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Should the Food Insecurity Experience Scale Crowd Out Other Food Access Measures?

Evidence from Nigeria

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Abstract

Measurement of food access typically relies on a consensus of different indicators. However, there is a growing list of surveys in which the Food Insecurity Experience Scale is one of the few food access indicators captured, likely because it is an official measure for tracking progress toward the Sustainable Development Goal of zero hunger. This paper uses a nationally representative, multipurpose household survey conducted in Nigeria to investigate the validity of the Food Insecurity Experience Scale. It compares the Food Insecurity Experience Scale to monetary poverty and a widely used food access metric that has been more extensively validated, the Food Consumption Score. Although it is possible for food access metrics to be poorly aligned and capture different dimensions of poor food access, empirically supported assumptions in standard consumption models result in many dimensions of poor food access being concentrated among the poorest segments of the population. However, the paper demonstrates that the Food Insecurity Experience Scale does not appear to correctly identify the population with poor food access—it finds little difference in the share with poor food access among poor and nonpoor Nigerians. Moreover, even the very richest and very poorest households have a similar prevalence of poor food access, according to the Food Insecurity Experience Scale. These patterns are in stark contrast to the Food Consumption Score, which suggests that food access is significantly lower for poorer Nigerians. Combined, the results demonstrate the importance of measuring food access with more than one indicator, and they call into question the notion of using the Food Insecurity Experience Scale alone, despite the measure being a key Sustainable Development Goal food security indicator.

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Should the Food Insecurity Experience Scale Crowd Out Other Food Access Measures? Evidence from Nigeria

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Section1. Introduction

Measurement of food access typically relies on more than a single indicator, particularly when making decisions about how and where to target emergency food assistance (e.g., Barrett 2010; IPC 2021; etc.). In part, this is because food access metrics may capture different aspects of poor food access and a wider range of metrics maximizes the chances that the various manifestations of poor food access be captured (e.g., Maxwell et al. 2014). But what exactly is captured by each indicator and which specific indicators should be included in a suite of indicators to best target food assistance and measure progress towards reducing food insecurity is far from settled (e.g., Headey and Ecker 2013; ICRC 2021; etc.). This is an urgent issue given rising levels of food insecurity in recent years and the need to distribute increasingly scarce resources to populations with the worst food access (e.g., UN 2020; FAO 2021; World Bank 2022; etc.).

Despite the clear need to track a number of different food access indicators, national statistical systems typically only collect data on a small number of food access indicators. In part, this is because the multipurpose household surveys in which food access indicators are often included are already long and survey fatigue can threaten overall data quality.[1] Within the small number of food security modules included in these surveys, there is a growing trend of including the FIES as one of the few food access measures. Nearly 100 countries have either incorporated the FIES into their national statistical systems or are in the process of doing so as of 2019.[2] Furthermore, in tracking the impacts of the COVID-19 pandemic, there were a very large number of surveys that included the FIES as the *only* food access measure (e.g., FAO 2020; United Nations 2020; World Bank 2020; Adjognon et al. 2021; Amare et al. 2021; etc.). Part of the reason for the extensive reliance on the indicator is likely its inclusion as an official measure for tracking progress towards Sustainable Development Goal 2 (zero hunger).

However, the FIES needs to be more extensively validated beyond the work that

[1] For example, in the nationally representative survey analyzed here — the 2018/19 Nigerian Living Standards Survey (NLSS) — the only food access modules included are the Food Insecurity Experience Scale (FIES) and the Food Consumption Score (FCS).

[2] See " https://www.fao.org/in-action/voices-of-the-hungry/background/en/" for a list of countries that have or are in the process of adopting the FIES.

has been done to date.[3] Ideally, we would expect to understand the degree to which a metric tracks the underlying dimensions of food access that are intended to be captured. The FIES was initially implemented globally in the Gallup World Poll (GWP), and unfortunately the GWP cannot completely validate the FIES in this way given that there is no information on actual household food consumption, on other food access metrics, or on other traditional welfare metrics (e.g., Gallup World Poll 2019). Rather, much of the validation of the FIES has been done by correlating the FIES to other subjective welfare metrics and the limited household characteristics captured in the GWP (e.g., Smith et al. 2017; Wambogo et al. 2018; etc.). However, given that a number of other closely related experiential measures of food access align poorly with other food access metrics (e.g., Headey and Ecker 2013; Maxwell et al. 2014; Broussard and Tandon 2016; etc.), it is important to more thoroughly validate the FIES and understand what aspects of poor food access are being captured.

We perform a more thorough validation of the FIES in Nigeria using data from a nationally representative multipurpose survey that captures a number of food access and welfare indicators from each household. Nigeria is important for regional and global measurement of poor food access. By official global measures, Africa is the continent with the highest prevalence of both undernourishment and the inability to afford a diet sufficient to maintain an active and healthy lifestyle (e.g., FAO 2021), and Nigeria alone accounts for approximately 20 percent of Africa's entire population.

In this important setting, we compare estimates of food access using the FIES to monetary poverty. Although monetary poverty and food access are distinct concepts, we illustrate there exist empirically supported assumptions under which models of consumer theory predict that many key manifestations of poor food access —undernourishment and undernutrition — are more prevalent in poorer households (e.g., Jensen and Miller 2010).[4] Importantly, given this predicted relationship, and given that both undernourishment and

[3] For a comprehensive list of research articles performing this type of analysis, see "https://www.fao.org/in-action/voices-of-the-hungry/resources/research/en/".

[4] This is distinct from the more dynamic relationship with how households become food insecure and poor, where poor human development outcomes can lead to and are also potentially a result of poor earnings (e.g., Kremer and Miguel 2004; Vermeersch and Kremer 2004; Glewwe and Miguel 2008; etc.).

undernutrition are both difficult to precisely measure (e.g., Gibson 2005; Fiedler et al. 2013; etc.), poverty is a critical validation measure for food access metrics. Thus, we investigate whether the FIES correctly identifies poorer households as having worse food access, and further compare the performance of the FIES to another commonly used food access metric that has been more extensively validated— the Food Consumption Score (FCS).[5]

The data demonstrate that the FIES performs poorly overall and is not well aligned with monetary poverty. First, the FIES identifies roughly equal shares of the poor and non-poor populations as having severely poor food access, with 26.7 and 25.3 percent of the poor and non-poor populations respectively having severely poor food access. This is in stark contrast to the FCS, where 26.6 and 7.2 percent of the poor and non-poor respectively had a poor or borderline FCS. In the case of the FCS, the share of poor households with poor food access was approximately 3.7 times the share of non-poor households.

Second, for the FIES, the lack of a difference in poor food access between the poor and non-poor households extends to the ends of the welfare distribution. The share of households with severely poor food access identified by the FIES was roughly equal in all expenditure deciles. Most notably, the share of the population with severely poor food access identified by the FIES in the bottom expenditure decile was statistically indistinguishable from the share in the eighth and ninth deciles and was only slightly larger than the share in the top expenditure decile (26 versus 18 percent).

Again, this is in stark contrast to the FCS. The share of households with a poor or borderline FCS is highly concentrated in lower expenditure deciles, with 42 percent of households having poor food access in the bottom decile. The share with poor food access sharply and monotonically decreases for higher expenditure deciles. By the top expenditure deciles, the share that has poor food access is between 3.5 and 5.5 percent, which is 7 to 10.5 times less than in the bottom expenditure decile.

Crucially, we also investigate the possibility that monetary poverty and the FCS

[5] For example, see Weismann et al. (2009).

might both be poorly capturing food access and instead the FIES might be correctly identifying the population with poor food access. However, this possibility does not seem likely. Specifically, we perform a common check on the validity of monetary poverty and corroborate that the share of expenditure devoted to food, itself a measure of food access, is declining for higher expenditure deciles in the household survey (Engel's Law); and we verify using sub-national food access estimates from other data sources that the regions with the poorest food access are correctly identified by the FCS and monetary poverty and incorrectly identified by the FIES. Furthermore, other research using the same data used in this analysis has extensively validated the quality of the household survey used in the analysis (e.g., Lain and Vishwanath 2021).[6]

Combined, the evidence suggests that the FIES is not working well in the particularly important context of Nigeria. However, we further find that although the overall scale is poorly aligned with monetary poverty and the FCS, the alignment varies by the specific coping strategies and behaviors that make up the scale. First, some of the more subjective questions on food access had significant deviations from the predicted relationship between food access and poverty, which is consistent with previous work illustrating difficulties in interpreting subjective welfare questions (e.g., Ravallion 2013; Tandon 2021; etc.). And second, for the more objective questions, some of the questions aligned well with monetary poverty, while others performed less well. This pattern is consistent with the validation of other indices based on food coping strategies (e.g., the Coping Strategy Index), where many coping strategies are not necessarily universal and it is important to adapt the coping strategies that are captured to specific country contexts (e.g., Maxwell and Caldwell 2008).

Overall, one of the key implications of these findings is that it is important to continue to collect a variety of food access indicators and that the FIES should not crowd out other measures. These results corroborate previous research and help demonstrate that widely

[6] For example, as enumerators interview more households, they may begin to learn the ways that significantly reduce the amount of work they have to do in each survey, such as reducing the number of people in the household roster or reporting fewer distinct food items consumed. These and other household characteristics were analyzed over time and demonstrate little change over the survey implementation period, which is consistent with proper monitoring and good survey implementation. For more details, see Lain and Vishwanath (2022).

used food access metrics are capturing different aspects of poor food access (e.g., Maxwell et al. 2014). However, these findings build upon previous work and demonstrate that some of these coping strategies do not have the expected relationship with other key welfare indicators, suggesting that it might be unclear exactly what some of these coping strategies are capturing. Therefore, future work needs to be done to unpack the exact causes of these discrepancies and how generalizable the results are to additional contexts.

The rest of the paper is structured as follows. Section 2 presents a brief background on food access indicators and the FIES; Section 3 presents a simple model of consumption to illustrate the relationship between monetary poverty and poor food access; Section 4 describes the data; Section 5 describes the empirical strategy; Section 6 reports the empirical results; and Section 7 concludes.

Section 2. Background on Food Access Measures and the Food Insecurity Experience Scale

Food access is one of the four pillars defining food security agreed upon by stakeholders at the 1996 World Food Summit, with the original formulation ensuring that all individuals have access to "sufficient, safe and nutritious food." Given the many different components of food access alone, including consumption of macro-nutrients, food safety, and consumption of micro-nutrients, it is difficult for any single measure to capture all information relevant to policy makers (e.g., Barrett 2010).

Moreover, many dimensions of food access are difficult to measure precisely. Although there are a number of ways to try and estimate the quantity of calories consumed and the nutritional content of consumption, the methods thought to produce the most precise estimates involve individual-level surveys that are complex, expensive, difficult to analyze, and nearly impossible to perform on a large scale (e.g., Gibson 2005; Fiedler et al. 2013; etc.).[7] In the absence of these difficult-to-collect and expensive data, researchers often turn to household consumption and expenditure surveys (HCES's) to measure the quantity and quality of foods consumed (e.g., Wiesmann et al. 2009; etc.).

However, estimates from HCES's are subject to a substantial amount of measurement

[7] For example, one method is observed-weighed food record data. See Gibson (2005) for details.

error. For example, there is a wide range of macro- and micro-nutrients contained in nearly all individual food items captured in a typical HCES and it is difficult to assign the caloric and nutritional content of each food item consumed (e.g., USDA 2019); it is also difficult to identify the nutritional content of many processed foods and food consumed outside the household that are becoming important increasingly to modern diets (e.g., Deaton and Subramanian 1996); and many of the dietary needs of individuals are unobservable and based on individual choices and activities (e.g., Institute of Medicine of the National Academies 2006). These issues compound other traditional sources of measurement error that affect the measurement of expenditure in HCES's, such as recall biases, impacts of different questionnaire formats, and a wide variety of other concerns (e.g., Beegle et al. 2012; etc.). The variance on estimates of the quantity and quality of food consumption are therefore large and are potentially increasing over time as households consume more processed foods and meals outside the household (e.g., Tandon and Landes 2011; Tandon and Landes 2014).

Given these difficulties and the need to obtain estimates of food access in real time and in data-poor environments, practitioners and researchers have increasingly relied on metrics that are relatively easy to implement while also approximating the degree of food access in its many dimensions (e.g., Swindale and Billinsky 2006; WFP 2009; Maxwell and Caldwell 2008; etc.). Two common approaches include (1) measuring dietary diversity and the frequency with which individuals and households consume certain food groups, such as the Food Consumption Score and the Household Dietary Diversity Score (e.g., Swindale and Billinsky 2006; WFP 2009); and (2) measuring food coping strategies often associated with consuming too little or consuming a poor quality diet, such as the Coping Strategies Index and the Reduced Coping Strategies Index (e.g., Maxwell and Caldwell 2008).

However, others have argued that additional psychological aspects related to food access should be captured in standard metrics (e.g., Webb et al. 2006; etc.). An additional set of experiential measures of food access, such as the Latin America and Caribbean Food Security Scale and the Household Food Insecurity Access Scale, extend food access

measurement to these dimensions by asking about food coping strategies and anxiety over insufficient food access (e.g., Maxwell et al. 2014). However, there are significant additional challenges to incorporating anxiety regarding poor food access and other subjective measures. In particular, answers to subjective welfare questions depend on respondent-specific scales that: (1) may not be comparable across individuals or stable over time; (2) are potentially subject to frame-of-reference effects; and (3) suffer from measurement errors, over and above those affecting traditional welfare metrics (e.g., Ravallion 2013; Tandon 2021; etc.).

There have been extensive efforts to validate food access metrics by comparing them to the quantity of food consumed and to nutritional outcomes (e.g., Maxwell 1996; Weisman et al. 2009; Broussard and Tandon 2016; etc.). Yet measuring the quantity of calories consumed and the nutritional content of food consumption is difficult and nutritional outcomes are also strongly impacted by health and non-food factors. Therefore, food access measures have also been validated by comparing them to *other* household characteristics (e.g., Maxwell et al. 2014). One such household characteristic is monetary poverty and low levels of expenditure, which are strongly correlated with a number of key food access metrics (e.g., Maxwell et al. 1999; Webb et al. 2002).

However, it is important to note that one cannot validate a new food access measure simply by comparing it to another previously-validated food access measure. If different food access metrics are poorly aligned, it might be that each food access metric is capturing different dimensions of food access (e.g., Maxwell et al. 2014), or it might be that the new metric is indeed poorly correlated with the underlying dimensions of food access that it purports to capture. Better understanding the degree to which different metrics complement each other and knowing which metrics might be poorly suited to specific contexts will help to weight metrics properly and, in turn, to characterize overall food access more fully.

The FIES is an experiential food access metric that incorporates information on anxiety over poor food access, food coping strategies, and household behaviors that are consistent with low levels of consumption and poor diet quality through eight yes-no

questions.[8] If certain conditions are met, the sum of the eight dummy variables that comprise the FIES module responses can be used to classify the food access of individuals or households as moderately or severely food insecure (e.g., FAO 2016).[9,10] These individual- or household-level classifications can then be used to estimate the prevalence of food insecurity for the entire country, or regions within that country. However, country-level estimates for the prevalence of severe or moderate food insecurity according to the FIES can also be calculated by applying an Item Response Theory model (the Rasch Model), which assesses the suitability of each of the component questions and tries to make the scale more comparable across countries and contexts (e.g., Cafiero et al. 2018). As discussed in the introduction, the FIES has not been validated as fully as other more established food access metrics despite its rapid adoption globally in recent years, and the rest of the paper is devoted to better validating the FIES in Nigeria.[11]

Section 3. A Simple Model of Consumption

Despite the importance of validating food access measures using welfare indicators aside from estimates of food consumption and diet quality, previous work has not fully characterized how poor food access and monetary poverty might overlap given a fixed level of income. In standard consumer theory, preferences over food and non-food goods dictate the share of their income that households spend on food, and there are no firm predictions about how monetary poverty and food access might be related. In this section, however, we illustrate the conditions that result in many key dimensions of poor food access and monetary poverty to overlap.

Specifically, this section adopts the simple framework presented in Jensen and Miller

[8]The FIES is based on a nearly identical measure developed by the United States Department of Agriculture and expanded globally in the Gallup World Poll in 2014 (e.g., Coleman-Jensen et al. 2021).

[9]Specifically, using the raw score in this way is only possible if the data satisfy the underlying assumptions of the Rasch model, which underpins the FIES approach. Specifically, the infit statistics should range between 0.7 and 1.3 (FAO 2016).

[10]The FIES module and the individual questions on food access can be found at " https://www.fao.org/in-action/voices-of-the-hungry/fies/en/" (accessed July 2022).

[11]As mentioned above, the initial surveys in which the measure was captured did not include other food access metrics and did not include a variety of other household information that would help to more fully validate the measure. There have been validations of the measure in the United States (e.g., National Research Council 2006; etc.), and some similar measures have been more extensively validated in specific contexts (e.g., Coates et al. 2006; etc.).

(2010) to describe how incorporating a subsistence requirement in the standard consumer choice problem yields important insights into how low consumption is related to both micro- and macro-nutrient deficiencies.[12] Individuals consume a staple food (x_1), a more nutritious food good (x_2), and all other goods (x_3). Individuals are assumed to have homothetic preferences, which, among other things, implies that in response to a price increase, individuals will substitute away from the good made relatively more expensive, as in any standard utility maximization problem.

The staple good and the more nutritious food good are assumed to have c_1 and c_2 calories per unit consumed respectively, where the staple good is assumed to be a cheaper source of calories (i.e., $\frac{c_1}{p_1} > \frac{c_2}{p_2}$). Individuals meet their daily minimum energy requirement s through consumption of both food goods, but can choose to consume fewer than s calories and face a penalty for doing so of $f(c_1x_1 + c_2x_2 - s)$. It is assumed that the penalty decreases as calorie consumption approaches subsistence, and that the penalty rapidly becomes large as calorie consumption approaches zero.[13]

Denoting the price of each good as p_i and denoting income as w, individuals choose x_i to solve:

$$Max_{x_1,x_2,x_3 \geq 0} \quad u(x_1, x_2, x_3) - f(c_1x_1 + c_2x_2 - s) \qquad \text{s.t. } p \cdot x \leq w$$

Combined, this simple framework illustrates that many manifestations of poor food access — undernourishment and undernutrition — can be more prevalent among the poor, with only the poorest populations experiencing the most severe forms of poor food access. First, the model demonstrates that the poorest individuals will consume only the staple good and have the most severe macro- and micro-nutrient deprivations. However, the income at which households begin to become adequately nourished and the wealth at which households begin to diversify their consumption away from only staple grains and lessen their micronutrient deficiencies are both empirical issues and depend on the penalty households face to consuming below their minimum daily energy requirement. But for

[12] We add a non-food good to the Jensen and Miller (2010) model, and analyze slightly different scenarios.

[13] Namely, it is assumed that $f(\cdot)$ is decreasing and convex.

income sufficiently low that households consume only the staple good, deprivations in calorie consumption are being erased more rapidly as income increases than at other points of the welfare distribution.[14]

Second, in the case of a strong penalty to even a small amount of undernourishment, individuals first address undernourishment by consuming the staple grain before consuming the more nutritious food. Only after having enough income to meet their minimum daily energy requirement with the cheap calorie source alone do households begin to consume the more nutritious food and non-food goods. Importantly, in this scenario, there exists a level of income below which all individuals are undernourished and above which no individuals are undernourished, and the same level of income denotes the point at which micro-nutrient deficiencies begin to decline as well.[15]

Third, macro- and micro-nutrient deprivations will continue to abate with additional income. Although food access will begin to improve past a certain income level, there is no strong prediction in this framework about the degree to which individuals might spend on more nutritious calories versus non-food goods.[16] Thus, it is possible for non-poor households that value non-food goods much more so than more nutritious foods to continue to have a poor diet quality relative to recommended guidelines. But regardless, the share of the population that sufficiently values the nutritious food relative to non-food goods will rapidly eliminate macro- and micro-nutrient deficiencies; and all individuals, even those that have a diet that does not meet recommendations, will lessen the severity of macro- and micro-nutrient deprivation.[17]

This framework therefore helps to illustrate conditions under which key components of poor food access are concentrated among the monetarily poor. These are: (1) the existence of a penalty to consuming below one's minimum dietary energy requirement (undernourishment) and (2) the penalty being sufficiently severe relative to the marginal utility of consuming a more diversified bundle.

There are three streams of growing empirical support for the existence of this type

[14]See Appendix 1 for a discussion.
[15]See Appendix 1 for a discussion.
[16]One could add additional penalties for certain micronutrient deficiencies to alter this prediction.
[17]See Appendix 1 for a discussion.

of sharp penalty for undernourishment. First, the model described above is consistent with poorer households devoting a larger share of their total expenditure to food. This pattern — Engel's Law — emerges in empirical work from across the world (e.g., Kaus 2013).

Second, there is an expanding body of evidence demonstrating that households tend to be especially averse to undernourishment. In response to income and price shocks in developing countries, diet quality is much more responsive to income shocks than calorie consumption, which is consistent with households sacrificing primarily non-staple spending in order to avoid hunger (e.g., Block et al. 2004; Brinkman et al. 2009; etc.). Additionally, only richer households reduce overall calorie consumption in response to strong price shocks, while the poorest households are unable to reduce calorie consumption in response to such shocks and tend to reduce expenditure on other non-food goods to avoid hunger (e.g., D'Souza and Jolliffe 2014; etc.).

Third, the addition of a sharp penalty on undernourishment offers an additional way to reconcile why traditional consumption models do a poor job of predicting food access in certain instances. Specifically, in the event of a strong increase in the price of staple grains, traditional models of consumption predict that individuals would pivot away from consumption of staple grains towards other food and non-food items, which are made relatively less expensive. But empirically, the exact opposite happens: when the price of staple grains increases rapidly, households actually reduce the quality of their diet and rely *more* on staple grains (e.g., D'Souza and Jolliffe 2012; Tandon 2014; Tandon and Landes 2015; etc.). One explanation is that staple grains might be Giffen goods, with the income effect outweighing the substitution effect. However, these patterns are also consistent with a sharp penalty on undernourishment limiting households' ability to substitute away from staple grains and forcing households to sacrifice more nutritious food items — which represent a more expensive source of calories — and non-food goods.

Section 4. Data

The data for our analysis are taken from the 2018/19 Nigerian Living Standards Sur-

vey (NLSS), the most recent official survey for measuring welfare and poverty in Nigeria. The NLSS sample comprises approximately 22,000 households and is representative of Nigeria's 36 states and the Federal Capital Territory (FCT), aside from the state of Borno.[18,19] The 2018/19 NLSS is a multipurpose household survey that allows us to compare monetary poverty and overall expenditure to poor food access using either the FIES or FCS for each household.

The consumption aggregate used to identify monetary poverty includes information on consumption of food and non-food items, and expenditures on health, education, housing, and meals consumed outside the home.[20] The consumption aggregate is deflated spatially and temporally using unit values from the food consumption module, and can then be compared with the national poverty line of 137,430 naira per person per year to calculate poverty statistics.

We further follow FAO guidance on the construction of the FIES, which suggests that under certain conditions it is possible to use the "raw score" — the sum of the eight dummy variables that comprise the FIES module — to classify households' food access status. These conditions are met using the NLSS 2018/19 and, following other analysis on Sub-Saharan Africa (e.g., Wambogo 2018), we classify those households with a raw score of 7 or 8 as severely food insecure and those with a raw score of 4, 5, or 6 as moderately food insecure.[21,22]

Furthermore, the 2018/19 NLSS contains the full FCS module. The FCS is calculated in the typical way, providing a direct measure of dietary diversity and food access at the household level. Each food group is given a score from zero to seven, depending on the

[18]Following the guidance of Nigeria's National Bureau of Statistics (NBS), we dropped Borno state from the analysis. The 2018/19 NLSS is not representative of Borno state because violence prevented the survey field teams from accessing all of the sampled enumeration areas. For further details see NBS (2020).

[19]The sample is also representative at the national and zonal level.

[20]Further details on the construction of the consumption aggregate with the 2018/19 NLSS can be found in World Bank (2020b).

[21]Specifically, the infit statistics should range between 0.7 and 1.3; in the 2018/19 NLSS data they range from 0.85 to 1.15 for each of the eight FIES components. Similarly, the Rasch reliability statistic is 0.77, placing the 2018/19 NLSS data within the range of most other datasets considered in FAO's cross-country analysis (e.g., FAO 2016). For more details, see FAO (2016).

[22]As a robustness check, we also calculate moderate and severe food insecurity at the zone level by directly applying the full Rasch model to FIES module in the 2018/19 NLSS to better account for zone differences. This is implemented using the RM.weights package in R (Cafiero et al. 2018b).

number of days out of the past seven on which it was consumed. The FCS is then a weighted sum of these components. Households are classified as having poor food access if they have a poor or borderline FCS, which is defined as less than or equal to 42 (WFP 2009).

Importantly, the 2018/19 NLSS was carefully implemented to ensure the data used in this paper are of high quality. First, the questionnaire was brought in line with international best practices. For example, food consumption was collected through a set of seven-day recall questions. Second, the 2018/19 NLSS made extra effort to allow households to express their food quantities in non-standard units of measurement to help households better estimate consumption. And third, the 2018/19 NLSS was designed and collected using Computer Assisted Personal Interviewing (CAPI) software on tablet devices. This made it possible to conduct real-time data-quality checks to ensure accuracy. Consequently, the data collected in the 2018/19 NLSS were of significantly higher quality than in previous survey rounds.[23]

The basic summary statistics for the 2018/19 NLSS are presented in Table 1 and illustrate a number of important patterns about welfare and food access in Nigeria. First, both poverty and poor food access are widespread in the country. At the national poverty line, 40.1 percent of Nigerians live in poverty. Furthermore, approximately 14.9 percent of Nigerians have poor food access according to the FCS. Given that the threshold commonly used to denote poor food access using the FCS is generally used to target emergency humanitarian assistance and has been associated with calorie consumption well below minimum daily energy requirements (e.g., WFP 2012; Mathiassen 2013; etc.), there is probably an even higher share of Nigerians that have poor food access according to recommended guidelines.

Second, the share of households that have poor food access using the FIES is significantly higher than that of the FCS. Approximately 57.3 percent of Nigerians are moderately food insecure or worse according the FIES, and approximately 25.9 percent

[23] For example, the 2009/10 HNLSS data were marked by implausible seasonal movements in consumption and contradictions of Engel's Law. These issues were eliminated in the 2018/19 NLSS. For further discussion of data issues in the 2009/10 HNLSS, see World Bank (2016).

of Nigerians are classified as severely food insecure. However, there is also variation between the different components of the FIES module: the most prevalent element of food insecurity is being unable to eat healthy or nutritious foods (FIES Component 2), affecting 72.4 percent of households, while the least prevalent element of food insecurity is going a whole day without eating (FIES Component 8), affecting 10.0 percent of households. Importantly, there is little the FIES can do to differentiate among the large share of the population that is categorized as severely food insecure since those individuals already affirm nearly all of the component questions.

And lastly, aside from differences between the FIES and the FCS in the share of the population that poor food access, there are significant differences in the identity of those having poor food access in the two measures. Table 2 reports that approximately 21.0 percent of Nigerians are severely food insecure according to the FIES but have an adequate FCS; and approximately 10.1 percent of individuals are either moderately food insecure or food secure according to the FIES and have either a poor or borderline FCS. Strikingly, these figures illustrate that approximately two-thirds of the population with poor food access according to the FCS, which is a critical threshold used to target emergency food assistance, would either be categorized as moderately food insecure or food secure according to the FIES.[24]

As mentioned in the background section, these inconsistencies between the FIES and the FCS are difficult to interpret precisely. Misalignment between food access measures could be driven by differences in the severity of thresholds defining poor food access, differences in the exact dimensions captured, or poor alignment of one or more of the food access measures with the underlying food access dimensions that they are trying to capture.

Specifically, the higher share of poor food access when using the FIES could be consistent with the fact that the FIES has a lower severity threshold than the possibly over-restrictive threshold used to denote poor food access using the FCS (e.g., WFP 2012;

[24] The exact figure is the share of households that have a poor or borderline FCS and either are moderately food insecure or are food secure according to the FIES, divided by the total share of the population with a poor or borderline FCS ($\frac{10.1}{(4.8+10.1)}$).

Mathiassen 2013; etc.). Or the higher share when using the FIES could be consistent with the fact that the measure is also extending the dimensions beyond just the quantity and quality of food consumed to include dimensions relating to anxiety over poor food consumption.

Yet it may also be the case that, in Nigeria, the FIES is poorly aligned with the dimensions of food access that it is trying to capture. The simple consumption model presented above suggests that several more severe food access deprivations, such as undernourishment, coincide with less severe deprivations, such as poor diet quality. Thus, one might expect nearly all of those households with poor food access using a measure that only captures severe food access problems to also have poor food access using a measure that better captures less severe food access problems. However, Table 2 demonstrates that this is not happening: many households have poor food access according to the FIES and adequate food access according to the FCS, as well as vice versa.

Section 5. Empirical Strategy

Based on the predictions from the simple model of consumption presented above, we estimate two empirical specifications that explore the relationship between the FIES and monetary poverty. First, we estimate the difference in the prevalence of poor food access between poor and non-poor populations using the official national poverty line:

$$(1) \qquad Poor\_Access\_FIES_i = \beta_0 + \beta_1 Poor_i + \varepsilon_i$$

where $Poor\_Access\_FIES$ is an indicator if the household i is categorized as severely food insecure by the FIES or is an indicator if household i is categorized as at least moderately food insecure by the FIES; and $Poor_i$ is an indicator if the household is monetarily poor using the national poverty line.[25] The estimate of β_0 represents the share of the non-poor

[25] The specification does not include any regional or month fixed effects. Although fixed effects could be added and the results are qualitatively identical, β_0 in the current specification has a straightforward interpretation that is meaningful to national reporting of food access statistics. Additionally, there are no control variables included in the specification, particularly those that are correlated with monetary poverty. Our goal is not to explain the complicated causal and reverse-causal relationship between

population that is categorized as moderately or severely food insecure using the FIES depending on the dependent variable; and the estimate of β_1 represents how much higher the share is for the poor population. Based on the simple model above, if there was a sufficiently large penalty to undernourishment, we would expect both the prevalence and the severity of undernourishment and undernutrition to be worse for poor Nigerians than for non-poor, which would correspond to $\beta_1 > 0$.

Given that the severity of undernourishment and undernutrition are exacerbated along the welfare distribution and not just discontinuously at the poverty line, and given that the income at which households begin to tackle macro- and micro-nutrient deficiencies is an empirical issue, we also estimate how the FIES varies across all expenditure deciles. Specifically, we estimate the following specification:

$$(2) \qquad Poor\_Access\_FIES_i = \beta_0 + \Sigma_{j=2}^{10} \beta_j Expend\_Decile_i^j + E_i$$

where $Expend\_Decile_i^j$ denotes the expenditure decile of household i based on the expenditure used to identify the household's poverty status, with higher deciles corresponding to higher levels of expenditure; and all other variables are the same as above. The estimate of β_0 represents the share of the population in the first expenditure decile — the poorest — that is categorized as either at least moderately food insecure or severely food insecure according to the FIES depending on the dependent variable; and each β_j represents how much larger the share is in decile j than in the poorest decile.

Based on the simple model above, if there was a sufficiently large penalty to undernourishment, we would expect both the prevalence and the severity of undernourishment and undernutrition to be worst for the Nigerians in the poorest expenditure decile and for food access to improve for higher deciles, which corresponds to $\beta_j < 0$ for all j and for β_j to decrease in j. Furthermore, the model also predicts this improvement in certain

poor food access and monetary poverty. Rather, we simply want to characterize how households divide consumption among food goods and between food and non-food goods given a fixed amount of income, regardless of educational attainment, household size, etc. Adding control variables would obscure this relationship.

dimensions of food access to be most rapid for the poorest Nigerians who are severely undernourished, such that the drop between the second and the first expenditure deciles should be larger than the drop between the ninth and eighth expenditure deciles. Put differently, the model predicts that $|\beta_2 - \beta_1| > |\beta_9 - \beta_8|$.

We also estimate both Specifications (1) and (2) using an indicator for a poor or borderline FCS as the dependent variable. This allows a comparison of the baseline relationship (the relationship between the FIES and monetary poverty) to the relationship between the poverty and a more widely vetted food access indicator that is a pivotal measure used to target emergency humanitarian assistance (e.g., WFP 2009). The estimates using the FCS provide an important benchmark of not only the signs of estimated coefficients, but also the magnitude of the difference between the poor and non-poor populations and how quickly poor food access might decline as expenditure increases.[26]

Section 6a. Baseline Empirical Results

The estimates of Specification (1) are reported in Table 3 and demonstrate that the FIES is poorly aligned with monetary poverty in Nigeria. Column (1) estimates a specification using an indicator equaling one if the household is severely food insecure according to the FIES and zero otherwise. The results demonstrate that there is a large share of the non-poor population that has poor food access according to the FIES and that there is little difference in the share with poor food access using the FIES between the poor and non-poor populations. Approximately 25.3 percent of non-poor Nigerians are severely food insecure according to the FIES; and the difference in the share between poor and non-poor Nigerians is statistically indistinguishable from zero. Importantly, one can reject the hypothesis of the share being larger than 3.3 percentage points more for poor Nigerians at standard significance levels.[27]

The lack of a large difference between poor and non-poor Nigerians in the share with poor food access using the FIES extends to other FIES thresholds as well. Column (2) re-

[26] We also estimate specifications that directly estimate how much larger the increase in poor food access is for poor households when using the FCS relative to using the FIES. See Appendix 2.

[27] This is the upper bound of the 95 percent confidence interval of the estimate of β_1.

estimates Specification (1) using an indicator equaling one if the household is moderately food insecure or worse using the FIES and zero otherwise as the dependent variable. Approximately 56.0 percent of the non-poor population is moderately food insecure or worse, which is more than double the figure in Column (1); and the share for poor Nigerians was 3.2 percentage points larger. Although the difference between poor and non-poor populations is statistically different from zero, the magnitude of the difference is a small share of the population and is very low relative to the large share of the population that is moderately food insecure or worse according to the FIES. Furthermore, we can still rule out the possibility of the share being much larger for the poor population, where one can reject the hypothesis that the share is more than 5.5 percentage points larger at standard significance levels.

The results for the FIES are in stark contrast to the strong alignment between the FCS and monetary poverty. Column (3) re-estimates Specification (1) using an indicator equaling one if the household had a poor or borderline FCS and zero otherwise as the dependent variable. Only a small share of the non-poor population had poor food access according to the FCS, and the difference in the share between the poor and non-poor populations was large. Specifically, only 7.2 percent of the non-poor population had poor food access according to the FCS; and the share among the poor population was 19.4 percentage points larger than among the non-poor population.[28]

Not only is the magnitude of the simple percentage point difference larger for the FCS than for the FIES (19.4 versus 1.4 and 3.2), the resulting share of the poor population with poor food access is very large relative to the share of the non-poor population. Specifically, using the FCS, the prevalence of poor food access for the poor population is 3.7 times that of the non-poor population. Alternatively, the share of the population that is either moderately food insecure or severely food insecure using the FIES is nearly identical between the poor and non-poor populations.

Importantly, the lack of a difference in the share with poor food access using the FIES between the poor and non-poor population extends to the ends of the welfare distribution.

[28] See Appendix 2 for estimates from a specification that directly compares the alignment of the FIES and monetary poverty to the alignment of the FCS and monetary poverty.

Table 4 reports estimates from Specification (2), which quantifies the difference in the share with poor food access between the first expenditure decile and all other expenditure deciles. Column (1) estimates a specification using an indicator for the household being severely food insecure according to the FIES as the dependent variable, and illustrates that there is little difference between the share that is severely food insecure in the lowest expenditure decile and the share in nearly every other expenditure decile.

The estimate of the constant in Column (1) of Table 4 illustrates that 26.4 percent of households in the first expenditure decile — the very poorest Nigerians — are severely food insecure according to the FIES, which is nearly identical to the average share reported for the country in Table 1. Additionally, aside from the indicator for the tenth decile — the very richest Nigerian households — the estimates are small in magnitude, imprecisely estimated, vary in sign, and are statistically indistinguishable from zero at standard significance levels. Only for the richest decile is the share that is severely food insecure lower by approximately 8.1 percentage points, with the poorest Nigerians having only 1.4 times the share of individuals that are severely food insecure than the richest Nigerians.

The FIES is similarly poorly aligned with expenditure using different thresholds to denote poor food access. Column (2) re-estimates Specification (2) using an indicator for the household being moderately food insecure or worse according to the FIES. Similar to Column (1), the share of the population that is moderately food insecure or worse is similar for nearly all expenditure deciles. Until the ninth expenditure decile, the estimates are again small in magnitude, imprecisely estimated, and are statistically indistinguishable from zero at standard significance levels. Only for the ninth and the tenth deciles is the share with poor access significantly lower than in the first decile, with the share declining by 8.7 and 20.5 percentage points respectively. However, even with the decline, the share of the very poorest Nigerians that were moderately food insecure or worse was only 1.5 times more than the share of the very richest Nigerians.

Again, these patterns are in stark contrast to the FCS. Column (3) re-estimates Specification (2) using an indicator for the household having a poor or borderline FCS as the

dependent variable. The estimates illustrate that poor food access according to the FCS is highly concentrated in lower expenditure deciles, quickly declines for higher expenditure levels, and is almost non-existent for the highest expenditure deciles. Specifically, the share with poor food access in the bottom expenditure decile is 42.3 percent, with the share declining for each higher expenditure decile. By the top two expenditure deciles, the share with poor food access is between 3.5 and 5.5 percent, and the share of the population in the poorest expenditure deciles is between 7.7 and 12 times the share in the top two deciles.

Additionally, consistent with the simple model of consumption with a sufficiently severe penalty on undernourishment, the decline in the share with poor food access is largest for the poorest households when using the FCS. The difference between the first and the second decile is 13.9 percentage points, the difference between the second and the third deciles is 8.1 percentage points, and all subsequent differences were less than five percentage points. Again, this is in stark contrast to the FIES where there was essentially no decline in poor food access until the very top of the income distribution, and then the decline was not by nearly as much as the decline in the FCS.

Along with the summary statistics presented in the data section, these results illustrate that the FIES is poorly aligned with both monetary poverty and the FCS. Despite the fact that the FCS and monetary poverty align well, it is possible that both of those measures are incorrectly identifying the segment of the population with the poorest food access. However, we demonstrate that this explanation is not likely.

First, we corroborate that the share of expenditure devoted to food, itself a measure of poor food access, is decreasing for higher levels of expenditure (Engel's law). Specifically, we re-estimate Specification (2), but use the share of expenditure devoted to food as a continuous dependent variable. The estimates are reported in Table 5. As expected, the share of expenditure that is devoted to food is sharply decreasing for higher expenditure deciles. The shares in the bottom two deciles are statistically indistinguishable, but the share becomes significantly smaller for each higher expenditure decile. By the top deciles, the share of expenditure devoted to food is around 22 percentage points lower than in

the bottom expenditure decile.

Second, we find that the regions that monetary poverty and the FCS are identifying as having the worst deprivations are corroborated by other food access surveys. Figure 1 illustrates that both measures identify the north of Nigeria as being the poorest and having the worst food access. Importantly, a wide variety of other sources identify the north as having the worst food access (e.g., FRAYM 2020; IPC 2021b; etc.). By contrast, Figure 1 also illustrates that the FIES identifies the south of the country as having worse food access, which is inconsistent with monetary poverty, the FCS, and other sources.[29]

Section 6b. Potential Reasons for Poor Alignment between the FCS and Other Welfare Indicators

Combined, the results suggest that one of the reasons that the FIES and the FCS are poorly aligned is that the FIES is likely identifying a segment of the population as having the worst food access that does not have the largest macro- and micro-nutrient deprivations. We further investigate differences in the patterns described in Table 4 by the component questions of the FIES to try to infer why this might be the case. Specifically, we re-estimate Specification (2), but use each of the component questions of the FIES as the dependent variables. The results are presented in Table 6.

There are two ways in which the question-specific patterns in Table 6 differ from the patterns using the entire scale presented in Table 4. First, the more subjective questions in the scale, that are more likely to rely on individual-specific scales that are difficult to compare across individuals, performed particularly poorly. Specifically, the share responding affirmatively to the first FIES question, which asked whether any adult worried about food consumption, was essentially indistinguishable between the lowest expenditure decile and all higher deciles except for the top one (Column 1). And the share answering affirmatively to the fifth FIES question, which asked whether any adult ate less than they thought they should, actually increased for higher expenditure deciles. The highest prevalence for that question was in the sixth and seventh deciles (Column 5),

[29] Importantly, these regional differences in the prevalence of poor food access between the FIES and other welfare indicators survive estimating the prevalence of poor food access using the full Rasch model. See Appendix 3 for details.

which is an expenditure threshold that is far above the poverty line and also above the point at which Nigerians are particularly vulnerable to falling into poverty in response to a shock (e.g., Lain and Vishwanath 2022).[30]

And second, there was a subset of questions that had the expected relationship with expenditure. In particular, the more objective questions that were associated with milder problems with food access sharply declined for higher expenditure deciles relative to the poorest Nigerian households by magnitudes similar to those for the FCS in Table 4. These questions included the second FIES question asking about being unable to eat healthy or nutritious foods and the third FIES question about eating only a few kinds of foods.

Although we cannot identify exactly why the FIES does not appear to be performing well in this context and much more work needs to be done, these question-specific results offer some potential guidance. First, given the many difficulties in interpreting responses to subjective questions in a given context, let alone comparing those responses across countries (e.g., Ravallion 2013; etc.), the performance of the FIES might be improved by either placing less emphasis on subjective questions or more carefully thinking about how to elicit behaviors associated with the stress the questions are supposed to capture. Additionally, given that some of the more objective questions seem to perform better than others, it could be important to adapt the coping strategies captured to specific country contexts. This is consistent with the advice provided for other food access indices derived from common food coping strategies (e.g., Maxwell and Caldwell 2008).

Section 7. Conclusion

The results demonstrate that the FIES is poorly aligned with monetary poverty, the FCS, and other estimates of poor food access in Nigeria. Although the current results are not able to gauge how well the FIES might be capturing dimensions of food access aside from macro- and micro-nutrient deprivations, the misalignment between the FIES and more traditional metrics used to target social protection programs makes it difficult

[30] The definition of vulnerable to falling into poverty in the official Poverty Assessment was defined as those with expenditure above the poverty line and below one-and-a-half times the poverty line. Approximately 25.4 percent of the population was classified as vulnerable to falling into poverty, with a total of 65.5 percent of the population being either poor or vulnerable to falling into poverty (Lain and Vishwanath 2022).

to interpret the FIES precisely in Nigeria and further calls into question using the FIES alone to monitor food access and target interventions.

However, these questions about the FIES raise broader questions about how best to interpret food access metrics in general. Better illustrating the dimensions of poor food access captured by each metric and ensuring a wide range of metrics are collected will help policy makers and researchers best monitor food access and address the mounting challenges. Once provided with this information, then a determination can be made about the weight to give to particular dimensions of poor food access when designing policies and evaluating progress in addressing poor food access. Given the challenging environment that is currently unfolding, with food price inflation accelerating globally (e.g., UN 2022), these issues are becoming increasingly urgent and national statistical systems need to be better prepared for the challenge.

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Table 1. Summary Statistics

Variable	Mean	St.Dev.	Min.	Median	Max.
FIES- Raw Score	3.96	2.73	0	4	8
FIES- Severely Food Insecure	0.26	0.44	0	0	1
FIES- Moderately Food Insecure	0.57	0.49	0	1	1
FCS- Raw Score	62.84	19.08	0	63	112
FCS- Poor or Borderline	0.15	0.36	0	0	1
Poor at the National Line	0.40	0.49	0	0	1
Deflated Expenditure in 2018/19 Naira	199532	161858	16063	161182	14562751
FIES 1- Worry	0.61	0.49	0	1	1
FIES 2- Healthy Foods	0.72	0.45	0	1	1
FIES 3- Few Types	0.68	0.47	0	1	1
FIES 4- Skipped Meals	0.49	0.50	0	0	1
FIES 5- Eat Less than Should	0.61	0.49	0	1	1
FIES 6- Ran Out of Food	0.38	0.48	0	0	1
FIES 7- Went to Bed Hungry	0.36	0.48	0	0	1
FIES 8- Whole Day No Food	0.10	0.30	0	0	1

Note: Each variable has 21,580 observations. Estimates exclude Borno. National poverty line in deflated 2018/19 naira set at 137,430 naira per person per year. Monetary consumption deflated spatially and temporally using unit values from the 2018/19 NLSS.

Table 2. Share of Total Population by FIES and FCS Status

	Poor or Borderline Access- FCS	Adequate Access- FCS	Total
Severely Food Insecure- FIES	4.82	21.04	25.86
Moderate Food Insecurity or Better - FIES	10.11	64.03	74.14
Total	14.93	85.07	100

Notes: Table reports the share of households by food access status using both the FIES and the FCS. The totals report the share of either poor or adequate food access for each indicator.

Table 3. Poor Food Access by Poverty Status

	Dependent Variables:		
Variables	Indicator for Severe Food Insecurity - FIES (1)	Indicator for Moderate Food Insecurity or Worse - FIES (2)	Indicator for Poor or Borderline Food Consumption Score (3)
Poor at the national line	0.0137	0.0323***	0.1941***
	(0.0096)	(0.0116)	(0.0087)
Constant	0.2532***	0.5604***	0.0715***
	(0.0068)	(0.0082)	(0.0035)
Observations	21580	21580	21580
R-squared	0.0002	0.001	0.0713

Notes: This table estimates the share of households that have poor food access according to the FIES and the FCS separately for the poor and non-poor populations in Nigeria using the national poverty line. Columns (1) - (3) respectively use as the dependent variable an indicator for the household being severely food insecure according to the FIES, an indicator for the household being moderately food insecure or worse according to the FIES, and an indicator for the household have a poor or borderline Food Consumption Score. Standard errors clustered at the PSU level are reported; *** denotes statistical significance at the 1 percent level; ** denotes statistical significance at the 5 percent level; and * denotes statistical significance at the 10 percent level.

Table 4. Poor Food Access by Expenditure Deciles

	Dependent Variables: Indicator for Severe Food Insecurity - FIES	Indicator for Moderate Food Insecurity or Worse - FIES	Indicator for Poor or Borderline Food Consumption Score
Variables	(1)	(2)	(3)
Decile 2	0.0113	-0.0192	-0.1386***
	(0.0197)	(0.0221)	(0.0214)
Decile 3	0.0011	-0.0386*	-0.2198***
	(0.0192)	(0.0218)	(0.0216)
Decile 4	0.0019	-0.0449*	-0.2692***
	(0.0206)	(0.023)	(0.0201)
Decile 5	0.0171	-0.0108	-0.3037***
	(0.020)	(0.0222)	(0.0201)
Decile 6	0.0248	-0.0011	-0.3389***
	(0.0208)	(0.0223)	(0.020)
Decile 7	0.0046	-0.0049	-0.3476***
	(0.0198)	(0.0225)	(0.0197)
Decile 8	-0.008	-0.0395*	-0.3627***
	(0.0197)	(0.0218)	(0.0197)
Decile 9	-0.022	-0.0872***	-0.3878***
	(0.0204)	(0.0225)	(0.0192)
Decile 10	-0.0812***	-0.2045***	-0.3678***
	(0.0195)	(0.0235)	(0.0196)
Constant	0.2637***	0.6184***	0.4229***
	(0.0147)	(0.0163)	(0.0189)
Observations	21580	21580	21580
R-squared	0.0041	0.0142	0.1075

Notes: This table estimates the share of households that have poor food access according to the FIES and the FCS separately for each expenditure decile in Nigeria, with the first expenditure decile omitted. Columns (1) - (3) respectively use as the dependent variable an indicator for the household being severely food insecure according to the FIES, an indicator for the household being moderately food insecure or worse according to the FIES, and an indicator for the household have a poor or borderline Food Consumption Score. Standard errors clustered at the PSU level are reported; *** denotes statistical significance at the 1 percent level; ** denotes statistical significance at the 5 percent level; and * denotes statistical significance at the 10 percent level.

Table 5. Share of Expenditure Devoted to Food by Total Expenditure

	Dependent Variable: Share of Expenditure Devoted to Food	
Variables	(1)	(2)
Poor at the National Line	0.1062***	-
	(0.0038)	
Decile 2	-	-0.0044
		(0.0056)
Decile 3	-	-0.0165***
		(0.0057)
Decile 4	-	-0.0353***
		(0.0065)
Decile 5	-	-0.0549***
		(0.0061)
Decile 6	-	-0.0751***
		(0.006)
Decile 7	-	-0.0906***
		(0.0061)
Decile 8	-	-0.1228***
		(0.0064)
Decile 9	-	-0.1580***
		(0.0065)
Decile 10	-	-0.2194***
		(0.007)
Constant	0.4651***	0.5854***
	(0.0032)	(0.0044)
Observations	21580	21580
R-squared	0.1118	0.191

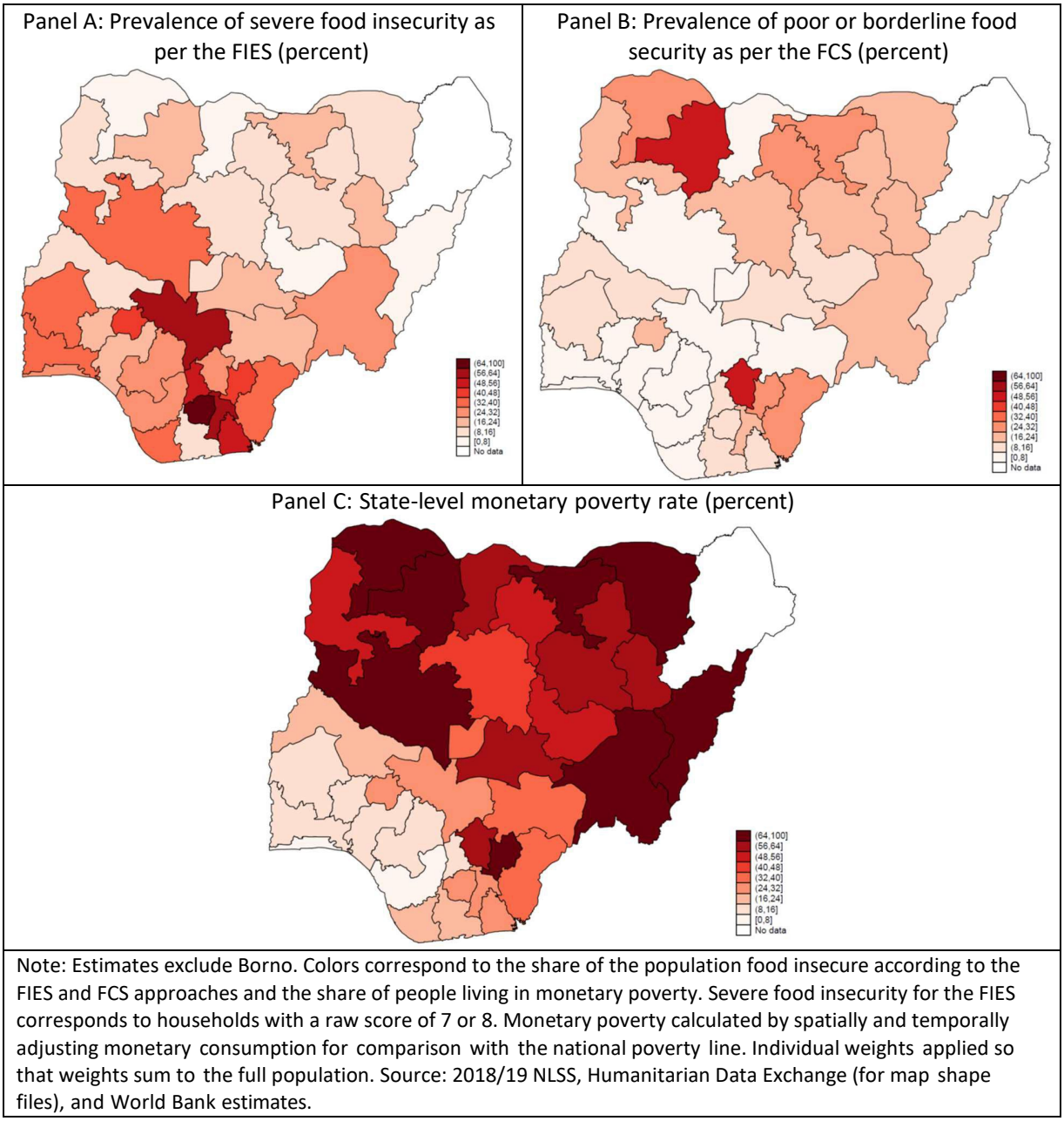
Notes: This table estimates the share of total expenditure devoted to food separately for expenditure deciles in Nigeria, with the first expenditure decile omitted. Column (1) regresses the share on a poverty indictor and column (2) regresses the share on expenditure decile indicators. Standard errors clustered at the PSU level are reported; *** denotes statistical significance at the 1 percent level; ** denotes statistical significance at the 5 percent level; and * denotes statistical significance at the 10 percent level.

Table 6. Share Responding Affirmatively to Individual FIES Questions

	Dependent Variables: Indicators for Household Answering Affirmatively to Each of the FIES Component Questions							
Variables	FIES 1- Worry (1)	FIES 2- Healthy Foods (2)	FIES 3- Few Types (3)	FIES 4- Skipped Meals (4)	FIES 5- Eat Less than Should (5)	FIES 6- Ran Out of Food (6)	FIES 7- Went to Bed Hungry (7)	FIES 8- Whole Day No Food (8)
Decile 2	-0.0513**	-0.0175	-0.0128	-0.0129	0.0293	0.0002	-0.016	-0.0074
	(0.0217)	(0.0176)	(0.0196)	(0.0229)	(0.0213)	(0.0214)	(0.022)	(0.0143)
Decile 3	-0.0369*	-0.0403**	-0.0346*	-0.0293	0.0006	-0.0093	-0.0394*	-0.0303**
	(0.0221)	(0.0187)	(0.0209)	(0.0232)	(0.0218)	(0.021)	(0.0219)	(0.0131)
Decile 4	-0.0493**	-0.0587***	-0.0617***	-0.0300	0.0069	0.0034	-0.0088	-0.0300**
	(0.0231)	(0.0195)	(0.0217)	(0.0234)	(0.0231)	(0.0224)	(0.0229)	(0.0138)
Decile 5	-0.0133	-0.0505***	-0.0191	-0.0007	0.0443*	0.0075	-0.0121	-0.0248*
	(0.0222)	(0.0195)	(0.0215)	(0.0238)	(0.0229)	(0.0215)	(0.0225)	(0.0137)
Decile 6	-0.0088	-0.0473***	-0.0394*	0.001	0.0556**	0.0304	0.0034	-0.0149
	(0.0223)	(0.0181)	(0.0204)	(0.0232)	(0.0222)	(0.0218)	(0.0234)	(0.0141)
Decile 7	-0.0101	-0.1016***	-0.0264	0.0006	0.0525**	0.004	-0.0245	-0.0504***
	(0.0225)	(0.0197)	(0.0203)	(0.0237)	(0.0218)	(0.0218)	(0.0229)	(0.0128)
Decile 8	-0.0356	-0.1377***	-0.0937***	-0.0217	0.0372*	-0.0108	-0.0415*	-0.0384***
	(0.022)	(0.0194)	(0.0216)	(0.0232)	(0.0219)	(0.0212)	(0.0222)	(0.0133)
Decile 9	-0.0469**	-0.1925***	-0.1208***	-0.0664***	-0.0039	-0.0353	-0.0622***	-0.0433***
	(0.0226)	(0.0203)	(0.0218)	(0.0233)	(0.0227)	(0.0221)	(0.0229)	(0.0152)
Decile 10	-0.1663***	-0.3263***	-0.2440***	-0.1654***	-0.1352***	-0.0922***	-0.1450***	-0.0574***
	(0.0235)	(0.0219)	(0.0225)	(0.0241)	(0.0229)	(0.0214)	(0.0218)	(0.0133)
Constant	0.6528***	0.8214***	0.7435***	0.5219***	0.6057***	0.3861***	0.3993***	0.1292***
	(0.0166)	(0.0134)	(0.0155)	(0.0176)	(0.0168)	(0.016)	(0.0169)	(0.0107)
Observations	21580	21580	21580	21580	21580	21580	21580	21580
R-squared	0.0086	0.0443	0.022	0.0094	0.0117	0.0042	0.0075	0.0034

Notes: This table estimates the share of households that answer affirmatively to each of the FIES component questions separately for each expenditure decile in Nigeria, with the first expenditure decile omitted. Standard errors clustered at the PSU level are reported; *** denotes statistical significance at the 1 percent level; ** denotes statistical significance at the 5 percent level; and * denotes statistical significance at the 10 percent level.

Figure 1. Food Access and Poverty by Region



Note: Estimates exclude Borno. Colors correspond to the share of the population food insecure according to the FIES and FCS approaches and the share of people living in monetary poverty. Severe food insecurity for the FIES corresponds to households with a raw score of 7 or 8. Monetary poverty calculated by spatially and temporally adjusting monetary consumption for comparison with the national poverty line. Individual weights applied so that weights sum to the full population. Source: 2018/19 NLSS, Humanitarian Data Exchange (for map shape files), and World Bank estimates.

Appendix 1a. Characterizing Consumption for Households Below a Sufficient Level of Income

Consider an individual whose income w is such that they could not reach their minimum daily energy requirement by spending all of their income only on the cheap calorie source. We can show there exists conditions such that the objective function is maximized consuming only x_1 as opposed to consuming a bundle with positive amounts of either x_2 or x_3.

Specifically, assume individual income is such that $c_1 \quad (w/p_1) < s$. Without a loss of generality, assume that this individual chose to consume $x_1 = (w - E)/p_1$ and $x_2 = E/p_2$ for $E > 0$. The difference in the objective function of the two bundles can be expressed as:

$$\Delta = \left(u\left(\frac{w}{p_1}, 0, 0\right) - f\left(\frac{c_1 \quad w}{p_1} - s\right) \right)^1 - \left(u\left(\frac{w - E}{p_1}, \frac{E}{p_2}, 0\right) - f\left(\frac{c_1 \quad (w - E)}{p_1} + \frac{c_2 \quad E}{p_2} - s\right) \right)^1$$

$$= \left(u\left(\frac{w}{p_1}, 0, 0\right) - u\left(\frac{w - E}{p_1}, \frac{E}{p_2}, 0\right) \right)^1 + \left(f\left(\frac{c_1 \quad (w - E)}{p_1} + \frac{c_2 \quad E}{p_2} - s\right) - f\left(\frac{c_1 \quad w}{p_1} - s\right) \right)^1$$

The assumption of calories from x_1 being cheaper than calories from x_2 (i.e., $\frac{c_1}{p_1} > \frac{c_2}{p_2}$) implies that $\frac{c_1 \ (w-E)}{p_1} + \frac{c_2 \ E}{p_2} - s < \frac{c_1 \ w}{p_1} - s$. Given the assumption that the penalty function f is decreasing in the total amount of calories above the MDER (i.e., the penalty is larger as the deficit gets larger), it follows that the second bracketed expression above is positive.

There are two separate scenarios under which the second bracketed expression can grow arbitrarily large and ensure $\Delta > 0$. In such a case, individuals only consume the staple good. First, it was assumed that the marginal change in the penalty function will grow arbitrarily large as income and calorie consumption approaches zero. As long as the marginal utility of consuming x_2 and x_3 are bounded, there exists a critical level of income $\bar{w}$ under which the penalty from foregoing any amount of x_1 outweighs any possible utility gain from diversifying consumption. In such a case, the second bracketed expression above becomes large and the individual will only consume x_1 and be undernourished.

Second, as long as the marginal utility of consuming x_2 and x_3 is bounded, it follows that we can choose a sufficiently punitive penalty function such that the marginal change of even a small change in calories when the individual is consuming below the MDER overwhelms any possible bounded increase in utility from consuming any positive amount of x_2. In such a case, Δ will be positive and the objective function is maximized by consuming only good x_1 for any income $w <= \frac{c^1}{p_1} \quad s$.

Appendix 1b. Characterizing Consumption above a Sufficient Level of Income

There are two cases to consider. First, consider the first case above where the penalty

function quickly declines as consumption approaches the MDER and the marginal utility of consuming small amounts of x_2 and x_3 potentially outweigh the cost of passing up additional calories from only consuming x_1 as total calorie consumption approaches s. In such a case, for income above $\bar{w}$, the first order conditions for the problem imply:

$$\frac{u_1(x)}{u_2(x)} = \frac{p_1}{p_2} + \frac{f'(c \cdot x - s)(c_1 p_2 - c_2 p_1)}{u_2(x) p_2} \tag{1}$$

$$\frac{u_1(x)}{u_3(x)} = \frac{p_1}{p_3} + \frac{c_1 f'(c \cdot x - s)}{u_3(x)} \tag{2}$$

These equations both differ from the standard utility maximization problem by the second term of the RHS. In each equation the second term of the RHS is negative given the assumption that the penalty function is decreasing in calories consumed, the assumption that the staple good is a cheaper source of calories, and the assumption of marginal utility being positive.[1] Thus, given that homothetic preferences imply that the LHS of (1) and (2) are decreasing in the ratio of the staple food to the more nutritious food ($\frac{x_1}{x_2}$) and the ratio of the staple food to all other goods ($\frac{x_1}{x_3}$), households who face a subsistence penalty choose a higher $\frac{x_1}{x_2}$ and $\frac{x_1}{x_3}$ than would be chosen in a standard utility maximization problem. In such a case, households are already beginning to reduce their micronutrient deprivations before they are adequately nourished.

The second case to consider is the case highlighted above where there is a sufficiently punitive penalty function such that households will only consume the staple good if they have wealth below the amount necessary to reach the MDER through consuming x_1 alone. In such a case, the above first order conditions no longer apply as the solution is necessarily a corner solution until $w = \frac{c^1}{p_1} s$. Once income reaches this level, the penalty function is zero. From this point, individuals will begin to consume x_2 and x_3 while always consuming enough x_1 to ensure the individual consumes enough calories to satisfy the MDER, and micro-nutrient deprivations would only begin to be addressed in households that are adequately nourished.

[1] The assumption $\frac{c_1}{c_2} > \frac{c_2}{c_2}$ implies that $c_1 p_2 - c_2 p_1 > 0$.

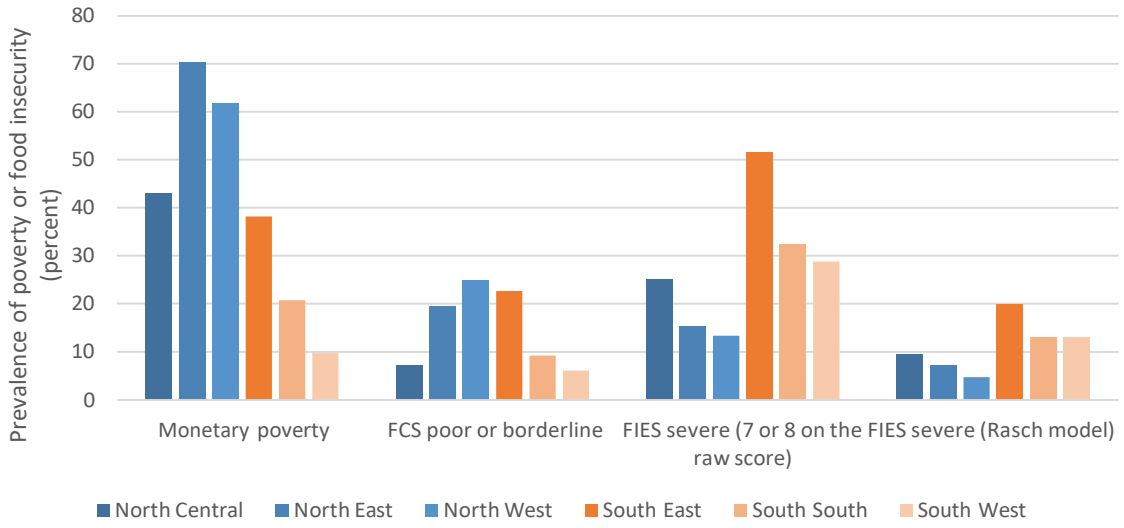
p_1 p_2

Appendix 2. Comparing the Increase in Poor Food Access for Poor Households Between the FCS and the FIES

	Dependent Variable: Indicator for Poor Food Access	
	FIES Poor Food Access Defined Using Threshold for Severely Food Insecure	FIES Poor Food Access Defined Using Threshold for Moderately Food Insecure or Worse
Variables	(1)	(2)
Poor at the national line	0.0137	0.0323***
	(0.0096)	(0.0116)
Indicator for Poor Food Access Defined Using FCS	-0.1817***	-0.4889***
	(0.0071)	(0.0085)
Poor x FCS Indicator	0.1804***	0.1618***
	(0.0125)	(0.0134)
Constant	0.2532***	0.5604***
	(0.0068)	(0.0082)
Observations	43,160	43,160
R-squared	0.0464	0.2149

Notes: This table estimates how much larger the increase in poor food access is for poor households when using the FCS than when using the FIES. Columns (1) and (2) respectively define poor food access when using the FIES using the threshold for severely food insecure and moderately food insecure or worse. Standard errors clustered at the PSU level are reported; *** denotes statistical significance at the 1 percent level; ** denotes statistical significance at the 5 percent level; and * denotes statistical significance at the 10 percent level.

Appendix 3, cont. Zone-level statistics on poverty and food access, including FIES estimates from the raw score and Rasch model



Note: Estimates exclude Borno. Monetary poverty calculated using the national poverty line of 137,430 naira per person per year, in 2018/19 prices. Rasch model implemented using the RM.weights package in R.