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Does the Urban Productive Safety Net Programme Alleviate Food Insecurity and Improve Education? Evidence from Tigray, Ethiopia

Yibrah Hagos Gebresilassie [1,2,*], Gebremeskel Berhane Tesfay [3,4], Tekeleweyni Hadush Abay [4] and Sakhile Mpungose [1]

[1] School of Accounting, Economics and Finance, University of KwaZulu-Natal (UKZN), Durban 4041, South Africa; mpungoses@ukzn.ac.za
[2] Department of Economics, Aksum University, Axum P.O. Box 1010, Ethiopia
[3] Department of Agricultural Economics, Extension and Rural Development, University of Pretoria, Pretoria 0002, South Africa; tbgmeskel@gmail.com
[4] Department of Economics, Mekelle University, Mekelle 0231, Ethiopia; abayhadush123@gmail.com
* Correspondence: yibraha@mail.aku.edu.et

Abstract: This study examines the effects of the urban productive safety net programme (uPSNP) on urban households' food insecurity (FIN) and children's school attendance in Tigray, Ethiopia. Data were collected from 333 urban households between August and September 2020. The FGT index was used to compute households' food insecurity intensity level, while the propensity score matching (PSM) technique was employed to examine the effect of the uPSNP on the food insecurity of urban households. The results indicated that approximately 56.7% of uPSNP beneficiaries were food-secure and able to consume an average of 2469.964 kcal per adult equivalent. Most importantly, uPSNP beneficiaries headed by women (50.8%) were more food-secure than non-beneficiaries headed by men (5.9%). Furthermore, the children of beneficiaries of the uPSNP attended school more often than the children of non-beneficiaries. This study highlights the need to scale up the uPSNP to address household food insecurity.

Keywords: beneficiary; food insecurity; household; Tigray; urban

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1. Introduction

Food is crucial for human survival (FAO et al., 2020). Food insecurity (FIN) refers to a condition in which an individual lacks sufficient economic, social, and physical access to adequate quantities of nutritious food to achieve average growth and a healthy life (Chowdhury et al., 2016; FAO et al., 2020). FIN is a global health issue, particularly in developing countries. For developing countries, achieving food security has become the most challenging issue (CIDA, 2010). It impairs health, education, working capacity, human rights, and equality in every individual. Women are more vulnerable to FIN because of limited access to and control over resources (CIDA, 2010; Welteji et al., 2017; Gebrihet et al., 2025; Gebrihet & Gebresilassie, 2025).

In 2021, about 29.3% of people experienced moderate FIN worldwide, while 923.7 million people (11.7%) faced severe FIN (FAO et al., 2022). Evidence also reveals persistent regional disparities in the level of FIN, with Africa having the highest prevalence. Africa continues to face the most FIN, which affects approximately 53% of its population and tends to worsen throughout the continent. Populations in eastern and sub-Saharan African (SSA) countries experienced varying degrees of FIN in 2018 at approximately 63% and 58%,

respectively (FAO et al., 2019). Globally, there is also an increasing gender disparity in FIN worldwide (FAO et al., 2022). Accordingly, in 2021, 31.9 and 27.7% of women and men worldwide experienced moderate (or severe) FIN, respectively, representing a disparity of more than 4 percentage points, up from 3 percentage points in 2020 (FAO et al., 2022).

Multiple interrelated factors have been found to contribute to the prevalence of food insecurity (FIN). Several empirical studies have examined major socioeconomic factors in East Africa, particularly Ethiopia. For example, Berhane et al. (2017), Abiye et al. (2019), Bahru et al. (2020), Derso et al. (2021), Hailu and Amare (2022), Tadesse and Gebremedhin (2022), Abay et al. (2023), Belete and Bayu (2023), and Gebrihet et al. (2025) consistently highlighted factors such as access to credit, household income, household size, and the educational status of the household head as significant factors affecting households' FIN status. Furthermore, these empirical studies also revealed that the social protection programme contributed to reducing the burden on households' FIN. Women are most susceptible to FIN due to inadequate access to resources and limited participation in decision-making. The programme documented the adverse effects of the existing gender disparity in achieving food security (Gebresilassie, 2020). Moreover, female-headed households benefited more from the programme and enhanced their food security status (Gebresilassie, 2020; Belete & Bayu, 2023). This is because social protection programmes (SPPs) are considered tools for enhancing food security (UNDP, 2011). Importantly, SPPs enabled households to overcome financial constraints, allowing them to invest in education. As parents' financial burden lessens, they allow their children to attend school more frequently (Abay et al., 2023; Berhane et al., 2017).

In Ethiopia, FIN affects millions of households, particularly poor and female-headed households (Welteji et al., 2017; Lukas & Mandado, 2018; Gebresilassie, 2020; Abay et al., 2023; Gebrihet et al., 2025; Gebrihet & Gebresilassie, 2025). Between 2016 and 2017, the severity of FIN increased, with approximately 8.5 million people facing a shortage of food due to displacement, political unrest, conflict, continuing drought, and increasing food prices (The Economist Intelligence Unit, 2018; Welteji et al., 2017). The Ethiopian government has established a large-scale SPP to tackle the prevalence of poverty and FIN across regions in rural settings. In 2005, a productive safety net programme (rPSNP) was launched and applied to rural areas in all regions of the country, where the majority of the population lives (Porter & Goyal, 2016). Evidence indicates that these programmes improved the FIN and poverty status of rural low-income households and enabled the beneficiaries of the programme to protect their assets and supported them in building assets in the long run (Gilligan et al., 2009; Welteji et al., 2017; Lukas & Mandado, 2018; Gebresilassie, 2020; Amede, 2020). In rural Ethiopia, the programme (rPSNP) has demonstrated that such interventions can meaningfully reduce FIN. However, in urban areas, this programme was a new intervention implemented in 2016 (MoUDH, 2016). Based on the achievements of the rPSNP, the Ethiopian government has also expanded the programme to begin covering urban households, under the name the "urban productive safety net programme (uPSNP)". It is an SPP applied in the largest cities of Ethiopia that targets urban food-insecure and poor households through the provision of cash, food, or a combination of both monthly to programme beneficiaries in exchange for their community work, which is known as "public works" (MoUDH, 2016). The programme was implemented in 11 major urban settings in 2017 and was administered by the Ethiopian government's "Ministry of Urban Development and Construction" (FDRE, 2016; Porter & Goyal, 2016; MoLSA, 2016; MoUDH, 2016). The uPSNP targets urban food-insecure, poor, and vulnerable households, with malnutrition and/or nutritionally vulnerable members included as programme beneficiaries. Beneficiaries receive either cash or in-kind (food items) in exchange for participating

in uPSNP work (FDRE, 2016; MoUDH, 2016). Thus, Mekelle, the capital city of Tigray, was one of the pilot projects for the programme in which this study was conducted.

The rPSNP has been the subject of extensive research since its inception. Several studies have evaluated the intended impacts of the programme, including its effect on asset protection of rural households, consumption expenditure, and food security (Amede, 2020; Gebresilassie, 2020; Lukas & Mandado, 2018; Welteji et al., 2017; Andersson et al., 2011; Gilligan et al., 2009), as well as its unintentional effect on the environment, though these include beneficial effects on greenhouse gas emissions (Woolf et al., 2018). Although these studies evaluated the effect of the rPSNP and found beneficial impacts on a variety of outcome variables, including improving rural households' food security, asset protection, and consumption expenditure, they focused on rural households as case studies and overlooked the urban context. Few studies have evaluated the impact of the uPSNP on household income, consumption, and food security outcome variables, particularly focusing on Addis Ababa, the capital of Ethiopia, as the study area (Derso et al., 2021; Tareke, 2022; Tadesse & Gebremedhin, 2022). However, the programme was evaluated at an early stage, and the findings may not have reflected the actual impact of the uPSNP. An effective programme or project evaluation requires adequate implementation time (WHO, 1989). Most importantly, since the inception of the programme (uPSNP), little is known about the role of the uPSNP in closing the gender gap in FIN status among uPSNP beneficiaries, as well as its effect on children's school attendance.

Therefore, this study was conducted by considering the role of household headships while assessing the impact of the uPSNP on urban households' FIN status and its effect on children's school attendance in Mekelle, Tigray, Ethiopia.

This paper is organised into five sections. Following the introduction, the related empirical literature is reviewed in Section 2. In Section 3, the data sources and methodology employed are outlined. The key findings and results are presented in Section 4, while Section 5 covers the discussion. Finally, Section 6 provides a brief conclusion.

2. Empirical Literature Review

Most research on social protection programmes (SPPs) such as the Ethiopian rPSNP has focused on their impact on rural households' food security, consumption expenditure, asset holdings, income, and other outcome variables (Gilligan et al., 2009; Berhane et al., 2013; Berhane et al., 2017; Welteji et al., 2017; Abiye et al., 2019; Amede, 2020; Bahru et al., 2020; Gebresilassie, 2020; Gebresilassie & Nyatanga, 2023; Hailu & Amare, 2022; Tadesse & Gebremedhin, 2022). However, few studies have evaluated the impact of the uPSNP in major cities in Ethiopia since its implementation. For example, Derso et al. (2021) explored the impact of the uPSNP on beneficiary households' FIN status in Addis Ababa, Ethiopia, using cross-sectional data collected from 624 uPSNP beneficiary households in 2019 (June and July). FIN status was analysed using the "household food insecurity access scale (HFIAS)", a tool developed by the "food and nutrition technical assistance (FANTA) scale". They found that 77.1% of sample households were food-insecure. Using logistic regression, they found that household size (more than four members), lack of access to credit, illiteracy of the head of the household, high dependency ratio, and low annual income were the major determinants of households' FIN status. Similarly, Tareke (2022) evaluated the impact of the uPSNP on the income, consumption, and food security of poor households in Addis Ababa, Ethiopia. Cross-sectional data were collected from 560 urban households in 2021. Using the PSM technique, the authors found that the uPSNP enhanced poor households' food consumption expenditure, income, and food security status. Furthermore, using a logistic model, the authors found that monthly income, savings, and access to credit were factors affecting households' food security.

Recent evidence, such as the study by Amosha and Abi (2023), assessed the impact of the uPSNP on food security of urban households in Addis Ababa (Guele sub-city), Ethiopia, using data obtained from 271 sample households and analysed using an ordinary logistic technique based on the "household food insecurity access scale—HFIAS". They found that the majority, 49%, of the households, were "moderately food-insecure", while 26% and 23% of the households were "mildly food-insecure" and "severely food-insecure", respectively. However, they found that only 2% of them were "food-insecure". Furthermore, they found that savings, household size, consumption spending (durable goods), and age were the major factors affecting households' food insecurity. Moreover, although the uPSNP had a beneficial impact on uPSNP beneficiary households' food security status, it did not affect households' livelihoods or asset accumulation. Similarly, Gebresilassie and Nyatanga (2023) examined the impact of the uPSNP on urban households' food security in Tigray, Ethiopia, using data collected in March 2020 from 398 households (168 non-beneficiaries and 230 uPSNP beneficiaries). They found that 22% of uPSNP beneficiaries were food-insecure, while the largest proportion, 36%, of non-beneficiaries were food-insecure. Using propensity score matching (PSM), they found a positive effect of the uPSNP on programme (uPSNP) beneficiaries' income and consumption expenditure. However, they failed to evaluate the impact of the uPSNP on female-headed households' food security because the programme specifically targets urban female-headed households. In addition, they failed to assess the effect of the programme on the school attendance of uPSNP beneficiaries' school-age children.

Abdulahi et al. (2024) assessed the impact of the uPSNP on households' food security and poverty in eastern Ethiopian cities (Jigjiga, Harari, and Dire Dawa) using data obtained from 507 urban households (272 non-beneficiaries versus 235 uPSNP beneficiaries) in 2022. Using the "household food security index; the Foster, Greer, and Thorbecke (FGT) index'; endogenous switching regression (ESR); and propensity score matching (PSM)" estimators, they found that ownership of household, savings, number of children and age were found to influence households' participation in the uPSNP. Moreover, using both ESR and PSM, they found that the uPSNP enhances households' food security and reduces household poverty. Hence, the uPSNP beneficiaries consumed more food calories than non-beneficiaries. However, this study failed to examine the effect of the uPSNP on beneficiaries' children's schooling. In a similar vein, Demsash et al. (2023) assessed the spatial patterns of households receiving food or cash from the productive safety net programme (PSNP) in Ethiopia. A total sample of 8595 households was obtained from the "Ethiopian Demographic and Health Survey" (EPHI, 2019). They found that about 14% of PSNP beneficiary households received food or cash from the program. The spatial distribution was not random for PSNP beneficiaries who received food or cash from the PSNP. Accordingly, households in the Amhara, Addis Ababa, Oromia, and SNNP regions had better access to food or cash. Using "multilevel mixed-effect logistic regression analysis", the results revealed that age (25–44 years), participation in community-based health-insurance, being a female-headed household, and being a rural resident significantly affected households' likelihood of receiving food or/and cash from the PSNP. However, they used aggregate data for both the uPSNP and rPSNP (rural) from the national dataset, which failed to explore the effect of the uPSNP on beneficiaries' food security and children's schooling.

Furthermore, Song and Imai (2019) examined the impact of the hunger safety net programme (KHSNP) on households' multidimensional poverty status. Using difference-in-difference (DiD) and propensity score matching (PSM) estimation techniques, they found that the programme reduces the multidimensionality poverty of beneficiary households when compared to non-beneficiary households. The reduction in multidimensionality of poverty was mainly driven by enhancing programme beneficiary households' food insecurity.

The above-reviewed literature provides valuable, insightful evidence on social protection programmes such as the uPSNP. However, although some empirical studies have explored the overall effect of the uPSNP on food security, evidence is scarce, particularly regarding the effect of the uPSNP on urban households' FIN and educational outcomes in Tigray, particularly in Ethiopia, where the uPSNP is operating. This study differs from the existing literature in several ways. First, earlier research emphasised the overall effect of the uPSNP on households' food security (Derso et al., 2021; Tareke, 2022; Abdulahi et al., 2024; Amosha & Abi, 2023; Gebresilassie & Nyatanga, 2023; Demsash et al., 2023). Second, the majority of the local studies have been conducted outside the region (Tigray) where this study was carried out, except for the recent study by Gebresilassie and Nyatanga (2023). Third, none of these studies have examined the role of the uPSNP in the educational outcomes of uPSNP beneficiary households.

Empirical research on the effect of the uPSNP on female-headed programme beneficiary households and educational outcomes is scarce and indicates the need for further study. To address these knowledge gaps in the literature, we assessed the impact of the urban productive safety net programme on food insecurity and educational outcomes for female-headed households in Mekelle, Tigray, Ethiopia.

3. Methodology

3.1. Data Source and Sample Size

Initially, the uPSNP, an SPP, targeted approximately 10,000 individuals for enrolment in the program. From August to September 2020, a household-level survey (of the heads of household) was conducted in Mekelle, the largest city and capital of Tigray, Ethiopia. Primary cross-sectional data were obtained from both beneficiaries and non-beneficiaries of the uPSNP using a structured questionnaire prepared in English, which was translated into Tigrinya (the local survey language). A four-stage multistage sampling technique was used to obtain the required samples. In the first stage, Mekelle was purposefully selected. This is because Mekelle is among the 11 major cities that have implemented the program. In the second stage, three of the six sub-cities, chosen because they were the first to implement the uPSNP, were randomly selected using a lottery method. In the third stage, two 'Tabias' (the smallest administrative unit) from each sub-city were randomly selected using a lottery method. The heads of households were classified into two strata: beneficiaries of the uPSNP and non-beneficiaries. Finally, 333 households were chosen from each selected 'Tabia' using a systematic random sampling procedure. Urban food-insecure, poor, and vulnerable households, with malnutrition and/or nutritionally vulnerable members, were included or targeted by the uPSNP as programme beneficiaries. However, due to budget constraints, not all eligible urban households were included in the programme. Hence, this study systematically selected beneficiaries of the uPSNP and treated them as the "treatment group". Non-beneficiaries who were eligible but not targeted by the programme were also selected systematically and treated as the "control group". The survey was administered by the researchers, while the data collectors collected data from households. Before undertaking the survey, oral consent was acquired from all participants, and confidential information was maintained. Demographic and socioeconomic information were key items included in the household survey, as indicated in Table 1.

Thus, the computation of sample size was based on Kothari's (2004) formula, which is given as follows:

$$n_0 = \frac{b(1-b)x^2}{m^2} = n_0 = \frac{0.5(1-0.5)(1.96)^2}{(0.05)^2} = 384 \quad (1)$$

where n_0 is the sample size, b is the estimated proportion of households (0.5), x is the number of standard errors corresponding to the 95% confidence intervals (1.96), and m is the marginal error (0.05). Therefore, by using the finite population sample size determination formula, the final sample size was calculated as follows:

$$n = \frac{384}{(1 + \frac{(384-1)}{2955})} = 340 \quad (2)$$

Table 1. Study variables: definitions and measurements.

Variables	Definition	Measurement
Dependent variables	Household participation in the uPSNP (Dummy: uPSNP beneficiaries versus non-beneficiaries).	
Outcome/dependent variables		
Household consumption expenditure	It is the household's consumption expenditure per annum per adult equivalent (continuous).	It is measured in Ethiopian Birr.
Child school attendance	It is a dummy variable.	It is measured by whether a child attends his/her school regularly (all school days) or not.
Independent variables		
Sex of household head	It is the gender of the household head (dummy).	It is a dummy variable, which is categorised as 1 for male-headed households, 0 otherwise.
Age of household head	It is the age of the head of household (continuous).	It is measured in years completed.
Marital status	It is the marital status of the head of household (dummy).	It is a dummy variable, which is categorised as 1 for married households, 0 otherwise.
Family size	It is the family size (continuous).	It is the number of household members per household, which is measured in numbers.
Housing condition	It is the household's housing condition (dummy).	It is a dummy variable, which is categorised as 0 for a household whose house is self-owned, 1 for a household whose house is publicly owned, and 2 for a household whose house is rented.
Access to credit	Access to credit services from microcredit institutions like the Dedebit Micro and Saving Credit in Tigray, Ethiopia (dummy).	It is a dummy variable, which is categorised as 1 for the households that received credit services, 0 otherwise.
Annual income	The household's annual average income (continuous).	It is measured in Ethiopian Birr
Number of employees	The number of employed household members (continuous).	The number of household members who are currently employed
Education of the household head	The education status of the head of household (continuous).	It is measured in years of schooling.
Number of children	The number of school-age children who attend their school regularly (dummy).	It is a dummy variable, which is categorised as 1 for a household whose child attends his/her school regularly, 0 otherwise.

Source: authors' compilation.

Therefore, the final sample size in this study was 333 households, of which 141 (42.34%) were beneficiaries and 192 (57.66%) were non-beneficiaries of the uPSNP. The reason for the reduction in the sample size is that seven observations were dropped during the matching estimator selection. The response rate was 100% because of the respondents' encouragement and the researchers' follow-up.

The enumerators collected data following the World Health Organisation's protocol (e.g., keeping their distance and wearing face masks) to ensure the process would not be affected by the coronavirus pandemic. Hence, except for the delay in data collection and analysis, we assert that the pandemic did not lead to biased results.

3.2. Model Specification

To examine the impact of the uPSNP on household FIN, this study employed three estimators. These include the household food security index, the FGT index (Foster et al., 1984) and propensity score matching (PSM).

3.2.1. Measuring Households' Food Security Status

We used the food calorie intake per adult equivalent (AE) approach to compute the food security status of the households in the sample. In this study, both (daily) food calorie intake and consumption expenditure per adult equivalent (AE) were used as outcome variables measured at the household level. Accordingly, to compute the intensity level of households' food insecurity, the following steps were taken: First, the most consumed basket of food items in the study area that provides 2200 kilocalories (kcal) per AE was selected according to the "Ethiopian Institute of Nutrition and Health Research" (EHNRI, 2000) (Table A1, Appendix A).

Furthermore, the AE conversion variables proposed by Dercon and Krishnan (2000) were used to regulate consumption disparities caused by age and sex differences among household members. In the second step, the food items were weighted using appropriate units of measurement (litres, numbers, and kilograms). In the third step, to compute the kcal of food consumed per individual, the total amount of food consumed by a household in a month was divided by the number of AEs (Table A2, Appendix A). In the fourth step, we added all the food items consumed and reported by each household member in a week and then divided by seven to obtain the equivalent daily calorie intake per AE for each sample household. Finally, 2200 kcal/AE was adopted as the minimal calorie requirement, the food security threshold level, to categorise respondents into either "food-secure households" or "food-insecure households".

Thus, based on the work of Aragie and Genanu (2017), household food calorie intake per AE was computed as follows:

$$C_i = \sum W_{ij} S_j \tag{3}$$

where C_i refers to the number of kilocalories (kcal) consumed by the ith household. W_{ij} is the weight of the jth food item in kilograms consumed by the ith household. S_j refers to the "standardised food energy content" of the jth food item.

3.2.2. Estimation of Households' FIN

Furthermore, to compute the intensity level (magnitude) of households' FIN, we used the FGT index (Foster et al., 1984), which is commonly employed for poverty analysis estimations (Ravallion & Bidani, 1994).

Thus, the food insecurity intensity level was analysed using the FGT index (p_α) as follows:

$$p_\alpha = \frac{1}{n} \sum_{i=1}^{q} \left\{ \frac{z - c_i}{z} \right\}^{\alpha}, \alpha \geq 0 \tag{4}$$

where 'p_α' computes the status of urban households' food insecurity intensity level. 'n' is the total population size and 'q' refers to the number of food-insecure households. 'c_i' measures the food calorie intake per AE of the 'i^{th}' household, which is obtained from Equation (3). 'z' measures the food security threshold (2200 Kcal), while 'α' measures the level of FIN. When the value of $\alpha = 0$ ($\frac{q}{n}$), the number of households is below the food security threshold (p_0). When the value of $\alpha = 1$ (food-insecure depth), the FIN gap meets the minimal calorie requirement (p_1). Finally, when the value of $\alpha = 2$ (FIN severity gap), it captures the gaps and discrepancies among food-insecure households (p_2).

Furthermore, to assess the impact of the uPSNP on children's school attendance, the sample households were also asked whether their school-age children attended school regularly. A child who attended school for more than three days a week was considered a regular school attendee; otherwise, they were not.

3.2.3. Impact Evaluation

- **Logit model estimation: Participation equation**

The propensity score matching (PSM) technique was used to examine the effect of the uPSNP on food security and children's schooling in participating urban households. The PSM technique entails building a statistical comparison group by simulating the likelihood of joining the programme based on observed programme-unaffected parameters. Before evaluating the impact of the uPSNP on food security, the participation equation must first be estimated. Accordingly, the probability of a household participating in the uPSNP was computed using binary logistic regression because the outcome variable was dichotomous (Gujarati, 2003). In this study, the dependent variable (the outcome variable) is household participation in the uPSNP, with a value of 1 if the household participates in the uPSNP and 0 otherwise. The propensity score (PSC), estimated by logistic regression, is the likelihood of specific circumstances calculated based on covariates (Rosenbaum & Rubin, 1983). The covariates were chosen based on theory and previous studies that identified the drivers of uPSNP participation decisions (Gilligan et al., 2009; Welteji et al., 2017; Gebresilassie, 2020; Derso et al., 2021; Gebresilassie & Nyatanga, 2023). Hence, estimating PSCs for both beneficiaries and non-beneficiaries of the uPSNP, identifying the common support regions (CSRs), excluding observations whose estimated propensity falls outside the range of CSRs, and conducting sensitivity analysis are the four basic tasks that must be performed before conducting matching estimation.

Thus, to examine the independent effects of the covariates, we carried out a binary logistic regression model, as specified below:

$$P_r(D_i = 1|x_i) = F(x_i) \tag{5}$$

Using the log-odds, Equation (4) can be rewritten as follows:

$$ln\left(\frac{D_i}{1 - D_i}\right) = \alpha_0 + \alpha_i x_i \tag{6}$$

where D_i refers to whether the household participates in the uPSNP and x_i's is the covariate.

- **Propensity Score Matching (PSM)**

PSM is the best estimator for evaluating how well a programme or an intervention works where uPSNP beneficiary households are not selected at random (Rosenbaum & Rubin, 1983). Hence, the impact of the uPSNP on urban households' FIN status was computed by the difference in outcomes of the uPSNP beneficiary (treated) and non-beneficiary (control) groups through the "average treatment effect on the treated (ATT)"

(Khandker et al., 2009; Masha et al., 2024). Thus, the ATT was computed using the estimated PS as follows:

$$ATT^{PSM} = \in \left(y_{i,\ beneficiary}^{Households} - y_{i,\ non-beneficiary}^{Households} \middle| D = 1,\ P_r(D_i = 1|x_i) \right) \quad (7)$$

$$ATT^{PSM} = \in [\in \left(y_{i,\ beneficiary}^{Households} \middle| D = 1,\ P_r(D_i = 1|x_i) \right) - \in \left(y_{i,\ non-beneficiary}^{Households} \middle| D = 1,\ P_r(D_i = 1|x_i) \right)] \quad (8)$$

where ATT^{PSM} represents the average effect of the programme on treated groups, estimated using propensity score matching (PSM). The term $y_{i,\ beneficiary}^{Households}$ refers to the expected value of households participating in the uPSNP. In contrast, $y_{i,\ non-beneficiary}^{Households}$ refers to the expected value of households not participating in the uPSNP. x_i's represents the set of observed household characteristics. D_i refers to households' participation in the uPSNP (1 if the household is participating in the uPSNP, 0 otherwise). The PSM technique in Equation (8) provides the ATT estimates, which are exactly weighted by the PSC in each group.

Based on Becker and Ichino (2002), the PSM technique should satisfy the "conditional independent assumption—CIA" and the "common support region—CSR—condition", which are briefly stated as follows:

- The CIA states that the outcome variables of interest should be independent of programme participation, given observable household characteristics (x_i). D $\perp x_i \mid P_r(D_i = 1|x_i)$
- The CSR condition states that for all x_is, there is a positive likelihood of either participating ($D = 1$) or not participating in a given programme. Hence, this guarantees that there are non-participant counterparts for every programme participant.

$$y_{i,\ beneficiary}^{Households},\ y_{i,\ \ non-beneficiary}^{Households} \perp D \mid x_i$$

Although various tests can be used to select matching estimators (kernel, calliper, and nearest neighbour), the most preferred estimator is one that yields the same average mean of covariates for both treated and controlled groups (balancing test) (Caliendo & Kopeinig, 2008), has the smallest value of "pseudo-R2" (Leuven & Sianesi, 2018), retains the largest sample size (matched), and has an insignificant likelihood ratio test (LR Chi2) after matching (Smith & Todd, 2005). Therefore, an estimator with the largest matched sample size, the smallest value of "pseudo-R2", and an equal mean test is the most preferred estimator. Accordingly, in this study, the nearest neighbour (3 NNE) was chosen as the best matching estimator (Table A3).

3.3. Hypothesis Development

To address these research gaps, the following two interconnected research hypotheses are proposed.

The overall hypothesis is that the uPSNP has a strong beneficial effect on uPSNP beneficiary households' food security, while the specific or sub-hypotheses are as follows:

Hypothesis 1. *The uPSNP has a stronger beneficial impact on female-headed uPSNP beneficiary households' food security than on their male-headed counterparts.*

Hypothesis 2. *The uPSNP also has a strong beneficial impact on children's school attendance for uPSNP beneficiary households when compared to non-beneficiary households' children.*

To address the stated hypotheses, an adequate sample size of uPSNP and non-uPSNP households was employed using cross-sectional survey data. Hence, the information

obtained from the sample households through structured questionnaires was suitable and adequate for examining the hypotheses stated above.

Similarly, in most cases, data are not gathered through randomised surveys, but rather through non-randomised observational studies. Admission of individuals to the treatment and control groups in observational studies is not always possible. Using these observational datasets, Rosenbaum and Rubin (1983) introduced a PSM estimator to decrease bias when calculating treatment effects. As indicated in Figure 1, PSM is the most effective technique for evaluating treatment effects when programme participation is not random (Khandker et al., 2009; Rosenbaum & Rubin, 1983). The main advantage of using PSM is that it can eliminate selection bias (Heckman & Leamer, 2007). Moreover, in the absence of baseline data before the onset of the program, as in our case, PSM was the most appropriate impact estimation technique. PSM was used to establish counterfactual relationships between households participating in the uPSNP and those which are not. Hence, the average treatment effect of uPSNP beneficiaries (ATT) is defined as the change in the outcome variables between the programme participants and their counterfactuals. The term 'counterfactual' alludes to what would have happened if programme participants had not participated (Rosenbaum & Rubin, 1983; Khandker et al., 2009). Furthermore, the FGT index is the most appropriate estimation technique for analysing household food security (Foster et al., 1984). It uses countries' calorie intake measures (for example, 2100 kcal in Ethiopia's case) as a food security threshold to identify households' food security status. Hence, the combined techniques strengthen the robustness of the results of this study through triangulation.

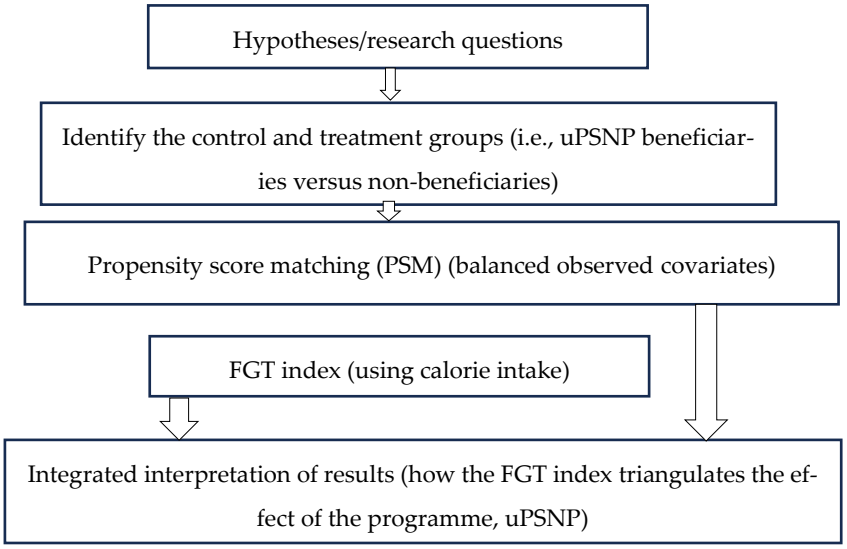

Figure 1. Analytical framework. Source: Authors' compilation.

4. Results

4.1. Description Statistics

Table 2 provides the descriptive statistics of the sample households. Of the 333 samples, 141 were beneficiaries of the uPSNP and 192 were non-beneficiaries. On average, the household size and age of the sample household head are 2.61 and 42.95, respectively. On average, the sample household earns ETB 86,596 per annum, with a considerable disparity between uPSNP beneficiaries and non-beneficiaries. More than half (54.68%) of the sample were unmarried (see Table 2). The majority of the sample (77.9%) were women, with men accounting for the remaining 22.9%. The average annual income of uPSNP beneficiaries was ETB 77,267, while that of non-uPSNP households was ETB 73,056. This figure implies

that the uPSNP beneficiaries demonstrated a saving culture and participated in income-generating activities such as engaging in petty trading. Importantly, only 0.01% of the sample households, that is, from the non-uPSNP beneficiaries, owned their own houses, while the largest 99.99% of the sample households did not own their private houses.

Table 2. Descriptive statistics of sample households.

Continuous Variables	**Total Sample HH**		**uPSNP HH**		**Non-uPSNP HH**		**Difference in Means**	***t*-Value**
	Mean	**Std.**	**Mean**	**Std.**	**Mean**	**Std.**		
Age of household head	42.95	7.98	39.96	8.24	43.67	7.65	−3.71	−1.34
Education of household head	2.43	3.21	3.53	1.64	2.12	2.18	1.41 *	2.15
Family size	2.61	2.65	3.57	1.35	2.41	1.23	1.16 *	1.97
Number of employees	2.10	1.27	1.03	0.32	2.02	0.75	0.99 *	1.78
Annual income	86,596	3.29	77,267	2.02	73,056	4.32	4211 ***	3.21
Categorical Variables	Category		Total sample HH		uPSNP HH		Non-uPSNP HH	χ^2
			Freq.	%	Freq.	%	Freq.	%	
Sex of household head	Female		257	77.90	114	43.80	146	56.20	3.15 **
	Male		76	22.90	28	36.80	48	63.20	
Marital status	Married		151	45.32	68	46.67	84	53.50	5.57 ***
	Unmarried		182	54.68	71	39.23	110	60.77	
Housing condition	Self-owned		3	0.01	0	0.00	2	0.01	1.48
	Public owned		1	0.30	0	0.00	1	0.00	
	Rented out		329	99.90	138	41.69	190	57.40	
Access to credit	Received credit		248	74.90	104	42.80	142	57.20	6.05 **
	Not received credit		85	25.10	34	40.06	51	60.04	

Source: authors' computation. *** $p < 0.01$, ** $p < 0.1$, and * $p < 0.05$. Std. = standard deviation; Freq. = frequency; HH = households.

4.2. Propensity Score Estimates

Table 3 shows the estimates of the logistic regression approach used to estimate the P SC, which indicates the factors that influence household involvement in the uPSNP. The "pseudo-R2" estimate was 0.3723, which is low and indicates that the allocation of the programme has been random (Pradhan & Rawlings, 2002; Caliendo & Kopeinig, 2008). The results reveal that factors such as the gender of the household head, education status, household size, access to credit, average annual income, and number of employed household members significantly determine the propensity of households to participate in the uPSNP.

Figure 2 illustrates the estimated PSC of the two groups (treated or uPSNP beneficiaries, and untreated or non-beneficiaries). The bar graphs below the horizontal line show the PSC estimates for the untreated groups (non-beneficiaries), while the bar graphs above the horizontal line show the PSC estimates for the treated groups (uPSNP beneficiaries). Accordingly, the estimated PSC lies between 0.0571 and 0.8971 for beneficiaries and between 0.0064 and 0.8621 for non-beneficiaries. Thus, the CSR lies between 0.0571 and 0.8621, implying that observations whose estimated PSs are less than 0.0571 and greater than 0.8621 were not considered for the matching analysis. Accordingly, seven observations (three from the uPSNP group and four from non-beneficiaries) were dropped from the

matching estimation. Thus, out of the total sample households (340), 333 were used for the final analysis.

Table 3. Estimates of propensity scores by a logistic regression technique (n = 333).

Covariates	Coef.	Std. Err.	p-Value
Sex of head of household (female)	1.255 ***	0.273	0.000
Marital status of head of household (married)	0.030	0.206	0.886
Family size	0.706 ***	0.150	0.000
Household housing condition: public-owned	−0.426	0.275	0.212
Household housing condition: rented out	0.006	0.005	0.258
Access to credit (yes)	−1.854 ***	0.213	0.000
Age of head of household	−0.023	0.015	0.123
Annual average income	−2.546 ***	0.698	0.000
Number of employed household members	−0.676 ***	0.242	0.005
Education status of head of household	−0.043	0.042	0.307
Constant	5.552	1.254	0.000

Source: authors' computation. Pseudo-R2 = 0.3723; prob > Chi2 = 0.000; *** $p < 0.01$.

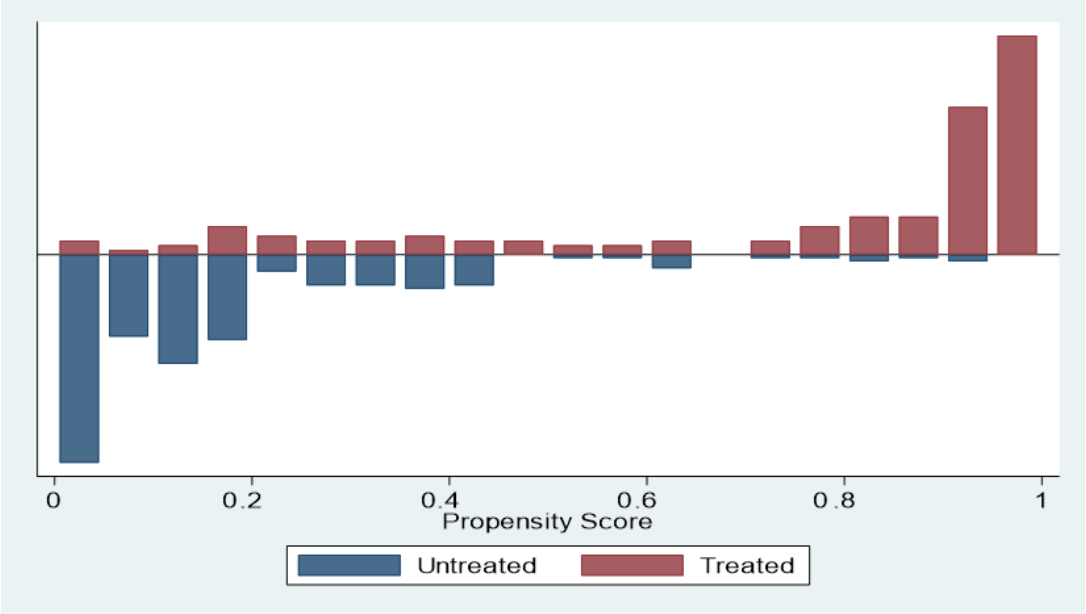

Figure 2. The distribution of the propensity scores for the treated and untreated groups. Source: authors' computation.

Furthermore, as shown in Table 3, the findings of this study indicate that the tendency for households' participation in the uPSNP will increase with family size and for households headed by women. A household with a large size has a higher propensity to participate in the uPSNP than a household with a relatively small size. Similarly, the probability of a household participating in the uPSNP tends to increase when it is female-headed. However, the likelihood of participation in the uPSNP falls for a household with access to credit services, such as microcredit institutions, employed household members, and an annual average income. As the primary goal of the logistic model is to compute the PSC, the computed coefficients are analysed to a minimum. Thus, this study focused on the analysis of ATT outcomes.

4.3. Household's Food Security Status

This study aimed to explore the effect of the uPSNP on urban households' FIN status. A household that consumes less than the minimum calorie requirement (i.e., 2200 kcal

per day per AE) is considered food-insecure, whereas a household that consumes at least 2200 kcal per day per AE is considered food-secure (EHNRI, 2000). As shown in Table 4, the findings reveal that 60% of the sample belonged to food-secure households. Of this total, about 56.7% and 43% of beneficiaries of the uPSNP and non-beneficiaries, respectively, were food-secure. Furthermore, of the total food-secure uPSNP beneficiaries, the majority (51%) were female-headed households, while about 6% were male-headed uPSNP beneficiary households. Similarly, about 39.94% of the sample households experienced FIN, of which the largest food-insecure households (79.7%) were non-beneficiaries, while the lowest food-insecure households (18.05%) were beneficiaries of the uPSNP.

Table 4. Summary of households' food security status based on Kcal per AE.

Food Security Status	uPSNP Beneficiaries			Non-Beneficiaries			Total
	MHH	FHH	Sub-Total	MHH	FHH	Sub-Total	
Food-secure	12 (5.9)	102 (50.8)	114 (56.7)	16 (8.5)	70 (34.8)	86 (43)	200 (60.06)
Food-insecure	16 (12.0)	11 (8.3)	27 (18.05)	31 (29.2)	75 (70.8)	106 (79.7)	133 (39.94)
	χ^2 = 6.002 ***		141 (42.34)	χ^2 = 1.267		192 (57.66)	333 (100)

Source: authors' computations. *** $p < 0.01$; values in parentheses are percentages. MHH: male-headed households; FHH: female-headed households.

Importantly, a notable disparity was seen in the proportion of uPSNP beneficiaries headed by women compared to those headed by men. Accordingly, the majority of the uPSNP beneficiaries headed by women (50.8%) were more food-secure than the non-beneficiaries of the uPSNP headed by men (5.9%) (Table 4). Furthermore, as illustrated in Table 5, most of the sample households (68.84%) indicated that their overall consumption expenditure was much better after participating in the uPSNP than when they were not participating in the program. Very few sample households (10.87%) indicated that their consumption expenditure remained unchanged.

Table 5. uPSNP beneficiaries' consumption expenditure (before and after joining the uPSNP).

Status	Frequency	Percentage	Cumulative Percentage
Much better today	19	13.47	13.47
Better today	95	67.37	80.84
The same	16	11.35	92.19
Worse today	5	3.55	95.74
Much worse today	4	2.84	98.58
Do not know	2	1.42	100.00
Total	141	100	

Source: authors' computation.

4.4. The Impact of the uPSNP on Households' Food Security

As shown in Table 6, the smallest value of "pseudo-R2" as well as the insignificant LR Chi2 test confirm that after matching, both groups, beneficiaries of the uPSNP and non-beneficiaries, have the same distribution in the covariates. This implies that the characteristics of the uPSNP beneficiary and non-beneficiary groups have been balanced during a matching procedure, which confirms that the evaluation of the impact of the uPSNP on households' food security compares two groups with similar observed characteristics. The analysis allows us to match observed outcomes for uPSNP beneficiary (treatment) with non-beneficiary (control) groups that share CSRs.

Table 6. Estimates of Chi-square test for matched and unmatched samples.

Sample	Psuedo-R2	Likelihood Ratio Test (LR Chi2)	$p >$ Chi2
Matched	0.317	126.31	0.000 ***
Unmatched	0.029	11.24	0.361

Source: authors' computation. *** $p < 0.01$.

The estimated ATT denotes the effect of the uPSNP on urban household food security, as shown in Table 7. PSM reveals that the uPSNP could decrease urban households' FIN status. The results indicate that the uPSNP has a strong positive effect on the food security of uPSNP beneficiaries in Mekelle, urban Tigray, Ethiopia, as it increases households' calorie intake and improves their food security status. Accordingly, the average calorie intake for beneficiaries of the uPSNP and non-beneficiaries was 2469.964 and 2102.317 kcal per day per AE, respectively. The average disparity in daily calorie consumption between beneficiaries of the uPSNP and non-beneficiaries was 367.647 kcal per day per AE. In other words, the programme raised beneficiaries' calorie consumption by 15% compared to that of non-beneficiaries. This study provides substantial evidence that participation in the uPSNP improves calorie acquisition among beneficiaries.

Table 7. Estimates of average treatment effect on the treated for the matched groups.

Effects of the uPSNP on Outcome Variables	uPSNP Beneficiaries	Non-Beneficiaries	Difference	Std. Err	*t*-Value
Daily calorie intake	2469.964	2102.3170	367.647 *	159.55	1.89
Average consumption expenditure per adult equivalent	62,949.520	52,365.610	10,583.9 **	83.92	2.46
Primary school	0.837	0.690	0.147 **	21.56	1.98
Secondary school	0.816	0.396	0.420 ***	142.87	2.87

Source: authors' computations. *** $p < 0.01$, ** $p < 0.1$, and * $p < 0.05$.

Furthermore, the annual average consumption expenditure for beneficiaries of the uPSNP and non-beneficiaries is ETB 62,949.52 and ETB 52,365.61, respectively. This implies that the uPSNP increased beneficiaries' consumption expenditure by 19.8% compared to that of non-beneficiaries' food-insecure urban households.

This study also evaluated the effect of the uPSNP on a child's school attendance. We begin by examining the average number of children attending school and comparing the average attendance of children of uPSNP beneficiaries to that of children of non-beneficiaries. The primary determinants of school attendance are parental attitudes towards education and their belief that education would enhance their children's employment opportunities. In this study, the children of beneficiaries of the uPSNP could attend school more often than the children of non-beneficiaries (Table 7). The average number of primary school children attending school was estimated at around 84 and 69% for uPSNP beneficiaries and non-beneficiaries, respectively, while for secondary school children, it was 82 and 40% for uPSNP beneficiaries and non-beneficiaries, respectively. A child of a uPSNP beneficiary household is more likely to attend school, both in primary and secondary school, than a child of their non-beneficiary counterparts. This implies that the uPSNP enabled more uPSNP beneficiaries to attend school than non-beneficiaries.

5. Discussion

This study examined the impact of the social protection programme uPSNP on household FIN and children's school attendance in Mekelle, Tigray, Ethiopia. The results indicate

that over half of the sample households were food-secure. This implies that the number of food-insecure uPSNP beneficiaries is much lower than that of the non-beneficiaries. Hence, the uPSNP (social protection programme) enabled urban poor female-headed households to be food-secure through their participation in or benefit from the programme. Hence, the results of this study confirm our first hypothesis that the uPSNP has a strong positive and significant effect on female-headed uPSNP beneficiary households' food security level compared to that of their male-headed counterparts. The majority of beneficiaries of the uPSNP led by women had greater food security than non-beneficiaries of the uPSNP led by their male counterparts. This implies that although the uPSNP enhances the overall food security status of uPSNP beneficiaries (56.7%), the uPSNP improves the food security of female-headed uPSNP beneficiary households more than male-headed non-uPSNP beneficiary households. This finding confirms those of previous studies, such as those by Abay et al. (2023), Belete and Bayu (2023), Mustafa et al. (2023), Hailu and Amare (2022), Tadesse and Gebremedhin (2022), Tareke (2022), Amede (2020), Gebresilassie (2020), Bahru et al. (2020), Abiye et al. (2019), Song and Imai (2019), Berhane et al. (2017), and Welteji et al. (2017), who found that the safety net programme enabled beneficiaries of the programme headed by women to enhance their food security status more than the non-beneficiaries of the programme headed by men. This implies that the uPSNP significantly enhances the food security status of uPSNP beneficiaries headed by women. On the contrary, this finding is not in line with those reported by Derso et al. (2021), who found that 75% of the beneficiaries of the uPSNP experienced FIN in Addis Ababa, Ethiopia.

This study found substantial evidence that participation in the uPSNP improves the calorie intake of beneficiaries of the uPSNP, which improves urban households' food security status. The findings of this study are in complete agreement with those of Abay et al. (2023), Mustafa et al. (2023), Hailu and Amare (2022), Tadesse and Gebremedhin (2022), Tareke (2022), Derso et al. (2021), Amede (2020), Gebresilassie (2020), Bahru et al. (2020), Abiye et al. (2019), Song and Imai (2019), Berhane et al. (2017), and Welteji et al. (2017). However, this is contrary to earlier studies on the effect of the uPSNP on calorie acquisition. In this regard, Gilligan et al. (2009) found no difference in the growth rates of calorie acquisition between participants and non-participants in the programme from 2006 to 2008. Similarly, Berhane et al. (2013) found no evidence of changes in programme participants' caloric intake. Furthermore, the average annual consumption expenditure of beneficiaries of the uPSNP was higher than that of non-beneficiaries. This implies that the uPSNP has enhanced the consumption expenditure of programme beneficiaries in comparison to a similar group of poor urban households that are not beneficiaries. Abay et al. (2023), Hailu and Amare (2022), Tadesse and Gebremedhin (2022), Tareke (2022), Derso et al. (2021), Amede (2020), Gebresilassie (2020), Bahru et al. (2020), Abiye et al. (2019), Song and Imai (2019), Berhane et al. (2017), Welteji et al. (2017), and Gilligan et al. (2009) agreed with the findings of this study. However, this finding differs from that of Bahru et al. (2020), who found that SPPs only increased the frequency of child meals while having no other positive effect on SPP beneficiaries' food security.

Importantly, this study also examined the impact of the uPSNP on children's school attendance. The results of this study confirm our second hypothesis that the uPSNP also has a positive and significant impact on children's school attendance for uPSNP beneficiaries when compared to that of non-beneficiaries' children. Children of uPSNP beneficiary households attended their school more regularly in both primary and secondary school than children of their non-beneficiary counterparts. This is because the uPSNP beneficiaries benefited from the uPSNP, resulting in sending their school-age children to both primary and secondary schools. According to Berhane et al. (2017), the primary determinant of school attendance is parental attitudes towards education and their belief that

education enhances their children's employment opportunities. Accordingly, children of poor households engage in vendor shopping activities (short-term benefits) as an immediate source of income to support their parents. In this study, children of beneficiaries of the uPSNP had a higher probability of attending both primary and secondary school than children of their non-beneficiary counterparts. Hence, children of beneficiaries of the uPSNP had higher school attendance both in primary and secondary school than the children of non-beneficiary counterparts. This implies that uPSNP beneficiary households generated income that supported their children's education and school expenses from participating in the programme (uPSNP). Our findings are consistent with those of earlier research conducted by Abay et al. (2023) and Berhane et al. (2017). According to their findings, the children of beneficiaries of the uPSNP attend school more often than the children of non-beneficiaries. This implies that the programme enables uPSNP beneficiaries to send their children to school. The programme (uPSNP) enabled beneficiary households to reduce their financial constraints, allowing them to invest in education. As parents' financial burden lessens, they allow their children to attend school more frequently and regularly (Abay et al., 2023; Berhane et al., 2017).

However, since the inception of the programme (uPSNP), little is known about the role of the uPSNP in closing the gender gap in FIN status among uPSNP beneficiaries, as well as its effect on children's school attendance in Tigray, Ethiopia. Regardless of the existence of limited studies in Ethiopia, focusing on rural parts of the country with great focus on the impact of the productive safety net programme (rural) on households' food security is an important next step.

Limitations of This Study

This study had some limitations that should be acknowledged. First, the collection of data was constrained by limited resources, as this study was geographically restricted to one specific city (Mekelle) among the 11 cities that have implemented the uPSNP in Ethiopia, which might influence the scope of the findings pertaining to the impact of the uPSNP on households' food security and educational outcomes. Second, the self-reported information provided by the sample households on income and food consumption expenditure might lead to measurement bias, as households might overestimate or underreport certain details. Using panel or longitudinal data would not only allow researchers to observe causal dynamics but also reduce the risk of misreporting. Third, this study's cross-sectional design limits its capacity to draw definitive causal inferences. Finally, this study overlooked the impact of the uPSNP on household health outcomes, which might affect household productivity. Future research should aim to address these limitations by expanding the geographical coverage, addressing the issue of self-reporting in areas or cities where the uPSNP is operating, and evaluating the role of the uPSNP on households' health outcomes.

6. Conclusions and Recommendations

This study aimed to examine the effects of the uPSNP on food insecurity in urban households and children's school attendance in Tigray (Mekelle), Ethiopia. The findings revealed that a considerable number of urban households in Mekelle, Tigray, Ethiopia were food-secure due to participation in the uPSNP. Hence, this study concluded that being beneficiaries of the uPSNP enabled urban households to enhance their food security. The majority of uPSNP beneficiaries (68%) were food-secure. Most importantly, the results indicated that higher food security levels were observed among uPSNP beneficiary households headed by women compared to beneficiaries of the uPSNP headed by men. This implies that the uPSNP plays an important role in minimising food insecurity in urban female-headed households by enhancing food consumption and nutritional outcomes.

Furthermore, the programme enabled beneficiaries of the uPSNP to send school-age children to school more often than non-beneficiaries. Hence, the results of this study confirm our hypothesis that the uPSNP contributed significantly to the livelihoods of the urban female-headed uPSNP beneficiaries by enhancing their food security status. Moreover, the uPSNP enabled beneficiaries' school-age children to attend school in both primary and secondary schools more regularly than non-beneficiaries.

The findings of this study can help to facilitate the expansion of the uPSNP to additional Ethiopian urban areas where the programme has not yet been implemented, contributing to the overall reduction of national FIN. This expansion may be carried out in cooperation with non-governmental organisations and governments to ensure a sustainable approach to improving the food security status of poor urban households.

The policy implications based on the findings of this study are indicated as follows:

- Policymakers and stakeholders should focus on improving uPSNP implementation and ensuring that local governments include more female-headed households in the uPSNP to improve their food security, thereby reducing overall national food insecurity and achieving long-term sustainable development goals.
- Non-governmental organisations and governments should strengthen and scale up the existing uPSNP as an improvement intervention to other cities and towns in the region (Tigray). This will help poor urban households consume more food items while also enhancing their food security status and contributing to the achievement of the UN "Sustainable Development Goal" to eliminate all forms of malnutrition.
- The programme should also target female-headed households that have more underage children. Including the findings of this study and many other empirical studies, family size determines household food security. Hence, the inclusion of such female-headed households in the programme could enable them to send their children to school. As a result, children could have a bright future, which, in turn, allows their families to benefit from their children's long-term educational outcomes, having improved and sustained food security.

As programme evaluation studies vary in breadth and focus, this study recommends undertaking more research with a wider scope and in diverse places to acquire a better understanding of the effectiveness of the uPSNP and its impact on health-related outcomes.

Author Contributions: Y.H.G. and T.H.A. contributed to the conception and design of the study, data review, analysis, interpretation, manuscript drafting, and revisions. G.B.T. and S.M. contributed to the literature review, data analysis, manuscript writing, and revisions. All authors approved the final version of the manuscript and agreed to be accountable for all aspects of the research. All authors have read and agreed to the published version of the manuscript.

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Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki, and approved by the ethical review committee (HRERC) of the college of health Sciences and Specialized referral hospital (CHS-SRH), Aksum University, Tigray, Ethiopia (IRB Number: 054/2024). The ethical approval was obtained from the corresponding author's affiliation. Verbal consent was obtained from each participant prior to the interaction.

Informed Consent Statement: Informed consent was obtained from all participants involved in the study.

Data Availability Statement: Data supporting the conclusions of this study may be supplied upon request.

Conflicts of Interest: The authors declare no conflicts of interest.

Appendix A

Table A1. Basket of food items that provides 2200 kcal PAPD selected while computing food security status.

Food Items	Kg/Week/AE	Kcal/Kg	Kcal/Week/AE	Kcal/Day/AE	Share (%)	Average Price	Food Expense
'Taff'	1.31	3657	4725	236.54	12.13	45.00	14.35
Maize	4.56	3871	19,378	961.76	38.62	28.50	21.25
Wheat	5.34	4764	7865	335.86	18.81	28.00	17.71
Figure millet	3.12	4489	8976	367.65	15.23	17.00	13.20
Potato	0.76	1287	765.99	32.87	1.67	1300	2.45
Tomato	0.29	484	149.86	4.88	0.26	19.90	2.53
Pepper	0.20	179	98.68	1.58	0.07	87.90	8.41
Oil	0.26	9874	2478.9	111.32	5.74	87.23	5.53
Onion	0.34	4678	356.67	15.56	0.73	24.67	3.13
Sugar	0.24	4256	1278.45	46.74	3.23	2.98	2.31
Bean	0.21	5432	267.89	14.84	0.56	24.10	0.65
Pea	0.09	5567	298.34	17.56	0.62	23.45	0.57
Lentil	0.17	5647	567.76	22.71	1.12	78.56	2.73
Meat	0.11	1567	172.87	6.98	0.25	342.00	2.45
Milk	0.24	653	288.98	13.78	0.53	31.52	1.86
Egg	0.13	75	18.56	0.34	0.02	45.00	0.21
Butter	0.02	8752	76.00	9.03	0.41	200.00	1.73
	17.39	65,232	47,762.95	2200	100		101.07

Source: adapted from Dercon and Krishnan (2000). Note: PAPD: per adult equivalent per day.

Table A2. Calorie intake (nutrition) requirement based on an equivalent scale.

Age (in Years)	Gender		Age (in Years)	Gender	
	Female	Male		Female	Male
0–1	0.33	0.33	10–12	0.78	0.88
1–2	0.46	0.46	12–14	0.84	0.96
2–3	0.54	0.54	14–16	0.86	1.06
3–5	0.62	0.62	16–18	0.86	1.14
5–7	0.70	0.74	18–30	0.80	1.04
7–10	0.72	0.84	30–60	0.82	1.00
			>60	0.74	0.84

Source: adapted from Dercon and Krishnan (2000).

Table A3. Estimates of matching estimators.

Estimators	Sample Size (Matched)	Pseudo-R2	Balancing Test
Nearest neighbour estimator (NNE): 3NNE	331	0.027	11
: 2 NNE	325	0.036	10
: 1 NNE	328	0.039	10
Kernel: 0.5 bandwidth	315	0.271	7
0.1 bandwidth	321	0.352	6
Calliper: 0.5	271	0.025	10
0.1	277	0.019	11

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