is crucial to consider the developmental characteristics and common injury types associated with each age group. A thorough analysis of age-specific risk behaviors and their evolution can offer parents valuable insights into the potential hazards children encounter as they explore the home environment. This approach not only enhances the effectiveness of interventions but also serves as an essential resource for parents, particularly first-time parents, helping them to better prevent injuries and establish a safer home environment for their children.

Home Environment Risks: Overlooked Hazards and the Importance of Parental Awareness

There was a substantial adverse correlation found between home environment risks and UHI in this study. Similarly, a study conducted in Nepal indicated that an increase in home injury hazards led to a rise in child injury incidence [29]. In addition, many potential sources of danger in the home environment can be easily overlooked, such as home structures (slippery floors, stairs/steps, bathtubs/showers) and furnishings (mainly beds, chairs and rugs/carpets/doormats), small objects (e.g., coins, buttons, screws, cotton and nylon containers), medicines, chemical substances, sharp objects (knives, razors, glass and containers) that can lead to UI [11]. However, environmental changes may be effective in reducing home hazards [13] and parental awareness plays an integral role in this process. In particular, parental risk perception is a facilitator of parents' efforts to prevent UHI [30]. Studies show that strengthening risk perception among families of affected children is essential. Parents more receptive to threat-related information are likelier to take preventive action. Pang et al [31] used visuals showing the child's parents the whole process from various risk factors, including home environment, to injury to improve parents' situational awareness of UHI and reduce home environment risk factors accordingly. In addition, community-led, sustained safety education can enhance child safety awareness, improve parental knowledge, and foster a safer environment for children. Feng et al [5] conducted a WeChat-group-based parental health education including making changes to the home environment centered on community-based basic public services, and the results showed that this health education program could decrease the occurrence of IUIs by enhancing the safety consciousness of parents of children under 3 years old to modify children's surroundings. We recommend a comprehensive, community-based child injury prevention program that includes accident prevention, home safety enhancement, parental safety awareness, and emergency response planning, emphasizing the community's critical role in UHI prevention. Additionally, given that caregivers may be distracted by children's needs, engaging visual materials (slides, videos) combined with demonstrations and interactive parent sessions are suggested to maintain focus. Regular family meetings are also encouraged to systematically identify and reduce household hazards, further lowering overall risk levels.

Parental Supervision as a Protective Factor: Mediating Environmental Risks and UHI

The study results indicate that children with lower levels of parental supervision experience a higher incidence of UHI, consistent with previous research findings [17]. This result could be attributed to the influence of parental supervision on children's behaviors; by actively supervising, parents play a critical role in mitigating risky behaviors, thereby reducing the likelihood of UHI [32]. This study identified that parental supervision partially mediates the relationship between home environmental risks and UHI. Social Cognitive Theory, which emphasizes the role of environmental factors in shaping behavior through observational learning and self-efficacy [33], supports parental supervision as a critical protective factor. Within this framework, parental supervision functions as both a risk management strategy and a behavioral model for children. By actively monitoring their children's activities and promptly mitigating hazards, parents create a buffer against environmental risks, reducing the likelihood of injury [30, 33]. Additionally, children who observe their parents' proactive behaviors gradually internalize these safety practices, developing the ability to recognize and avoid risks independently. Thus, through consistent and engaged supervision, parents not only reduce immediate dangers but also instill safer habits in their children, leading to a meaningful decrease in UHI incidence. However, this finding contrasts with those of Ma et al. [12], who reported that parental supervision did not mediate the relationship between home environmental risks and

UHI, suggesting that supervision was not a significant factor in reducing injury risk for children with an average age above 3 years, either directly or indirectly, as shown through structural equation modeling. The potential reason for this discrepancy could be that parental supervision styles vary across different age groups. Children aged 0–3 years tend to be highly mobile and display more risk-taking behaviors, increasing their vulnerability to UHI [17, 28]. Consequently, parents of younger children typically emphasize both the frequency and proximity of supervision. As children grow older, however, parents may underestimate the need for close supervision or may assume that their children can independently manage risks of injury [17, 34]. Morrongiello et al. [35] developed the "Supervising for Home Safety" program, aimed at helping parents decrease unsupervised time, increase direct visual supervision, and extend monitoring even when children are out of sight. Results confirmed that increased supervision through this program effectively reduced injury risk, underscoring the protective role of parental supervision in preventing UHI.

However, there is currently no comprehensive definition of what constitutes adequate supervision. Future research on parental supervision should, therefore, focus on developing a robust conceptual analysis to clarify what defines adequate parental supervision. Additionally, research should prioritize evaluating and enhancing the effectiveness of parental supervision interventions specifically aimed at preventing UHI in children aged 0–3.

Limitations

Despite some important findings in this study, there are several limitations to the extension of our results to the wider population. Firstly, the cross-sectional design used in the present study cannot establish a causal relationship between home environment risks, parental supervision and UHI. Future research could employ a longitudinal design to explore the causal relationship, particularly between parental supervision and UHI, across different age groups. Additionally, examining the supervisory behaviors of mothers and fathers separately could provide insights into how each parent's supervision style influences injury risk, thus enabling the development of more targeted and specific strategies to reduce the occurrence of unintentional injuries. Secondly, the study recruited participants from a hospital setting rather than the community, which may not fully represent the general population's UHI-related characteristics. The choice to recruit from a hospital setting was based on accessibility to a concentrated group of affected families, ensuring a sample with firsthand experience of UHI. However, this may introduce a selection bias, as these families might differ from those in community settings regarding injury risk perception and management behaviors. Third, conducting this study in Shanghai, China, may limit the applicability of our findings to other regions. Shanghai, as a large, urbanized city, presents unique environmental and social factors that may differ from other areas. Studying UHI in Shanghai provides valuable insights into urban injury prevention and parental supervision patterns, which can serve as a reference for other metropolitan areas. Nonetheless, further research across diverse geographic regions in China is needed to better understand the regional variations in parental supervision and UHI risk for children under three.

Conclusion

This study showed that in-home environment risks and parental supervision affected UHI among children under 3 years, while parental supervision partially mediated the relationship between in-home environment risks and UHI. As the primary environment for young children, the home requires parents to eliminate safety hazards and maintain strong safety awareness. By strengthening supervision, parents play a crucial role in reducing unintentional injuries. However, injury prevention should extend beyond family efforts; community support in education and resources is also essential. Health practitioners should encourage community engagement by establishing support networks that provide families with essential resources and education. Community-based interventions can empower parents to manage risks effectively, offering practical guidance on supervision and environmental safety. Specifically, community programs tailored to children's age, gender, and seasonal risks are crucial. By focusing on injury prevention knowledge, basic first-aid skills, and health guidance, these programs build a collaborative framework in which families and communities work together to ensure children's safety.

ETHICS STATEMENT

The studies involving humans were approved by the Ethics Committee of the Shanghai Children's hospital, China (Reference number: 2023R086-E01). The studies were conducted in accordance with the local legislation and institutional requirements. Written informed consent for participation in this study was provided by the participants' legal guardians/next of kin.

AUTHOR CONTRIBUTIONS

JJ and QL designed the study. JJ, OC, and CZ collected data. JJ and HY drafted the manuscript and contributed to the final analyses and critical work on the final versions of the article. JJ, HY, and QL contributed to the critical revision and approval of the final manuscript. All authors contributed to the article and approved the submitted version.

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CONFLICT OF INTEREST

The authors declare that they do not have any conflicts of interest.

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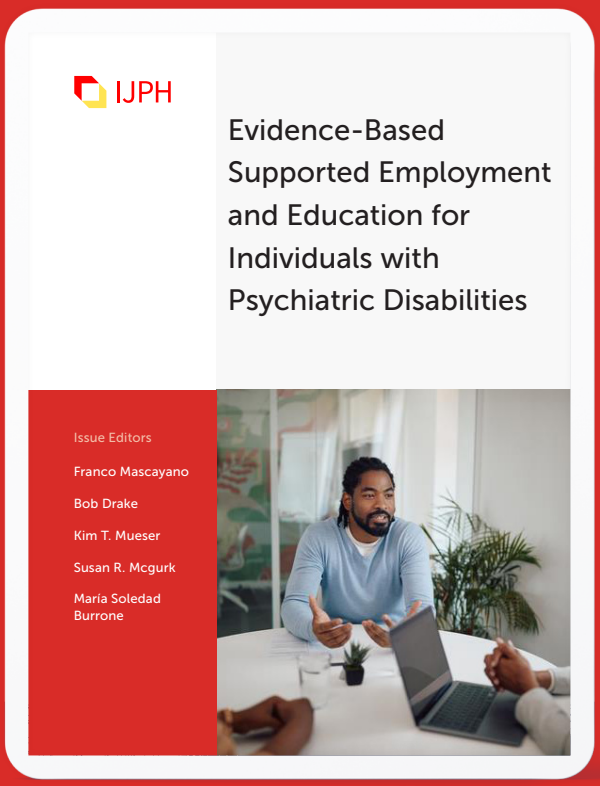

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