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Research article

Measuring food insecurity: Food Affordability Index as a measure of territorial inequalities

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Abstract. The devastating economic and social impact of COVID-19 and the war in Ukraine has exacerbated poverty and food insecurity, making it harder for people to access food. Based on a multidimensional understanding of food insecurity, this study focuses on one of the most challenging dimensions for affluent societies, namely, the economic access to food. Therefore, the research aims to develop an innovative Food Affordability Index (FIA) that captures the inter-territorial inequalities and critical problems created by the economic disruptions in the local food system that prevent people from eating healthy. The index is based on a survey of the prices of products suitable for healthy eating in thirty shops in Rome, Italy. A distinction was made both by the type of distribution channel (e.g. discount and supermarket) and by the area in which the survey was conducted, i.e., the 15 municipalities of Rome. This study sheds light on the problem of food insecurity and highlights areas where households are far from an ideal healthy diet. Understanding the spatial distribution of economic inequalities in access to healthy food seems crucial for the implementation of targeted policies and programmes to address this problem, which is increasingly structural in affluent societies.

Keywords: food insecurity, food affordability index, economic access, healthy diet, territorial inequalities.
JEL codes: I32, Q18, Z13.

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HIGHLIGHTS

- Poverty and food insecurity are increasing dramatically even in affluent societies.
- People in economic hardship limit their spending on food in terms of quantity and quality.
- The food affordability index provides information on how far people are from a healthy diet.
- The territorial distribution of economic inequalities in access to healthy food is crucial for the implementation of targeted interventions.

INTRODUCTION: POVERTY AND FOOD INSECURITY IN AFFLUENT SOCIETIES

In Minima Moralia (1951: 54), Theodor Adorno questions the end of emancipated society, suggesting that "*It would be advisable to think of progress in the crudest most basic terms: that no one should go hungry anymore*". Unfortunately, while we live in a world characterized by unprecedented abundance, i.e., overproduction and plenty of food availability (Stringer, 2016), we also live in a world characterized by deprivation, hunger, poverty, and overcoming these problems is an essential part of the development process (Sen, 2001).

As Campiglio and Rovati (2019) note, we therefore live in what they call as the "paradox of the scarcity in the abundance", in other words, the overlapping economic crises (2007 and 2013), rising unemployment, social retrenchment, the devastating economic and social impact of the Covid 19 pandemic and the recent war in Ukraine (CGIAR, 2022) have combined to produce high rates of poverty, social exclusion, and food insecurity even in affluent societies.

According to recent surveys (FAO, 2021, 2022; Eurostat, 2022; UNICEF, WHO and World Bank Group, 2021; Carrillo-Alvarez *et al.*, 2021; Gundersen *et al.*, 2021), food insecurity has increased significantly in recent years, affecting about 8% (in some areas as much as 10.5% of the population) of the European and North American populations experiencing severe to moderate food insecurity (FAO *et al.*, 2022). Several research works (HLPE, 2023; Lambie-Mumford and Silvasti, 2020; Swinburn *et al.*, 2019; Loopstra, 2016; Maino *et al.*, 2016) clearly indicate that people, who are in economic hardship and therefore have insufficient sources of income (i.e. working poor) or suddenly lose them (a circumstance that can be exacerbated by the absence or scarcity of public income support mechanisms), tend to reduce their spending on food. Indeed, food expenditure proves to be more elastic than other expenditures such as rents, mortgages, and utility bills, as it can be reduced not only quantitatively (i.e., by reducing the number of meals eaten per day) but also, and more importantly, qualitatively[1], with a significant impact on people's health (Goudie, 2023; Cattaneo *et al.*, 2023; Marino *et al.*, 2022).

When these strategies prove insufficient to curb food deprivation, families are forced to rely on the support of family social networks (O'Connell and Brannen, 2021; Cabot, 2018; Papadopoulos and Roumpakis, 2013) or, in the case of a "severe emergency", to apply for food aid (i.e., food vouchers, food parcels or meals from soup kitchens), which is considered the first rough measure of poverty and food insecurity (O'Brien, 2014; Poppendieck, 2014; Purdam *et al.*, 2016; Riches, 2002).

On the one hand, this research is in line with the literature that analyses food insecurity as one of the multiple symptoms of poverty and thus as a lack of capabilities (Sen, 2001), i.e., a lack of security, dignity and materialized inequality that deprives citizens of their rights (Appadurai, 2014). According to the recent HLPE report (2023) *Reducing inequalities for food security and nutrition* (which confirms the thesis of Smith *et al.*, 2017), the factors associated with an increased likelihood of food insecurity are indeed: low levels of education, weak social ties, lower social capital, and low household income.

On the other hand, it is consistent with studies that aim to go beyond the number of food aid recipients, and instead, examine food insecurity to identify not only the most vulnerable social categories, but also the geographical areas and neighbourhoods characterized by critical access to food resources available on the market[2]. This results in recommendations for active social policies to address the root causes of a problem that is increasingly structural in nature.

This article explores the conceptual and measurable aspect of food security through a local case study, using Rome as a pilot case. The main objective is to develop an index of healthy food affordability that captures the inter-territorial inequalities and critical problems created by the economic disruptions in the local food system that prevent people from eating healthy. More specifically, this study aims to identify not only the cost of healthy eating, but more importantly, how far families are from an ideal healthy diet. It proves to be a crucial study for the implementation of targeted policies and allows science and policy to meet and share knowledge.

The relevance of this study lies in its locally focused approach. Most official surveys on poverty and food insecurity take place at the national or regional level (e.g., the Eurostat indicator on the number of protein meals or the ISTAT[3] indicator on household food insecurity). On the contrary, in our research, the local and territorial dimension is considered relevant to the study (Felici *et al.*, 2022; Borrelli and Corti, 2019; Daconto, 2017; Sganzetta and Tricarico, 2018; Geurden *et al.*, 2022). This provides insight into the socio-economic characteristics of each context and the spatial distri-

[1] A quality diet is a healthy, balanced, diversified, and nutritious diet (FAO, 2020; CREA, 2018; Willett *et al.*, 2019).

[2] In a previous study, we coined the term *blacked-out food area* (Bernaschi *et al.*, 2023), which are defined as areas where people are socially excluded and therefore cannot enjoy the same substantial food freedoms as people in other areas. These are, therefore, areas where there is a simultaneous lack of food outlets, affordability is compromised and there are no solidarity networks that distribute free food.

[3] The Italian National Institute of Statistics.

bution of inequalities and provides information and knowledge for designing tailored interventions. In this perspective of analysis, "place" becomes, as Sonnino *et al.* (2016) note, an "active mediator" that dynamically holds together different physical, social, and cultural elements (Sonnino and Milbourne, 2022: 917; Casey, 1996).

The article is divided into three main sections: the first looks at the defining aspect and challenge of measuring food insecurity issues; the second describes the methodology of a pilot healthy food affordability index. Finally, the third section tests the index using the case study of Rome and shows how food insecurity varies at the territorial level and over time. It highlights the most critical and vulnerable areas where households are far from ideal healthy diets.

1. THEORETICAL FRAMEWORK: USE OF THE CONCEPT OF FOOD INSECURITY AND MEASUREMENT

1.1. The challenge of definition

Food insecurity is a problem that cannot be solved with simple measures. It must be addressed in innovative ways and therefore requires, as Mazzuccato (2021) would put it, "strategic missions" capable of inspiring and stimulating the imagination. To do this, it is first necessary to focus on the definition of the problem and how it affects the subsequent measurement and resulting actions to solve it (Stiglitz *et al.*, 2009; Hamilton *et al.*, 2006).

In terms of definition and problematization, the debate on poverty and food insecurity in Italy began mainly in the 1950s, in the midst of the post-war reconstruction period, when the country was characterized by a backward economy (especially in agriculture) and by unemployment and poverty (especially in the South).

The most important social surveys of this period were two: *the Parliamentary Inquiry on Poverty and the Means to Combat It* in 1951[4] and *the Nutrition Survey of the National Institute of Nutrition of the National Research Council* (CNR) in 1954. The latter promoted, in particular, a broad study of the relationship between food consumption and the state of health of the population in small towns in central and southern Italy.

The study took a multidimensional approach to food insecurity and placed it within a broader approach to poverty as a lack of capabilities (Sen, 2005). In fact, it consisted of four main phases: Food Consumption Monitoring, Household Economic Conditions, Housing Conditions and finally Household Health Surveys.

The survey showed the negative impact of poor nutrition on household health and child growth. The isolation (lack of infrastructure and transport) of the small communities condemned the population to poor nutrition and uniform consumption (the population lived only on local food). The fight against poverty and food insecurity was seen in terms of activation and empowerment. In fact, the survey aimed not only to promote measures to increase food consumption, but also to identify the initiatives that could be useful for the population to obtain new employment opportunities and thus improve their living conditions.

Although the "food problem" is deeply rooted in history, it was only in 2009 that a state of food deprivation began to be defined as "food poverty", at the very time when the number of food banks and their beneficiaries increased after the economic crisis of 2007-2008, when the rise in poverty and unemployment was accompanied by social cuts (Rovati and Campiglio, 2009; Pesenti, 2009; Lunghi, 2009). This led to a definition of food poverty based on the Anglo-Saxon definition of Dowler *et al.* (2001), which is conceptually similar to the definition of food insecurity used in the US literature (Loopstra and Lambie-Mumford, 2022), such as in the early studies of women and children experiencing food insecurity (Radimer *et al.*, 1990, 1992; Radimer, 2002; Caraher and Conveney, 2004). Dowler *et al.* (2001:12), for example, define food poverty as "*the inability to acquire or consume an adequate quality or quantity of food in a socially acceptable manner, or the uncertainty that one will be able to do so*". It turns out that food poverty is not a supply-side problem, but rather a failure of food access entitlement (Sen, 1981; Marsden *et al.*, 2014) and of nutritional capabilities (Drèze and Sen, 1989).

The concept of food security, a much debated and changing term (Dowler and O'Connor, 2012: 4), allows us to specify the dimension of access and broadly describes a multi-layered situation in which "*all people at all times have physical, economic and social access to sufficient, safe and nutritious food that meets their dietary needs and preferences for an active and healthy life*" (Riches, 2002: 92).

This concept, on which this study is based, allows us to highlight a representation of food that is more than just a means of sustenance, but a medium for personal choices, symbolic, emotional, and cultural meanings linked to the history and traditions of each community (Materia, 2023). Lack of food becomes a loss of social ties, it becomes loneliness that requires forms of material

[4] It is part of a well-established tradition of parliamentary enquiries, the first in 1906 "Faina Inquiry" on the conditions of peasants in the southern provinces.

help that can restore social ties (Campiglio and Rovati, 2009; Loopstra and Lambie-Mumford, 2022).

The socially destructive and disruptive nature of food insecurity thus presents itself like a three-headed Cerberus:

i. The *nutrition dimension*: poverty is a major cause of food insecurity and makes low- and middle-income households more likely to consume unhealthy foods (Goudie, 2023; Cattaneo *et al.*, 2023; Marino *et al.*, 2022; FAO *et al.*, 2022). As a result, food insecurity and poverty not only contribute to the rise in undernutrition, but can also increase the prevalence of obesity, leading to a real paradox where people with limited access to food are also obese (Carvajal-Aldaz *et al.*, 2022; Narayan *et al.*, 2022; Nettle *et al.*, 2017). Children's health status becomes a litmus test for the manifestation of this paradox. Indeed, childhood obesity and overweight are confirmed as one of the most important public health problems (WHO, 2021). Greece, Italy, Portugal, Spain and Slovenia are among the countries with the highest percentages of overweight and obesity in Europe (in Italy, 39% of 8-year-olds are overweight, of which 17% are obese[5]), showing a strong correlation with economic and educational poverty in the household.
ii. The *intangible dimension:* people feed "*not only on protein, fat, carbohydrates, but also on symbols, myths, fantasies*" (Fischler, 1980: 937). Food is not only a means of survival, but also a medium for relationships and social networks that contribute to the cultural identification of people and places (Loda *et al.*, 2020; Hyde, 2014). Social and cultural needs are strongly linked to the specific socio-cultural context (O'Connel and Branner, 2021; Bernaschi, 2020). An example of this, are eating habits and the relational, sociable, and convivial aspect (Illich, 1972) associated with eating food that fails in a state of food deprivation. In a perspective of social exclusion, the lack of food becomes a loss of social ties.
iii. The *psycho-emotional dimension*: food insecurity is more than a state of neediness, it is much more than an empty fridge and pantry. Food insecurity is a sign of a life deprived of capabilities, threatened by social exclusion. Food insecurity leads to a lack of control, autonomy and freedom over one's diet and becomes an explosive source of social exclusion, causing anxiety, frustration, shame and social stigmatisation (Horst *et al.*, 2014; Baraniuk, 2019). Shame becomes one of the key emotional features of poverty and food insecurity. The stigma associated with a socially vulnerable condition and the feeling of inferiority that arises, for example, from dependence on external help, underlie the deep feelings of humiliation and shame (Bernaschi and Leonardi, 2022; Lynn-Ee Ho, 2009).

Conversely, a state of food security (especially in affluent societies) means that "*people have enough money to buy the food they want to eat to meet both social and health and nutritional norms; that this money is not absorbed by other expenses (rent, fuel, debt repayment, etc.); that people can access shops or markets that carry suitable food at affordable prices, or that they can grow or otherwise obtain food in a way that is humane and meets social norms*" (Dowler and O'Connor, 2012:4).

1.2. The measurement challenge: from the number of food aid recipients to a more systemic measurement

Although the right to food, as a strategic and enabling right for the enjoyment of all other rights, is deeply rooted in the historical tradition of the United Nations, which also emphasizes the obligation of states to directly fulfil (provide) this right (CESCR, 1999), countries rarely fulfil this obligation and do so systematically (Dowler and O' Connor, 2012: 16). Indeed, under the influence of neoliberal policies, a process of individualization of social risks prevails (Beck, 2009; Giddens, 1999; Bauman, 2001), transforming them into self-care problems (Lemke, 2002, Glaze and Richardon, 2017). This leads, as pointed out by Lang (2009), mainly to a process of delegation of the state to solidarity initiatives to feed those who do not have food or sufficient means to access food (Riches, 2002), mainly through the redistribution of food surpluses. This makes food security a right that depends on charity (Paget, 2015) and increases the number of recipients of food parcels, soup kitchens and FEAD[6] assistance for the needy, thus providing an initial measure of the food insecurity phenomenon as a whole. However, they represent only the tip of the iceberg of a multi-layered phenomenon.

The multidimensionality of food security leads to significant measurement challenges. Food insecurity studies take place at global, national, and household levels. In terms of measurement tools, following the research of Grimaccia and Naccarato (2018), we can distinguish three different generations of indicators. The first includes indicators that mainly reflect different trends in actual food availability at the national level,

[5] The situation is more critical in the South and Islands, presenting a greater increase in metropolitan areas and suburbs.

[6] Fund for European Aid to the Most Deprived.

e.g., the number of undernourished people -NoU- and the percentage of undernourished people -PoU- (FAO *et al.*, 2018, 2022).

The second generation focuses on measuring access to food and seems more in line with Goal 2 of the 2030 Agenda, which aims to monitor the actual state of food insecurity of the population. Within this generation, studies using indicators linked to income and food consumption are reported (Borrelli and Corti, 2019; Marchetti and Secondi, 2022; Accolla, 2015; Marino *et al.*, 2022; Pauw *et al.*, 2023; Bernaschi *et al.*, 2023).

Finally, there is a third generation of indicators that attempt to capture the subjective dimension of food insecurity (Frongillo, 2013), such as the Food Insecurity Experience Scale (FIES) developed by FAO (FAO, 2016; Cafiero *et al.*, 2018), which aims to give a direct voice to those suffering from food shortages, by addressing food accessibility also in terms of fear and anxiety about one's food.

Given the multidimensionality of food security, this study aims to focus on one of the most difficult and complex dimensions for affluent societies, namely, the access to food. An analysis of the conditions that enable or hinder access to food, also appears as a heuristic key to subsequently gain insight (through further research) into the other nutritional, intangible, and psycho-emotional dimensions of food insecurity.

As Marchetti and Secondi (2022: 999) note, the literature dealing with food access can be divided into two macro domains: one aims to examine average consumption of micronutrients and dietary diversity (quality) (Smith and Subandoro, 2007); the other examines economic access by looking at the different sources of food supply, the Engels ratio (the share of food consumption in total income or consumption expenditure), income inequality and the impact of all these factors on nutrition.

Here (as described in section 2.), the research overlaps with the two macro domains and aims to analyse household food insecurity by assessing affordability (based on income, food consumption and propensity to save) for a healthy diet over time and at the local level. While official research focuses on food insecurity analysis at the national level, such as Eurostat (2022) which measures food insecurity through the ability of households to afford a meal with meat, fish or a vegetarian equivalent every two days as part of the AROPE indicator (people at risk of poverty or social exclusion), or like ISTAT (2022) which analyses, at the level of geographical areas, the percentage of households that report not having enough money to buy food during certain periods of the year and not being able to afford a protein meal every other day.

This research follows literature that seeks to emphasize the role of the local dimension, i.e., how food insecurity manifests itself at the local level. This can be seen, for example, in studies that analyse the relationship between poverty and food insecurity at the city level, as in the case of Corti and Borrelli (2019) and Daconte (2017) in Milan, or that analyse places and means of access to food, as in Sganzetta and Tricarico (2018), or that examine differential access to food in suburbs, as in Geurden *et al.* (2022) in Antwerp (Belgium). The local dimension thus seems to play a key role in problematizing and measuring the state of food insecurity.

The local dimension is important in two fundamental aspects. One is the rights, entitlements and provisions that contribute to define a state of food insecurity, as Sonnino *et al.* (2016) point out, "*essentially (vertically and horizontally) embedded place-based constructions, and that they imply a spatially reorganised set of relationalities and politics associated with food access, consumption and production*" (p. 484). On the other hand, the local perspective allows for an analysis of the inter-territorial inequalities and weaknesses created by economic disruptions to the local food system that prevent people from eating healthily, but also for the identification of the most vulnerable social groups and geographical areas – neighbourhoods characterized by critical access to food (for more details, see Bernaschi *et al.*, 2023, where the concept of blacked-out food areas is coined).

2. METHODOLOGY

In this paper, a new affordability index – the Food Affordability Index (FAI) – has been developed to address the economic access to healthy diets at the territorial level[7].

The construction of the index is based on a "healthy diet" model taken from the "Healthy Diet Guidelines" published by CREA in 2018[8]. The diet was calculated based on a monthly diet for a family of four (two adults and two children). The next step was the translation of the nutritional amounts into commercial references. Then, a survey of the prices of the products included in the diet was carried out in thirty stores in Rome, distinguishing both by type of distribution channel (discount

[7] Early versions of this index can be found in Marino *et al.* (2022) and Felici *et al.* (2022). However, the index formula has been modified and further surveys have been carried out.

[8] The healthy diet model goes beyond identifying sufficient calories but focuses on the nutritional aspects, as for example, the consumption of fruits, vegetables, grains, legumes, eggs, and milk and dairy products, and limits the consumption of alcohol, sugar, red meat, frozen foods, and processed meats. The model refers to the Mediterranean Diet model.

and supermarket[9]) and on a territorial basis, distributing the survey among the 15 municipalities of Rome.

Once the cost of a healthy diet has been determined, the formulation of the affordability index consists of calculating the monthly share of spending on a healthy diet out of the total consumption of households in the area. This factor is compared with the national average household expenditure on food out of total consumption, as determined by ISTAT. Thus, the index aims to measure the gap between the actual expenditure on a healthy diet and the average Italian food expenditure. The greater the gap between these two values, the more difficult it will be to access a healthy and sustainable diet.

An index with a value of 1 indicates that to eat healthy, the household does not need to change its consumption basket. On the other hand, if the index is greater than 1, the family should reduce its consumption expenditures in the other areas (energy, housing, transportation, etc.) – compared to the average. Or, if it wanted to maintain non-food consumption, it would have to reduce spending on food, probably by changing its diet and avoiding the main products of a healthy diet (fruit, fish, etc.). On the other hand, with an index of less than 1, the family has the option of giving up neither the foods necessary for a healthy diet nor the other types of non-food products.

The index formula is as follows:

$$Food\ Affordability\ Index = \frac{(A)food\ expenditure\ for\ a\ healthy\ diet}{(B)total\ consumption} \Big/ \frac{(C)average\ food\ expenditure}{(D)average\ total\ consumption}$$

It is important to keep in mind that the index has a territorial meaning, since the cost of a healthy diet (Factor A) and total household consumption (Factor B) are calculated on a territorial basis, while Factor C and D are national values.

Factor A of the equation is calculated using surveys of product prices in outlets on a territorial basis (two surveys per municipality – supermarket or discount store).

Factor B uses income data at the municipal and sub-municipal level provided by the Italian Ministry of Economy and Finance, adjusted for the savings rate to obtain consumption, and considered on a household basis. Income data were selected at the local level because it has been demonstrated that significant income differences can occur at the territorial level (Faggian *et al.*, 2013), thus affecting affordability in addition to the value of prices.

Factors C and D are provided by the Italian Institute of Statistics, which reports the average monthly food expenditure for an Italian family of four. The national average is recalibrated with correction coefficients – calculated on an annual basis – to make it more specific according to territorial characteristics (urban context and central Italy).

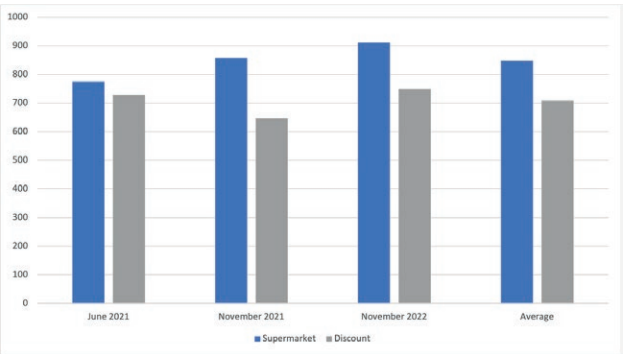
In the specific case of this study, three measurements were conducted over time: June 2021, November 2021, and November 2022.

3. RESULTS

The first result to be highlighted concerns factor A of the equation, namely the cost of a healthy diet that emerges from price surveys on supermarkets and discount stores (Figure 1). Data show that the cost of a healthy diet stands at 707,68 euros on average in discount stores and 847,87 euros in supermarkets (higher by 20%). The higher cost of supermarket spending makes it unaffordable for part of the population and forces people to reduce the quantity, but above all the quality, of food.

Another phenomenon to note is price change and inflationary dynamics. Due to the economic crisis in the aftermath of Covid-19 and the Russian-Ukrainian war, food prices varied greatly during the years 2021-2022. In both types of outlets, product prices have increased. In discount stores, despite an apparent improvement in November 2021, the price increase was 3%. In supermarkets, on the other hand, the price increase between 2021 and 2022 was 18%.

Figure 1. The cost of a healthy diet (in euros) by time of survey and type of stores.



[9] The sample of stores was chosen randomly using territorial stratification, specifically one discount store and one supermarket was chosen for each municipality in the city.

The application of the affordability index formula produced the following results (Figure 2 and 3). The accessibility at discount stores appears to be 16% higher than at supermarkets, as the average at discount stores stands at 0.89 compared to 1.06 at supermarkets (remember that values greater than 1 show undermined food affordability). This is mainly due to the difference in the cost of a healthy diet between the two types of stores.

When looking at the change in affordability during the three surveys in June 2021, November 2021 and December 2022, it is clear that the index is an effective tool for monitoring the affordability of healthy foods over time. According to the variation in food prices and the change in household incomes, affordability appears to have improved for discount stores, particularly from June to November 2021 (affordability changed from a value of 0.96 to 0.81 – an improvement of 16%). Despite the affordability worsened from November 2021 to November 2022 by 9%, it still represents an improvement from June 2021.

On the other hand, regarding supermarkets, accessibility seems to have worsened, as the values varied from 1.01 in June 2021 to 1.09 in November 2021 and 2022 (a decrease of 7%). This factor makes supermarkets even more unaffordable over time than discount stores, driving people to cheap, nutritionally deficient diets with strong environmental impacts.

Considering the different values between city municipalities (averaged over time), we find that in five areas accessibility is insufficient (*low* or *very low*) even if we consider discount stores (Figure 4). In supermarkets, accessibility is compromised in 9 municipalities, with the presence of three critical areas in the eastern part of the city (Figure 5).

Figure 2. The values of the affordability index at discount stores over time.

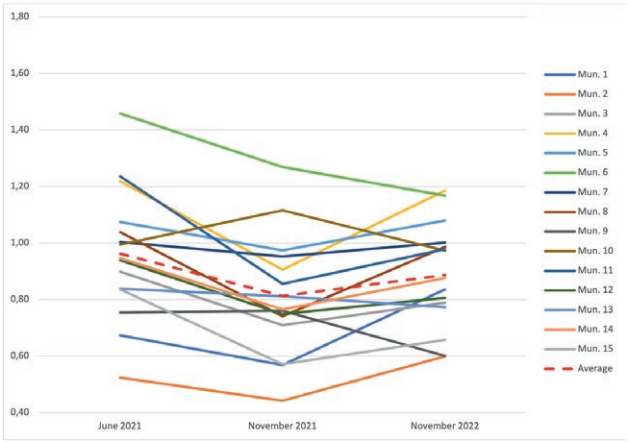


Figure 3. The values of the affordability index at supermarkets over time.

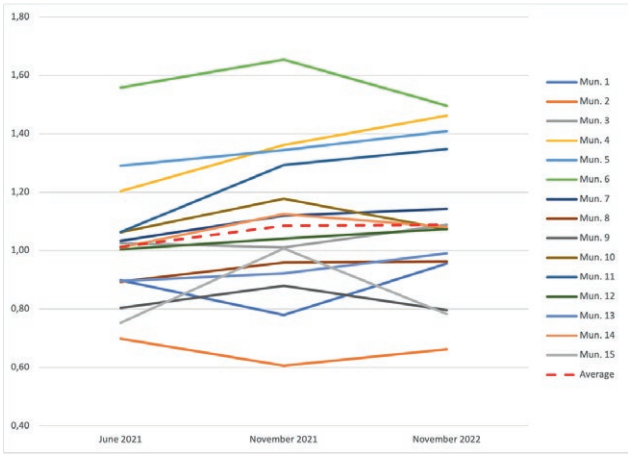
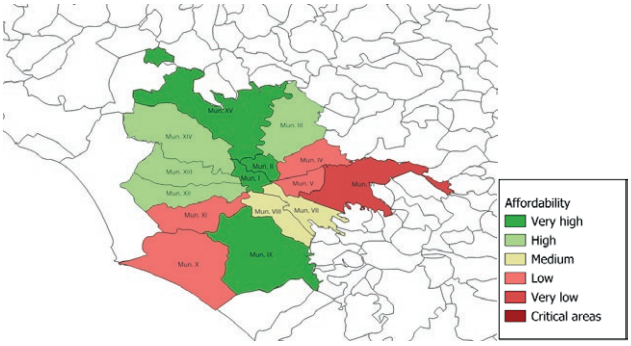


Figure 4. The territorial affordability at discount stores.



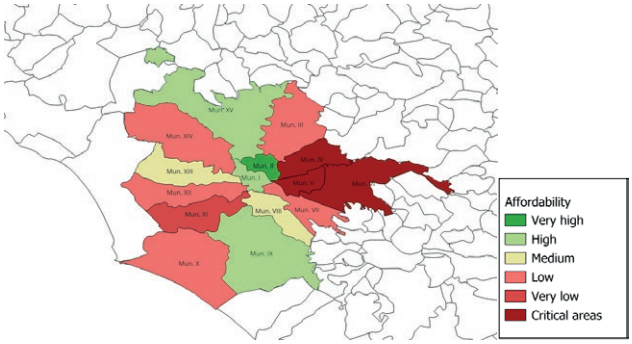
This shows how the phenomenon of affordability to healthy food has a strong territorial component, even in a single city composed of different municipalities. The lack of access to food is a spatial phenomenon that can lead to inequality.

We now examine the differences in affordability between the municipalities of the city of Rome. Figures 6 and 7 show a Cartesian plane in which we have on the x-axis the value of the index of each municipality for supermarkets and discounters from November 2022; while the y-axis shows the change in the index over time from June 2021 to November 2022. These charts give us an overview of the level of affordability in the municipalities: the current level and whether there has been a deterioration or improvement.

It should be noted that the index value has been normalized to an average value of 0 – not 1 as it appears in previous graphs – for a better understanding.

In the upper right quadrant (marked in red), we find the municipalities that are in a worse situation: impaired

Figure 5. The territorial affordability at supermarkets.



affordability index, which has deteriorated from the past. In the upper left (marked in light red) quadrant we find municipalities with a compromised index but still experienced an improvement over the past. In the lower right quadrant (marked in yellow) we find municipalities with a sufficient index, but whose accessibility has deteriorated compared to the past. In the lower left quadrant (marked in green) we find the most favourable condition: a sufficient index and an improvement in accessibility compared to the past.

If we look at the situation with the discounters, we see that most of the municipalities are in a favourable state. Municipality V is in the worst situation. However, other municipalities with a poor accessibility index have improved in the past (e.g. municipalities IV, VI). Two municipalities (respectively I and II), which have a favourable accessibility index, have experienced a deterioration in accessibility. This means that, apart from the municipalities in the yellow zone, all others are highly motivated to shop at discounters due to their high accessibility and a further improvement in this accessibility.

However, if we look at the situation in supermarkets, we see the opposite. Most municipalities are in the worst condition. This drives them even more to buy from the discounters. Some municipalities (I, VIII, XIII, XV) are in the condition of having a sufficient accessibility index but worsening accessibility over time. The accessibility of supermarkets has only improved in three municipali-

Figure 6. Index value in relation to the variation of this for each municipality (values at discount stores).

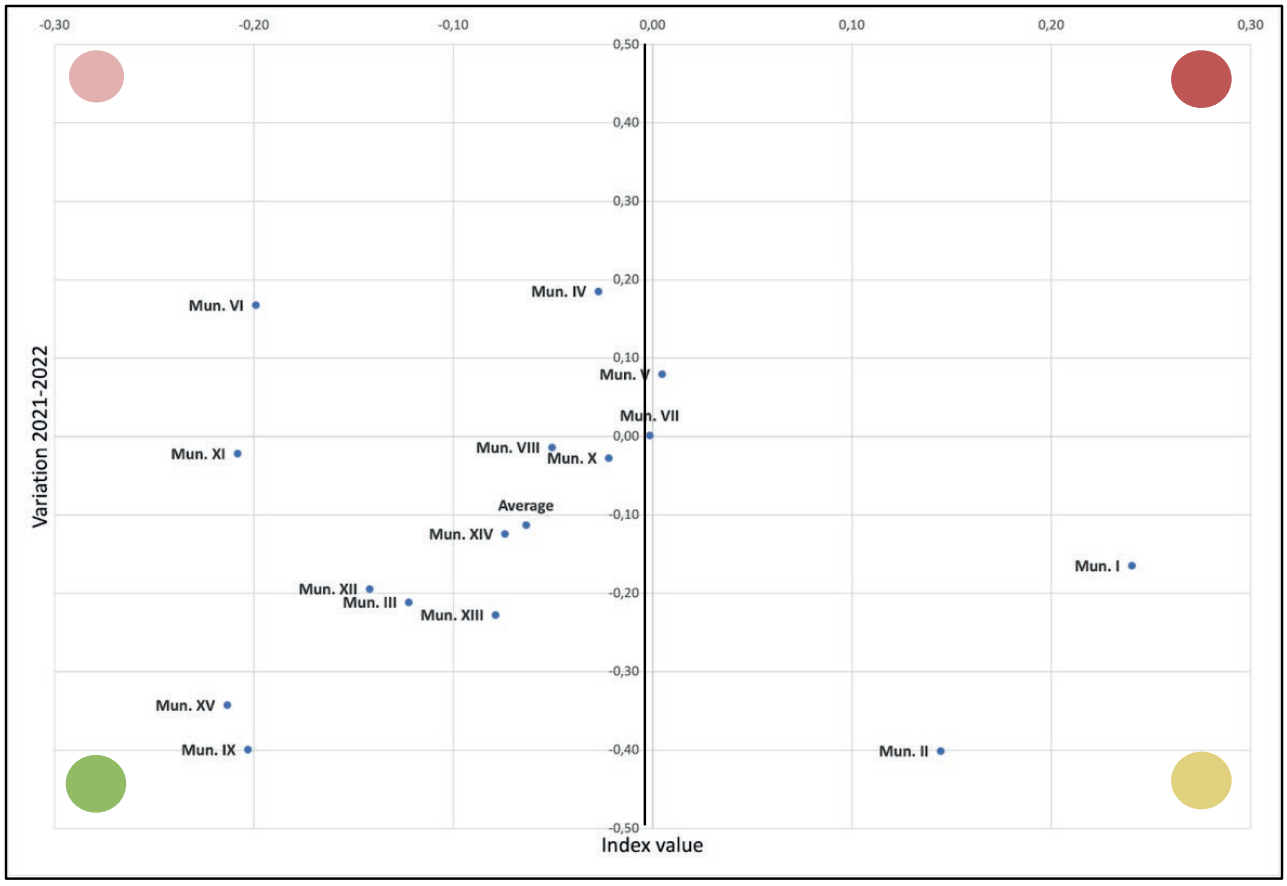
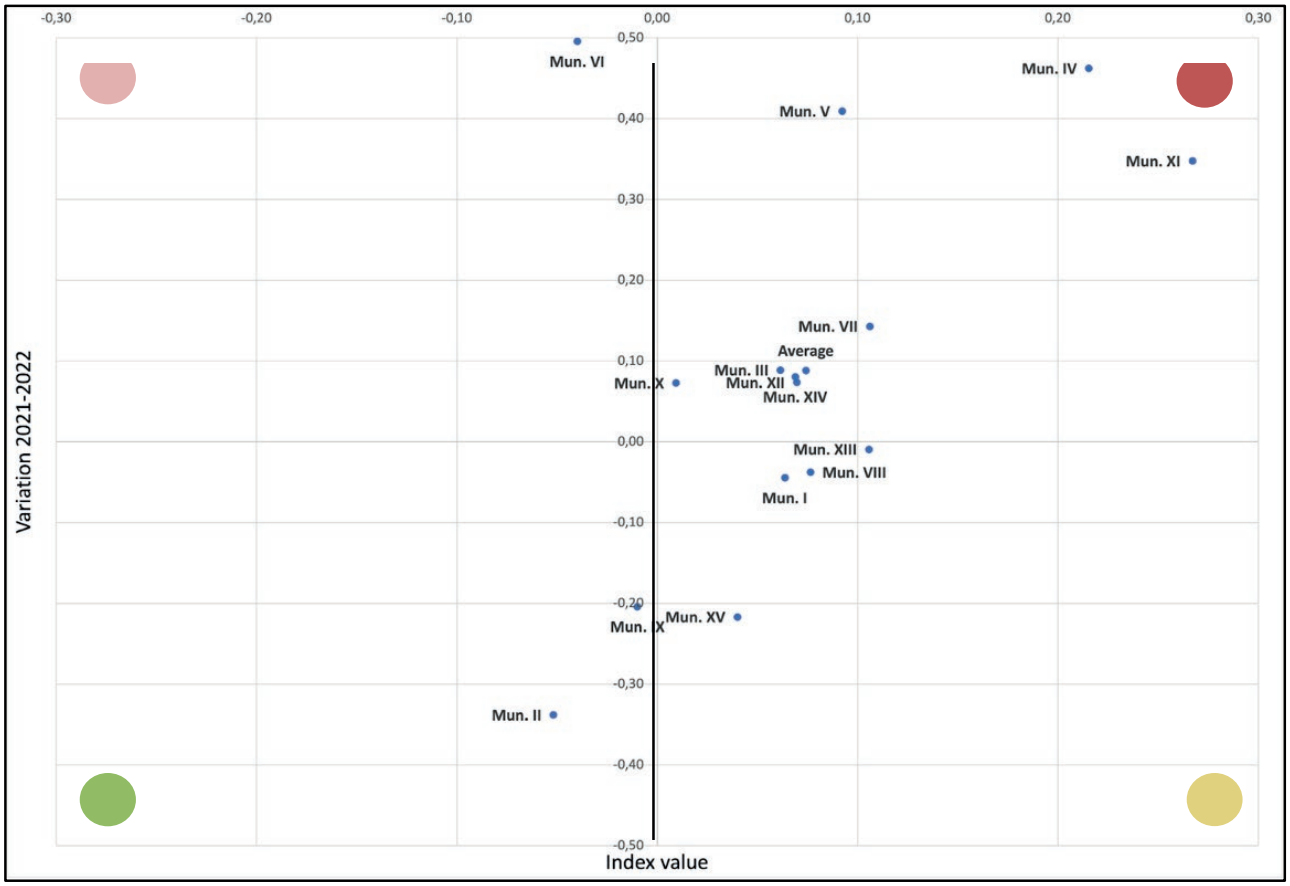


Figure 7. Index value in relation to the variation of this for each municipality (values at supermarkets).



ties (II, VI, IX). Comparing this graph with the previous one, only municipality II is really motivated to shop in supermarkets.

It is worth noting that many municipalities are close to the average for supermarkets. This means that there is less dispersion in the graph. Considering their position, we can observe a general trend of worsening affordability to healthy food.

4. CONCLUDING REMARKS

The problem of food insecurity is a growing global and local challenge, not least in the most developed countries (FAO *et al.*, 2022). Therefore, the need to measure it and understand how it occurs territorially is crucial for the implementation of targeted policies and programmes to address it. In addressing poverty and food insecurity, it is therefore essential to focus and work on new estimates and new measurements of food insecurity, as a lack of access to food proves to be a bellwether of a broader state of poverty (Rinella and Okoronko, 2015). Food becomes a thermometer of people's actual living conditions, which can reveal possible situations of social inequality (Marino *et al.*, 2022).

Our work aims to develop a new affordability index that can measure food access on a territorial basis. The index was applied to Rome and critical areas were identified where access to food is problematic. The territorial approach of this methodology allows for the implementation of specific "place-based" interventions to improve food access.

The index is not limited to the analysis of the economic dimension of food security, but also and above all, to the qualitative dimension of access, focusing on the nutritional aspect. In addition, it takes into account the variation of the data according to the type of outlet (supermarkets and discount stores) and by different areas. The basic assumption of the index is that food prices and household income significantly affect the affordability of a healthy diet. Inflationary phenomena as well as income-related inequalities at the territorial level can

affect food affordability. Therefore, understanding the spatial distribution of inequalities in economic access to a healthy diet, is an important step in implementing targeted policies and programmes to address this issue.

Overall, the index results show that affordability is significantly better in discount stores. This is due not only to the lower cost of food and generally better affordability in all municipalities surveyed, but also to the fact that affordability at discount stores has increased over time. This is not the case for supermarkets, where affordability is affected in many municipalities and only three municipalities (II, VI, IX) showed an improvement in affordability over time. Thus, it appears that households in each municipality are more motivated to shop at discount stores, both because of better accessibility and because of improvements in accessibility over time. Only the municipality II is motivated to shop at supermarkets because of the deterioration of accessibility to discount stores and the improvement of accessibility to supermarkets.

In summary, this food affordability research has shed light on the problem of food deprivation, by identifying the areas where families do not have access to an ideal healthy diet. The present work aimed at methodological and analytical objectives. Through an innovative and easy-to-calculate indicator, the attempt was pursued to provide useful information to stakeholders, in particular to the public decision-makers. At the same time, the research shows some limitations that can be overcome in future work. First, the healthy diet model presents average values and may not be appropriate for the whole population. Further research can apply the index with different healthy diet models, taking into account physiological and nutritional differences between different groups. In addition, future work may increase the number of stores (both discount and supermarket) considered in the survey, improving representativeness of the sample. Other distribution channels may also be considered.

Finally, the social challenges have prompted our research to develop further. In line with a multidimensional view of food security, the next steps in research are to deepen the nutritional, intangible and psycho-emotional dimensions. Thus, in addition to establishing an Observatory on Poverty and Food Insecurity in Rome as an experimental project for a permanent monitoring operation in the region, in-depth research on Roman families' food consumption, socio-cultural and economic status, and individuals' perceptions of food insecurity using the FAO Food Insecurity Experience Scale (FIES), has been conducted and is ongoing.

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