Urbanization, processed foods, and eating out in India

C. Bren d'Amour[a,b,c,*], B. Pandey[a], M. Reba[a], S. Ahmad[d], F. Creutzig[b,c], K.C. Seto[a]

[a]Yale School of Forestry and Environmental Studies, CT 06511, New Haven, USA

[b]Mercator Research Institute on Global Commons and Climate Change, 10829 Berlin, Germany

[c]Technische Universitaet Berlin, 10623 Berlin, Germany

[d]University of Glasgow, Glasgow G12 8QQ, Scotland

*Corresponding author: Yale School of Forestry and Environmental Studies, 380 Edwards Street New Haven, CT 06511, E-mail address: christopher.brendamour@yale.edu, Tel: +1(203)5353342

Abstract Urban consumption of processed and fast foods is a challenge to nutrition security. Observed differences in urban versus rural consumption are commonly attributed to higher income levels in urban areas. Yet, there is still no clear understanding why and how urban dwellers consume differently. Using India as case study, we analyze expenditure on processed foods and consumption of food away from home (FAFH) of urban, metropolitan, and rural populations using OLS regression models. We show that urban households spend more on processed foods and consume more FAFH than rural households. Most of this difference can be attributed to differing socio-economic and demographic factors, such as higher income, or smaller urban household size. However, even after controlling for these factors, we find differences not only between rural and urban areas but also between different urban areas: households in large metropolitan areas consume more than households in smaller non-metropolitan urban areas. These inter-urban variations suggest that the dichotomy of urban versus rural consumption does not adequately capture the full spectrum of food consumption complexity. Our findings indicate that the multidimensional process of urbanization is affecting how people consume food beyond shaping their socio-economic and demographic status and highlight the need to account for the role of urbanization—beyond an urban-rural dichotomy—when addressing the challenges associated with changing food consumption patterns.

Key words:

Urban food consumption, changing dietary patterns, urbanization, processed foods, food away from home, India

Highlights:

- We study determinants of consumption of processed foods and food away from home in India
- We differentiate between rural, non-metropolitan, and metropolitan urban areas
- We observe variation in consumption between different types of urban settings
- Dichotomy of urban versus rural consumption does not capture food consumption complexity
- A more nuanced understanding of urbanization's influence on food consumption is needed

1. Introduction

Addressing the challenges related to changing food consumption patterns—most notably malnutrition and environmental change—requires a better understanding of why people consume what they consume (Ingram 2017). Little consideration has been given to the fact that of the 9 billion people forecast to live on this planet in 2050, 6.7 billion will be living in urban areas (United Nations 2014). Compared to their rural counterparts, urban dwellers consume more diversified diets, mostly consisting of higher input grains, more animal products, more processed foods, as well as more food away from home (FAFH) (Popkin and Bisgrove 1988; Popkin 1999; Gaiha et al. 2009; Hawkes et al. 2017). These urban diets, combined with a more sedentary lifestyle, have wide-ranging implications for public health (Popkin 2001; Tilman and Clark 2014; Hawkes et al. 2017) and are linked to the environmental risk transition (Smith and Ezzati 2005; Seitzinger et al. 2012; Wu et al. 2017).

The studies related to urban food consumption span across different disciplines, including environmental sustainability, supply chains, food pricing, the nutrition transition, and food environments, among others (Popkin 1999; Regmi and Dyck 2001; Zhang and Wang 2003; Ma et al. 2006; Kearney 2010; Stage et al.

2010; Caspi et al. 2012; Reardon et al. 2014; Hovhannisyan and Devadoss 2017; Boyer et al. 2019). Overall, there is agreement that people living in urban areas consume differently than their rural counterparts. Yet, there is no clear understanding of *why* people consume differently in urban areas, nor do we clearly understand why variation exists within and between urban areas (Seto and Ramankutty 2016; Cockx et al. 2018). Many studies, for example, attribute the distinctness of urban diets to rising incomes or conflate rising incomes, westernization, and urbanization, or offer only a comparison of urban diets to rural ones. However, answering this question requires a better understanding of how urbanization is affecting what people consume (Hawkes et al. 2017). Do urban dwellers consume differently only because they have higher incomes, work different jobs, and live in smaller households? Or are there additional factors at play that relate more to the specific nature of urban areas?

Existing conceptualizations of the food environment-diet relationship suggest multiple dimensions of the local food environment that can influence diets—these dimensions include, availability, affordability, accessibility, acceptability, and accommodation (Caspi et al. 2012). Differences in these dimensions between urban and rural areas, as well as within and between urban areas themselves, can explain differences in diets. Similarly, social and individual factors such as skills, cognition, lifestyle, biology, and social networks can also influence diets (Story et al. 2008).

This current and dominant understanding of the urbanization-diet relationship is predicated on the increasing share of people living in urban areas and a binary understanding of 'urban' vs 'rural'. The literature on the nutrition transition, for example, differentiates urban from rural consumers and shows that urban populations in lower income countries are particularly at risks for nutrition related diseases and dietary excess (Popkin 1999; Mendez and Popkin 2004; Hawkes et al. 2017). While the importance of urbanization is explicitly acknowledged, the understanding of urbanization is still binary: the main distinction is whether a person lives in a city or not. However, urbanization is a process involving changes on multiple levels, including the share of people living in urban areas, urban area expansion, urban structure, and lifestyles. Time, for example, is valued differently in fast-paced urban environments,

partially because more women work outside of their home (Regmi and Dyck 2001). Better spatial and financial accessibility and higher availability of different food outlets are exposing urban consumers to new dietary options. These different dimensions of urbanization likely affect food systems in general, and ultimately what and how people consume (Seto and Ramankutty 2016).

How these multiple dimensions of urbanization affect food consumption, individually and collectively, is not well understood. As urbanization is not a uniform process, it is highly likely that there are differences in consumption between different urban areas, as confirmed by other studies (Boyer et al. 2019; Law et al. 2019). When analyzing determinants of consumption, there is a need to account for the fact that urbanization will affect consumption in multiple ways and differently. Therefore, here we build on the concept of the food environment and hypothesize that urbanization influences diets related to the level of urban development.

India is an interesting case to test this hypothesis for multiple reasons. As a predominantly rural country, with less than one-third of the total population living in urban areas (United Nations 2014), India is still in the early stages of its urban demographic transition, with comparatively low levels of urban population. Many urban households still lack access to basic amenities, such as electricity (Census of India 2011). In 2011, 79% of the urban population resided in settlements of 100,000 or fewer, and 52% lived in small towns and villages (Mitra et al. 2016). At the same time, India has extensive metropolitan areas such as New Delhi, Mumbai, or Bangalore. Understanding the current determinants of consumption, especially in India's more advanced metropolitan areas, will help to inform what can be expected in the future, as India continues to urbanize and urban areas continue to develop.

Here, we analyze determinants of processed food expenditure and FAFH consumption in rural, urban, and metropolitan households in India. We use household level consumer expenditure surveys from the National Sample Survey Office (NSSO) of India for the year 2010 (NSSO 2010). We use OLS regression models to identify determinants of household level expenditure and consumption. We further compare expenditure and consumption for 62 metropolitan urban areas. We conclude by discussing the

implications of our findings and how our findings on the role of urbanization in the context of food consumption in India complement the literature and inform important debates on changing food consumption patterns.

2. Materials and Methods

2.1. Data – National Survey Sample

The National Sample Survey Office (NSSO) conducts national household surveys across India. As part of the National Sample Survey, the NSSO collects data on consumer expenditure on a yearly basis. Our main analysis is based on the NSS round 66, which was sampled from July 2009 to June 2010. We supplement our main analysis with data from NSS round 55, sampled from July 1999 to June 2000. It is important to note that the two rounds use different recall periods, raising concerns regarding their comparability (Deaton 2003). Our main analysis is based on round 66 and we use round 55 as robustness check.

2.2. Data processing and terminology used in this study

We are interested in two items: (i) the number of meals consumed away from home *on payment*, and (ii) processed food expenditure. Ad (i): the survey provides information on four different types of FAFH consumption, for example from a school or the employer. We only focus on the 'on-payment' sub-section (i.e. consumed in restaurants etc.), which is reported in number of meals per household member during the last 30 days, because we are primarily interested in those meals that households actively bought themselves outside of their homes rather than those that were provided to them. We compute the average per capita value of households. Ad (ii): the NSSO list various food items as part of their processed foods category. We are interested in highly processed foods and include the following items: biscuits, cake and pastry, prepared sweets, salted refreshments, pickles, sauce, jam and jelly, and other processed foods (which includes purchased snacks). These processed food items are not home-produced. Some of them have information on the quantities consumed and the respective expenditure. Here, we focus on

expenditure for two reasons: (i) expenditure allows to aggregate across all processed food categories; and (ii) some items, such as biscuits or other processed foods, have no information on the quantities consumed. These aggregated expenditures are used to generate household level estimates. To determine the relative importance of processed foods for the overall breadbasket, we compute the share of processed food expenditure over total food expenditure at the household level which we use for our main analysis.

The NSS survey samples from two 'sectors': *rural* and *urban*. As we are also interested in inter-urban variation, we generate a *metropolitan* sector. To this end, we use data from the Census of India to identify districts that contain one of the metropolitan cities, which are defined as cities with a population exceeding 1 million inhabitants (see Table S1). We subsequently define these districts as metropolitan districts. In the process of re-assigning the households to the newly generated *metropolitan* sector, we assume that all urban households in a metropolitan district are living in metropolitan urban areas even though there might be multiple cities or towns in the district that may not be part of this particular metropolitan city. In doing so, we assume that all urban households in a metropolitan district share characteristics with the households in the related metropolitan city. It is also important to note that metropolitan areas are not metropolitan regions which at times span multiple districts.

Throughout the manuscript, we speak about 'areas' instead of 'sectors'. Further, our 'areas' will be referred to as *rural*, *urban*, and *metropolitan*. Technically, metropolitan areas are also urban and urban are all urban areas excluding those that are metropolitan. We use *2010* to refer to round 66. We further use the term *urban effect* which we define as variation in consumption between rural areas and urban areas that occurs with different levels of urban development, independent of differing socio-economic and demographic factors.

2.3. Methods

To identify determinants of processed foods and FAFH consumption, we run OLS regression models. We use the share of food expenditure spent on processed food and number of meals consumed away from home (per capita/month) as dependent variables.

For our models on FAFH consumption, we create a subset of only those households that consume at least one meal away from home. We control for a range of independent variables. Income is approximated by monthly per capita expenditure (MPCE, in rupees) and log transformed. We control for the household location with a categorical location variable. This location variable captures whether a household is located in a 'rural', 'urban', or 'metropolitan' area. Summary statistics can be found in Table S2.

Average household size and age are used to control for demographics of the households. To account for the fact that households in India might have a cooking aide, or a hired cook, we introduce a binary variable 'cooking aide'. We further introduce a binary variable to control if households have access to a cooking facility or not. We run our main models with state-level fixed effects to account for unobservable factors at the level of Indian states. To further analyze inter-urban variation, we compare expenditure on processed foods and FAFH consumption for the individual metropolitan areas (cf. Table S1 for a full list). To this end, we compute average values for the households in the respective metropolitan areas. In additional models in the SI, which we use as robustness checks, we further control for the level of education, the type of employment of the household head, and religion.

3. Results

The share spent on processed foods and FAFH consumption increases with income (Figure 1). Expenditure on processed foods increases with income in rural, urban, and metropolitan areas (Figure 1, A). Urban and metropolitan households spend more on processed foods than rural households in each income quartile excluding the lowest. Furthermore, in income quartiles 1 and 2, urban households spend more on processed foods compared to metropolitan households. This is different in the higher income quartiles: in the third, both spend approximately the same on processed foods (about 4%), while in the

fourth, metropolitan households spend 0.5 percentage points more (6.3% compared to 5.8%). The results from 2000 confirm the general picture of increasing consumption with increasing income and variation within income quartiles.

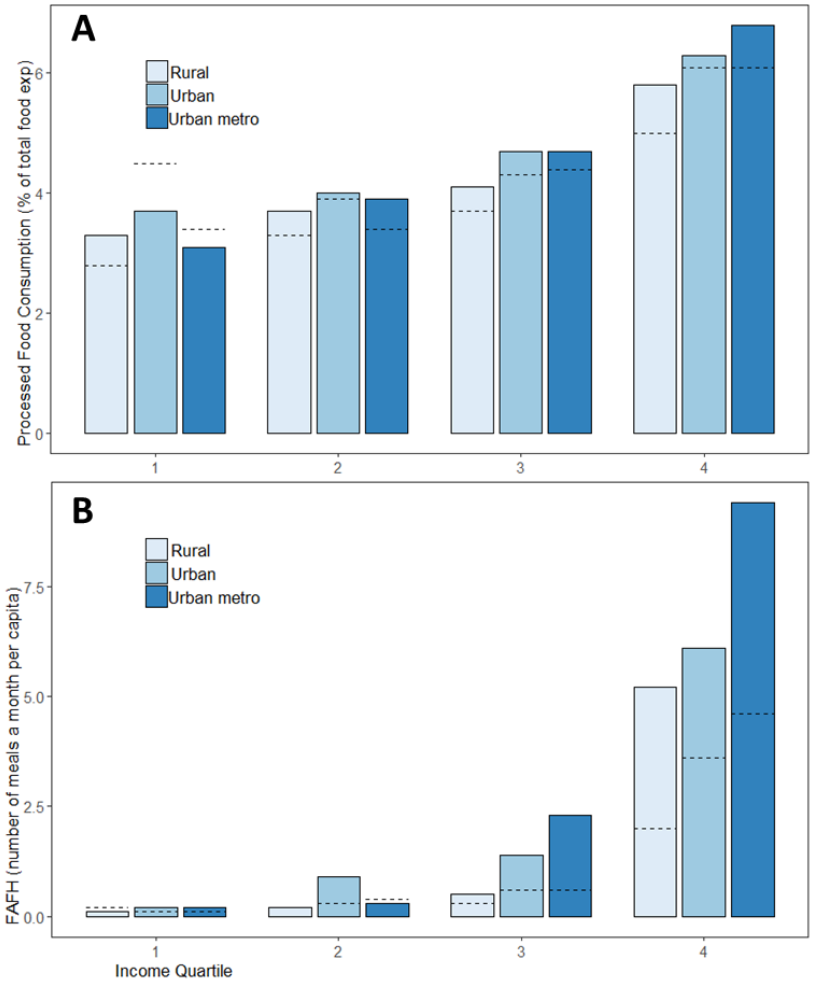

Figure 1 - Consumption by income quartiles and location in 2010. A) Processed food consumption is proxied by shares of total food expenditure; B) FAFH consumption in number of meals per capita over a 30-day period. Dashed lines represent values from 1999-2000 survey. Income quartiles are calculated for the entire population not for the individual areas, i.e. the same quartile breaks apply to rural, urban, and metropolitan populations.

The number of meals consumed away from home (in the following referred to as FAFH, panel B) is also increasing with income. Again, there are variations in consumption of FAFH within and between the income quartiles. In general, these variations are more pronounced for FAFH than they are for processed foods. The magnitude of these variations increases with income. In the third and fourth quartiles, there is

not only a notable increase in consumption compared to the respective lower quartiles but also a significant increase from rural to urban to metropolitan areas. Overall, the share of households that consume FAFH in metropolitan areas is more than twice as high as in rural areas (8% vs. 18%, cf. Table S2). Assuming that all households in the highest income quartile have sufficient income to purchase FAFH, this could indicate spatial accessibility and availability issues. More households in metropolitan areas might consume more food away from home because there are more options, something we discuss in more detail later. Households in metropolitan areas also spend more on processed foods in absolute terms (378 Rupees compared to 186 Rupees in rural and 234 Rupees in urban areas, cf. Table S2).

OLS regression results highlight additional urban effects

The differences in the same income quartiles indicate that there are additional factors that affect how people consume in urban surroundings. To identify these factors, we run linear OLS regression models. Both expenditure on processed foods and FAFH consumption increase with income (Table 1). A 10% increase in income leads to an average increase of 0.11 percentage points of processed food expenditure share and an average increase in meals away from home of 0.25. The results also show that the location of the households is significant in most cases: compared to rural households, households in urban and metropolitan areas spend more on processed foods (0.27 and 0.28 percentage points, respectively). The effect size is virtually the same for urban and metropolitan areas. So, while we observe an urban effect, the results for processed foods indicate no significant differences between urban and metropolitan areas. This result is different in the model without state-level fixed effects (model 1), where the effect size of metropolitan was higher than that of urban (0.38 compared to 0.27). This indicates that the urban effect in model 1 also captures variation that model 2 captures under the state-level fixed effects and this is the main reason why we use the state-level fixed effects for our main analysis. The results also hold when including additional variables, such as employment, education of the household head, or religion (Table S3).

For FAFH, the location variable is only significant for metropolitan areas (model 4). Households in metropolitan areas consume on average 0.8 more meals away from home than rural households. The differences in consumption between urban and metropolitan and urban and rural areas are not statistically significant.

There is a negative relationship between household size and both dependent variables. With every additional household member, the share spent on processed foods decreases by 0.2 percentage points and the average number of meals away from home decreases by 0.8. This also implies that smaller households spend and consume more of these items. Single households, in particular, are likely to consume significantly more FAFH. Household age is only a significant predictor for processed food expenditure, not for FAFH consumption, and associated with decreased expenditure, indicating that younger households spend a higher share on processed foods. There is no significant relationship between the household's average age and the number of meals consumed away from home.

Having a cook/cooking aide has mixed effects: it increases the expenditure share on processed foods by 0.8 percentage points and decreases the average number of meals consumed away from home by 2.2. The comparatively large effect size for FAFH is plausible. Households with a cooking aide do not need to eat out, for example to save time, because the meals are prepared for them.

The results further identify access to a cooking facility/kitchen as significant predictor: households that have no access spend 5.9 percentage points more on processed foods and consume 53 more meals away from home compared to households that have a cooking facility. The magnitudes of these effects indicate the households without access to a cooking facility are particularly associated with higher processed food expenditure and more FAFH consumption.

Table 1 - Cross sectional regression results for 2010. Linear OLS regression models are used, robust standard errors are reported. Dependent variables are (i) processed food expenditure share (% of total food expenditure), and (ii) FAFH on payment (number of meals) for households that eat out on payment. We run the models without (1 and 3) and with state level fixed effects (2 and 4). In the text, we report the findings from the models with state-level fixed effects (models 2 and 4). Models 3 and 4 are run on a subset of households that consume at least one meal away from home on payment. Summary statistics can be found in Table S2.

2010

	Dependent variable:			
	Processed food expenditure (% of total food expenditure)		FAFH on payment (no of meals per capita)	
	(1)	(2)	(3)	(4)
MPCE (log)	0.91*** (0.04)	1.11*** (0.04)	2.68*** (0.21)	2.64*** (0.22)
Urban (compared to rural)	0.27*** (0.03)	0.27*** (0.03)	0.33 (0.22)	0.09 (0.22)
Metro (compared to rural)	0.38*** (0.05)	0.28*** (0.05)	0.88*** (0.31)	0.81** (0.33)
HH size	-0.17*** (0.01)	-0.12*** (0.01)	-0.76*** (0.05)	-0.76*** (0.05)
Avg. HH age	-0.01*** (0.002)	-0.01*** (0.002)	0.02* (0.01)	0.02 (0.01)
Cooking aide (y/n)	1.18*** (0.07)	0.79*** (0.07)	-2.57*** (0.40)	-2.24*** (0.41)
No access to cooking facility (y/n)	6.42*** (0.35)	5.93*** (0.35)	52.72*** (0.55)	53.05*** (0.59)
Constant	-1.49*** (0.24)	-4.32*** (0.27)	-12.62*** (1.47)	-11.80*** (1.63)
State-level fixed effects	No	Yes	No	Yes
Observations	90,743	90,743	10,132	10,132
Adjusted R^2	0.11	0.17	0.81	0.82
Note:				*p**p***p<0.01

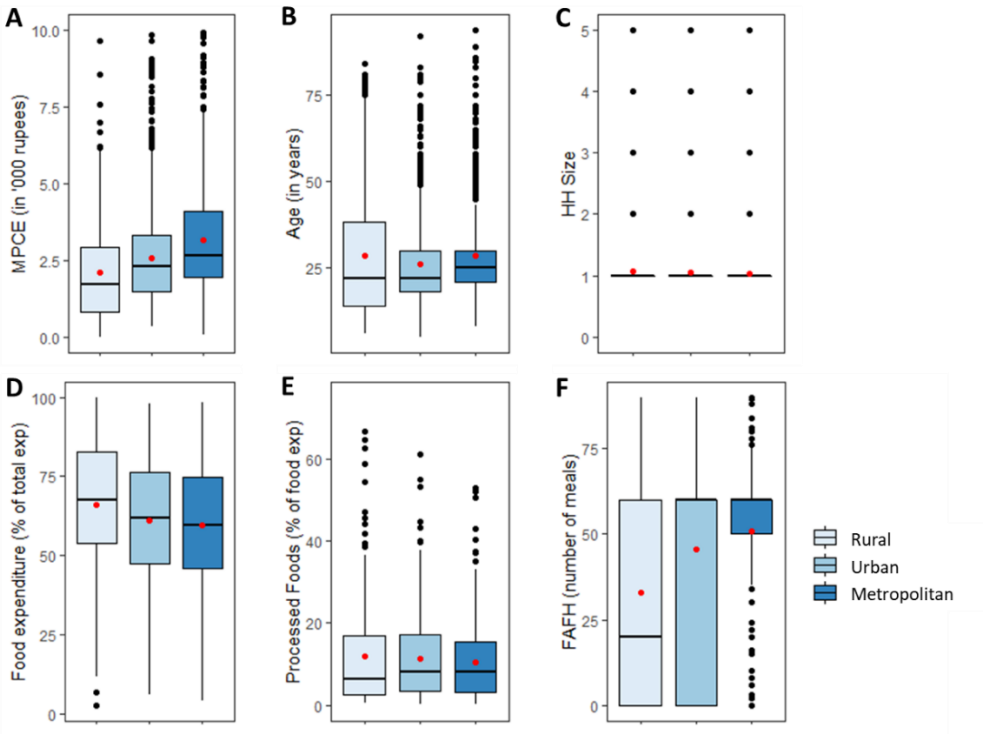

Figure 2 - Characteristics of households with no access to a cooking facility for rural, urban, and urban metropolitan areas in India in 2010. Presented are ranges of **A**) Income (proxied by MPCE), **B**) Age, **C**) Household size, **D**) Total Food Expenditure (share of total expenditure), **E**) Processed food expenditure (share of total food expenditure), **F**) FAFH on payment (number of meals). Red dots represent the averages. Bar chart presents additional information on the share of single households by sector as well as the share of single households without cooking facility.

The characteristics of these households are shown in Figure 2. These households are almost exclusively comprised of younger, single individuals who spend the largest share of their expenditure on food items (>50%), with up to 10% of this expenditure share allotted to processed foods in particular (Fig.2E). Importantly, they consume most of their meals outside their homes (Fig.2F). As these single households have no opportunity to prepare meals at home, it is plausible that they consume most of their meals away from home or in the form of processed snacks. Considering rural households, only 13% of single households do not have access to a cooking facility. This percentage increases to 33% for urban and 50% for single metropolitan households (Table S4). These results suggest that including households without access to a cooking facility might distort the results. To account for this concern, we re-run the models for

only those households that have access to a cooking facility (Table S5). While the R^2 drops significantly, the overall findings from our main models are confirmed. As a robustness check, we further run regression models for processed foods with expenditure as dependent variable rather than expenditure share (Table S6). While the models largely confirm the findings from Table 1, the urban location variable is no longer significant (the metropolitan location variable still is).

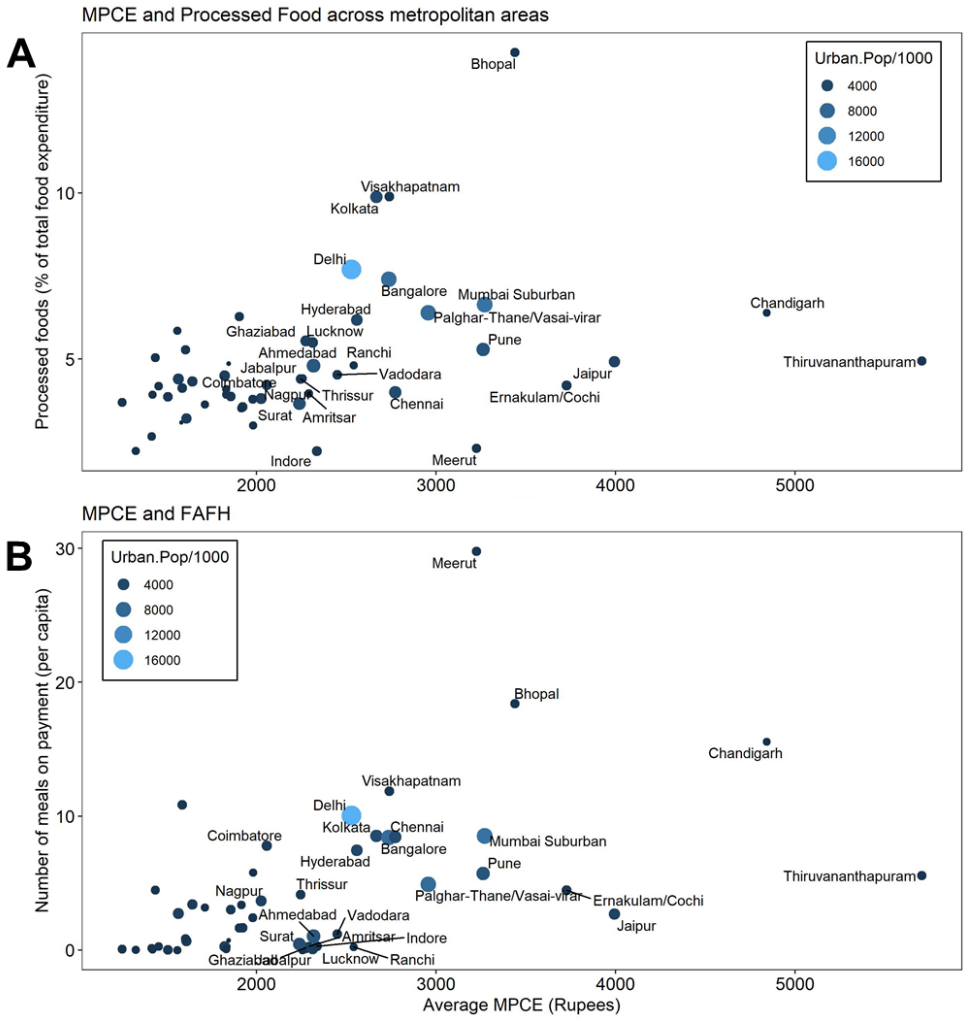

Figure 3 – Processed foods and FAFH consumption and MPCE across metropolitan areas. A) Processed food consumption, proxied by expenditure as share of total food expenditure. B) Food away from home consumption in number of meals per capita per month. Average monthly per capita expenditure (MPCE in Rupees) is used as a proxy for income. Bubble size and color represent the urban population of the metropolitan areas. Only metropolitan areas with avg. MPCE > 2000 Rupees are labelled. An overview over all areas can be found in Table S7. Note: these metropolitan areas correspond to districts, not individual cities. Districts can comprise multiple urban centers.

Variations between different urban areas

The OLS findings further suggest that there are variations in expenditure and consumption between urban and metropolitan households. To investigate these variations, we compare expenditure and consumption patterns across India's metropolitan areas (Figure 3).

We observe variation in expenditure and consumption between the metropolitan areas. In lower income regions, variation in processed food expenditure is comparatively low with most households spending between 2% and 5% of their total expenditure on processed foods (Fig. 3A). In metropolitan areas with higher income levels (e.g. >2,500 rupees MPCE), we see a larger variation in processed food expenditure shares. For example, Kolkata households on average spend 10% of their food expenditure on processed foods, while Jaipur households only spend about 5%. The findings on the relationship between income and FAFH consumption (Fig.3B) are similar. In lower income regions (< 2,500 rupees MPCE), FAFH consumption is lower or even non-existent for some metropolitan areas. Generally, people seem to consume more FAFH in higher income regions. However, as with processed food expenditure, the consumption varies and the relationship is not very clear. In this context, it is important to note that there is also variation within the respective metropolitan areas. In Chandigarh, for example, residents in higher income neighborhoods have been shown to dine out more frequently (Aloia et al. 2013). At the same time, however, households from both poorer and richer areas prefer home cooked over restaurant meals, and both recognize that home cooked food is healthier. This could explain why consumption of FAFH is low, despite the fact that average income in Chandigarh is higher.

Additionally, there are uncertainties, for instance due to the limited number of households in some metropolitan areas (cf. Table S7 for summary statistics). For FAFH consumption especially, the coefficients of variation (CV, ratio of the standard deviation to the mean) are very high (>1) in all metropolitan areas. The most likely reason is that not many households eat out (18%, Table S2) and that of the households that eat out, some consume almost all of their meals outside (those without a cooking facility).

To identify potential determinants, we analyze the socio-economic and demographic backgrounds of the average households from the individual metropolitan areas. Since the significant urban effect from our regression at the household level indicates that urbanization is affecting how people consume beyond socio-economics and demographics, we further include information on the total population and the built-up area of the metropolitan areas, as well as avg. household age and size (Figure 4).

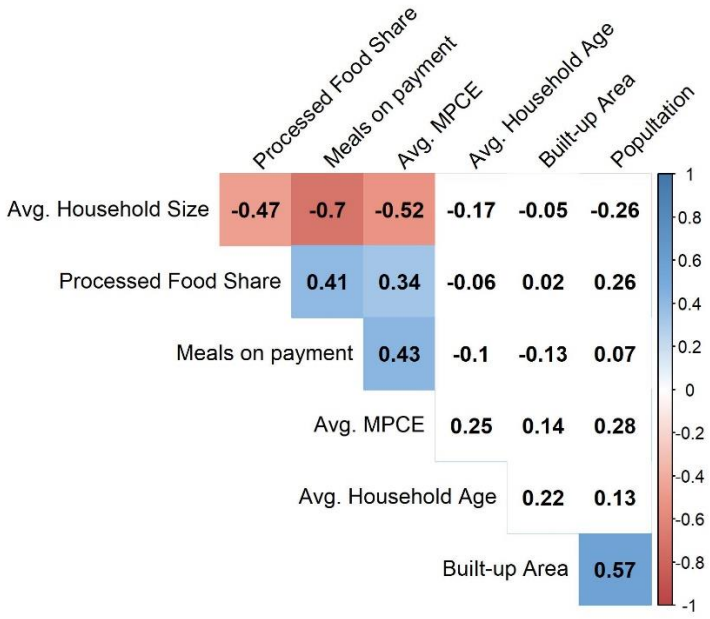

Figure 4 – Correlation matrix of metropolitan districts. Included are socio-economic and demographical factors as well as built-up area and urban population. Boxes are highlighted if the correlations are statistically significant.

We find that the expenditure of processed foods and the consumption of FAFH has the highest correlate with household size. There is a strong negative relationship, in particular for FAFH (correlation coefficient of -0.7). Household size is also negatively correlated with income (-0.52). These findings show that smaller households are associated with higher incomes, higher processed food expenditure shares, and more FAFH consumption. There is also a positive relationship between income and both items, although it is notably higher for FAFH (0.43 compared to 0.34).

Further, there is a significant positive correlation between processed food expenditure share and FAFH consumption, indicating that households that eat more outside are also likely to spend more on processed foods. There is no statistically significant correlation between neither built-up areas nor population size and processed food expenditure share and FAFH consumption. This shows that this urban effect is most likely not explained by the size of urban areas – whether that is in terms of built-up area or population.

4. Discussion

Our study shows that urban households spend more on processed foods and consume more away from home than their rural counterparts. Socio-economic and demographic factors explain parts of this variation. Independent of these factors, we observe an urban effect on expenditure and consumption. This effect is more pronounced in metropolitan areas than in urban areas, indicating that issues such as accessibility or availability of food service outlets play a role and that measurable differences between urban areas exist. We observe variation in expenditure and consumption among metropolitan areas. Our findings indicate that not only the changing socio-economic and demographic status of urban dwellers shape food consumption but also the urban areas themselves.

However, this work is not without limitations. First, our data and approach do not allow us to establish causality. Essentially, we generate stylized facts on urban consumption patterns in India using correlation analysis. As a result, we identify a significant urban effect through our categorical location variable. However, the data do not allow us to clearly identify what it contains. For instance, variations in consumption between households from different locations might be caused by geographical sorting of the population on the basis of other unobserved characteristics (e.g. Young 2013). Cultural influences that are not related to urbanization might also play a role when comparing consumption across different regions. To account for some of these features, we introduce state-level fixed effects.

Second, it is important to note that expenditure on food items does not correlate to actual food consumed. Generally, prices of packaged foods in India are regulated and must not exceed a government-set

maximum retail price (MRP). Nevertheless, price levels might differ; for instance, certain processed food items might be more expensive in remote or touristic locations, which might affect the quantities consumed. By analyzing expenditure, we are not able to determine the exact consumption. However, our use of state-level fixed effects accounts for some of the potential variation in prices between different states for processed food expenditure. Assuming that processed food item prices are higher in more remote and less accessible areas (e.g. rural or remote urban areas), the differences in actual consumption of processed foods would actually be greater than the observed differences in expenditure.

Third, there are concerns regarding the reliability of NSS and other expenditure survey data to get estimates of total calorie consumption. Smith (2015), for example, has shown that a key factor for reported undernourishment during India's economic growth was incomplete collection of data on FAFH (Smith 2015). Recent work by Fiedler and Yadav (Fiedler and Yadav 2017) proposes to capture FAFH at the individual level rather than the household level, which promises to increase the accuracy.

These inconsistencies point to a more general limitation of most expenditure surveys: the sources of FAFH are not clear. The NSS data does not provide any information regarding the origin of the FAFH on payment. Overall, there is a range of possible options for consuming FAFH, including food stalls, full service, and fast-food restaurants. We have compiled information on the number of food outlets in India (Figure 5, source: Euromonitor International 2017) and their growth over a ten-year period (2002-2012) to illustrate the potential implications of the trend of increasing FAFH. The number of full-service restaurants increased from 390k to 680k. At the same time, the number of street stalls and kiosks almost tripled from 440k to 1,165k over this period. While the numbers of fast food outlets are still comparatively low, the growth rate was similar to that of street stalls (+156% compared to +162%). This provides some indication that most of the additional meals that are consumed away from home are likely purchased from street stalls or kiosks. In any case, even though the fraction of people that it out on payment is still relatively low (cf. Table S2), it becomes increasingly important to capture what is being consumed away from home and from which type of food service outlet it is bought (Boyer et al. 2019).

Overall, the large variation in FAFH consumption between households and the dominant role of outliers, such as the households without access to a cooking facility, indicate that these results, especially on average consumption in metropolitan areas, should be interpreted with care.

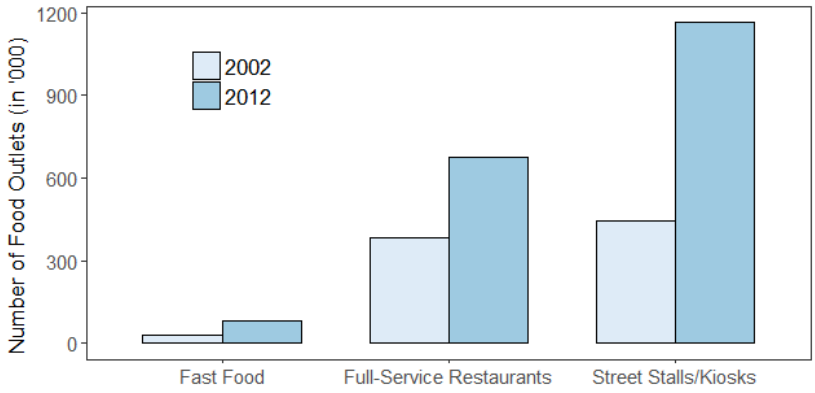

Figure 5 – Number and type of food service outlets in India, 2002 and 2012. Source: (Euromonitor International 2017).

Towards more processed foods and FAFH

It is well known that urbanization affects a range of socio-economic factors, most notably income (Popkin 1999). Here, we also find that income, which is highest in metropolitan areas (Table S2) affects expenditure on processed foods and the number of meals consumed away from home, confirming results from other countries, e.g. China (Ma et al. 2006; Liu et al. 2015). Beyond economic factors, our results show that whether or not a household has access to a cooking facility plays a major role in processed food and FAFH consumption. Virtually all of the households without access to a cooking facility are single households, most of which live in urban context (i.e. either urban or metropolitan, cf. Figure 2). These are most likely younger people that are renting a room and consume virtually all of their meals outside of their home. Given the trend towards more single households (Census of India 2011), we can expect an increase in these household constellations. Moreover, it is likely that these households will spend more on processed foods and consume more food away from home. A study from the US corroborates these findings—decreasing household size has been associated with increased consumption of FAFH (Stewart

and Yen 2004). Other studies also show that younger households consume more convenient foods in general, and highly processed foods in particular (Brunner et al. 2010).

Combined, these dynamics – increasing incomes, smaller and younger households, more single households – indicate that we are likely to observe a continuous increase in processed food and FAFH consumption in urban and metropolitan areas in the years to come.

The urban effect and processed food and FAFH consumption

Our results show an urban effect on the consumption of both processed foods and FAFH. After controlling for socio-economic and demographic variables, the location variable is significant, with few exceptions. The effect is more pronounced in metropolitan areas than in urban areas, implying that this urban effect becomes more visible in the metropolitan context—suggesting that the type and level of urbanization affect processed food and FAFH consumption. It is important to investigate how urbanization creates variation in the food environment to better understand food consumption patterns in a rapidly urbanizing world. Accessibility and availability of supermarkets and restaurants are likely to play a role. These food outlets might not be as accessible to lower income households, both spatially and financially, and are likely be more available in metropolitan areas. This could also explain differences in consumption between urban and metropolitan areas in the higher income quartiles in Figure 1B. Even though households in the highest income quartile have comparable income in all areas, we see that households from metropolitan areas consume much more away from home. Assuming that all of the households in this income quartile would have the financial means to access FAFH, it could indicate a lower availability that causes lower FAFH consumption. Although the food environment literature addresses both accessibility and availability, urban areas are often treated as a simple spatial variable related to geographic food access—such as proximity to nearest food outlet determined through a buffer or density measure (Caspi et al. 2012; Lytle and Sokol 2017). We assert that there is a more nuanced urbanization influence occurring which is still not well understood.

It is important to note that this urban effect is not just about urban households consuming differently than rural households. We observe that there is significant variation in the expenditure on processed foods and FAFH consumption among metropolitan areas of comparable average income. The variation for both food items is higher between metropolitan areas of a higher income level, here > 2,500 rupees MPCE. There seem to be other factors that vary between metropolitan areas that affect how households consume. Since this variation is higher in higher income metropolitan areas, this could be related again to factors such as spatial accessibility and availability in metropolitan areas. This is further reflected in the share of households that consume FAFH on payment: the share in metropolitan areas is almost twice as high as in other urban areas (18% vs. 11%, Table S2).

Convenience and convenience foods can also be considered part of the urban effect (Candel 2001; Brunner et al. 2010). As the opportunity cost of time increases in fast-paced urban environments, there is a natural tendency to look for convenient foods that are fast to prepare and often easy to get from a nearby vendor (Jabs and Devine 2006). Both the processed foods covered in this analysis and FAFH fall into this category. Although not quantified in this study, we assume that the time opportunity cost is one of the factors that influence how people consume in urban and metropolitan areas.

Implications for India's public health efforts

India has seen dramatic increases in noncommunicable diseases (Indian Council of Medical Research et al. 2017), many of which are linked to changing food consumption patterns. As the processed food items that we cover in this study – most notably sweet and salty highly processed snacks –are associated with noncommunicable diseases (Popkin et al. 2001; Garnett 2016), our findings are of particular importance to ongoing discussions on implications of dietary patterns for public health and nutrition security. Mitigating the risks for public health would require changes in existing and anticipated consumption. Changes in diets are the result of changes in environments, behavior, and food systems. Improving diets to mitigate negative public health outcomes hence requires policies that can address all of these drivers (IFPRI 2017). This includes policies at the national level, such as mandatory nutrition labelling of

packaged food (Lobstein and Davies 2009). Other available options include taxing of particularly unhealthy ultra-processed foods (Mytton et al. 2012), or educating about the importance of good nutrition. However, it is important to note that snacks and fast foods might be more prevalent in urban areas because people have less time to prepare their own meals. Hence, it may be harder to change the consumption of these convenience foods, especially when no healthy alternatives are available.

In the context of FAFH, the links to public health outcomes are less clear, mostly due to the lack of information on the source and the type. Fast-food is likely to have the biggest negative health impact (Rosenheck 2008). In the context of India, street stalls and kiosks play an important role (Fig. 4), which generally offer a wide variety of foods, ranging from traditional rice cakes to deep fried products (Choudhury et al. 2011). Depending on where the meals are bought, the health implications will vary. Hence, our findings underline the importance of accounting for food that is consumed away from home, specifically the type of foods. As the case of Chandigarh has shown, households are aware of the health ramifications of fast foods and as a result prefer home-cooked meals (Aloia et al. 2013). However, more research is needed to determine if urbanization and economic growth will lead to a shift in these perceptions and preferences.

Advancing our understanding of urbanization and food consumption

More generally, our findings highlight the importance of including urbanization processes when analyzing food consumption. Urbanization is often seen as the share of people living in urban areas. However, urbanization is much more than that. It affects socio-economic, demographic, and actual built up structures, but also how time is valued, how accessible and available food service outlet and retail options are (Seto and Ramankutty 2016). All of this has implications for the various aspects of food systems, shapes the local food environment, and will ultimately affect how people consume.

Our findings indicate that the rural urban dichotomy that has been used to formulate policies targeted to either rural or urban areas may be insufficient when it comes to addressing differences in food

consumption. The binary classification of households into ‘urban’ and ‘rural’ overlooks important variations between and within different urban areas. Urban in itself is more nuanced and this should be reflected in policies. However, while our findings indicate the importance of urbanization and how it relates to socio-economics and demographics of households, many open questions remain. A more conceptualized understanding of the role of urbanization and how it affects how people consume food would be an important guideline for further research.

Our findings could also potentially generate more reliable demand forecasts. Most current models estimate future demand based on projections of average incomes (Alexandratos and Bruinsma 2012). Accounting for the fact that most of the future demand is generated in urban areas could allow more precise estimates of numerous issues, ranging from resource use to prevalence of dietary related noncommunicable diseases.

5. Conclusion

Urban dwellers consume differently than their rural counterparts. In this study, we demonstrate that they spend more on processed foods and consume more away from home. These items are linked to dietary related noncommunicable diseases, and understanding the determinants of their consumption are hence important for tackling malnutrition, which is an increasingly important challenge across India, and, ultimately, nutrition security. Similarly, climate solution research seeks a more detailed understanding of the context and conditions of demand and consumption patterns to enable contextualized solutions (Creutzig et al. 2018). The urban component of changing demand plays a crucial role. However, the specific role of processed foods and food consumed away from home in this context is less clear, and crucially depends on the proportion of dairy and meat products, but also the detailed food supply chains (Edwards-Jones 2010; Sanjuán et al. 2014).

India’s Health of the Nation’s States report (Food Safety and Standards Authority of India 2018) has highlighted lifestyle changes as one of the reasons why dietary related noncommunicable diseases are on

the rise. Our findings underline the importance of these changes, and further emphasize the importance of urbanization in this context. India is still a predominantly rural country and the fact that it is in the earlier stages of its urban transition presents both a challenge and an opportunity. Purchases of ultra-processed foods have already increased rapidly (Law et al. 2019). As India continues to urbanize, more people are likely to consume more processed foods and FAFH. By recognizing the important role of urbanization and how it affects food consumption, there is an opportunity to use targeted policies to reduce the consumption of these food items and mitigate potentially negative health outcomes. By highlighting the role of urbanization as a multidimensional process, this study further provides a new perspective to the highly relevant literature on the determinants and drivers of dietary changes—beyond an urban-rural dichotomy.

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Conflict of interest

The authors declare no conflict of interest.

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Supplementary Material

Table S1 – List of metropolitan districts. District are sorted in terms of population (largest to smallest).

Metropolitan districts (n = 62)
Mumbai Suburban, Mumbai, Delhi (NW), Delhi (N), Delhi (NE), Delhi (E), New Delhi, Delhi (C), Delhi (W), Delhi (SW), Delhi (S), Kolkata, Chennai, Bangalore, Hyderabad, Ahmedabad, Pune, Surat, Jaipur, Ernakulam/Cochi, Kanpur Nagar, Lucknow, Nagpur, Ghaziabad, Indore, Coimbatore, Patna, Kozhikode, Bhopal, Thrissur, Vadodara, Agra, Visakhapatnam, Malappuram, Thiruvananthapuram, Kannur, Ludhiana, Nashik, Krishna/Vijayawada, Madurai, Varanasi, Meerut, Faridabad, Rajkot, Pashchimi Singhbhum/Jamshedpur, Jabalpur, Srinagar, Barddhaman/Asansol, Palghar-Thane/Vasai-virar, Allahabad, Dhanbad, Aurangabad, Amritsar, Jodhpur, Raipur, Ranchi, Gwalior, Kollam, Durg/Durg-Bhilainagar, Chandigarh, Tiruchirappalli, Kota

Table S2 – Summary statistics.

	Total		**Rural**		**Urban**		**Metropolitan**	
	N	**Share of total**	**N**	**Share of total**	**N**	**Share of total**	**N**	**Share of total**
Surveyed Households	100855	100%	59119	59%	30005	30%	11731	12%
Households that eat out on payment	10145	10%	4776	8%	3237	11%	2119	18%
Households with a cooking Aide	4740	5%	1060	2%	2181	7%	1499	13%
Households w/o Cooking Facility	1908	2%	324	1%	863	3%	721	6%
	Mean	**Std**	**Mean**	**Std**	**Mean**	**Std**	**Mean**	**Std**
FAFH total (# of meals per capita)	3.6	10.5	2.9	7.0	3.9	12.5	6.5	17.1
FAFH on payment (# of meals per capita)	1.2	8.0	0.4	4.0	1.7	9.7	4.0	14.6
Processed food exp (Rupees)	223	417	186	278	234	366	378	847
Processed food expenditure (% of total food expenditure	4.2	4.0	3.7	3.4	4.6	4.2	5.2	5.3
MPCE (Rupees)	1463	1462	1171	1136	1708	1524	2304	2157
Average Age of Household	30.2	12.1	29.9	12.1	30.5	11.9	31.5	12.3

Table S3 - Cross sectional regression results for 2010 including additional independent variables. Linear OLS regression models are used, robust standard errors are reported. Dependent variables are (i) processed food expenditure share (% of total food expenditure), and (ii) FAFH on payment (number of meals) for households that eat out on payment. We run the models without (1 and 3) and with state level fixed effects (2 and 4). These regression models confirm the results from the main models.

2010

	Dependent variable:			
	Processed food expenditure (% of total food expenditure)		FAFH on payment (no of meals per capita)	
	(1)	(2)	(3)	(4)
MPCE (log)	0.99*** (0.03)	1.15*** (0.04)	3.10*** (0.21)	3.13*** (0.22)
Urban (compared to rural)	0.16*** (0.03)	0.17*** (0.03)	0.27 (0.20)	0.04 (0.21)
Metro (compared to rural)	0.27*** (0.05)	0.20*** (0.05)	0.97*** (0.30)	0.98*** (0.32)
HH size	-0.14*** (0.01)	-0.09*** (0.01)	-0.55*** (0.04)	-0.55*** (0.04)
Avg. HH age	-0.01*** (0.001)	-0.02*** (0.001)	0.02* (0.01)	0.01 (0.01)
Cooking aide (y/n)	1.11*** (0.07)	0.70*** (0.07)	-2.06*** (0.37)	-1.96*** (0.38)
No access to cooking facility (y/n)	5.95*** (0.41)	5.47*** (0.41)	53.11*** (0.67)	53.38*** (0.74)
Employ: Agriculture (compared to no employment)	0.61*** (0.14)	0.38** (0.15)	0.81 (1.07)	0.22 (1.06)
Employ: Industry (compared to no employment)	0.88*** (0.14)	0.61*** (0.15)	1.69 (1.06)	1.18 (1.06)
Employ: Services (compared to no employment)	0.95*** (0.14)	0.69*** (0.15)	0.53 (1.06)	0.17 (1.06)
Employ: basic Services (compared to no employment)	1.06*** (0.16)	0.70*** (0.17)	0.72 (1.20)	0.22 (1.20)
Edu: Literate (compared to illiterate)	-0.46* (0.25)	-0.44* (0.24)	-1.35 (2.24)	-0.85 (2.28)
Edu: other (compared to illiterate)	-0.25*** (0.09)	-0.30*** (0.09)	-1.45 (1.04)	-1.40 (1.04)
Edu: Primary (compared to illiterate)	-0.25*** (0.07)	-0.35*** (0.07)	-1.73* (0.96)	-1.57 (0.97)

Edu: Secondary (compared to illiterate)	-0.30*** (0.08)	-0.35*** (0.07)	-2.16** (0.97)	-2.07** (0.98)
Edu: Graduate (compared to illiterate)	-0.11 (0.08)	-0.16** (0.08)	-3.12*** (0.98)	-2.99*** (0.99)
Religion: Islam (compared to Hindu)	-0.44*** (0.03)	-0.48*** (0.04)	-0.11 (0.25)	-0.34 (0.26)
Religion: Christian (compared to Hindu)	-0.28*** (0.05)	-0.12 (0.08)	-0.92*** (0.21)	0.12 (0.36)
Religion: other (compared to Hindu)	-0.45*** (0.05)	0.23*** (0.06)	-0.38 (0.41)	-0.04 (0.51)
Constant	-2.66*** (0.28)	-4.60*** (0.31)	-15.43*** (2.09)	-14.72*** (2.20)
State-level fixed effects	No	Yes	No	Yes
Observations	84,767	84,767	9,158	9,158
Adjusted R^2	0.11	0.17	0.80	0.81
Note:				*p**p***p<0.01

Table S4- Single households and their access to a cooking facility in 2010, by sector. Note: these correspond to the single households covered in the survey.

	Single HHs (% of total HHs)	**Single HHs w/o cooking facility (% of single HHs)**
Metropolitan	12.0	50.0
Urban	8.4	33.3
Rural	4.0	13.3
Total	6.2	29.6

Table S5- Cross sectional regression results for 2010 for households that have access to a cooking facility. Linear OLS regression models are used, robust standard errors are depicted. Dependent variables are (i) processed food expenditure share (% of total food expenditure), and (ii) FAFH on payment (number of meals) for households that eat out on payment. Models were run with state level fixed effects.

2010

	Dependent variable:	
	Processed food expenditure (% of total food expenditure)	FAFH on payment (no of meals per capita)
	(1)	(2)
MPCE (log)	1.22*** (0.03)	2.20*** (0.20)
Urban (compared to rural)	0.26*** (0.03)	0.24 (0.20)
Metro (compared to rural)	0.26*** (0.04)	1.21*** (0.31)
HH size	-0.11*** (0.01)	-0.82*** (0.05)
Avg. HH age	-0.01*** (0.001)	0.03** (0.02)
Cooking aide (y/n)	0.71*** (0.07)	-2.45*** (0.38)
Constant	-5.14*** (0.21)	-8.76*** (1.49)
State-level fixed effects	Yes	Yes
Observations	89,283	8,724
Adjusted R^2	0.14	0.15
Note:		*p**p***p<0.01

Table S6- Cross sectional regression results for 2010 using expenditure. Linear OLS regression models are used, robust standard errors are depicted. Dependent variables are (i) processed food expenditure (in Rupees). Model 2 was run with state level fixed effects.

2010

	Dependent variable:	
	Processed food expenditure (in Rupees)	
	(1)	(2)
MPCE (log)	112.92*** (2.42)	117.61*** (2.63)
Urban (compared to rural)	2.15 (1.31)	1.69 (1.31)
Metro (compared to rural)	10.25*** (2.38)	6.86*** (2.36)
HH size	18.42*** (0.38)	19.84*** (0.40)
Avg. HH age	-0.58*** (0.04)	-0.67*** (0.04)
Cooking aide (y/n)	75.17*** (4.91)	64.24*** (4.73)
No access to cooking facility (y/n)	40.58*** (5.46)	23.64*** (5.54)
Constant	-752.17*** (17.21)	-832.31*** (19.61)
State-level fixed effects	No	Yes
Observations	90,743	90,743
Adjusted R^2	0.22	0.25
Note:		*p**p***p<0.01

Table S7- Summary statistics for metropolitan areas, in alphabetical order. Presented are the number of households that are covered by the 66th survey (i.e. urban households are from one of the metropolitan districts), as well as the mean, standard deviation, and coefficient of variation (CV, ratio of the standard deviation to the mean) for MPCE, the share spend on processed foods, and the number of meals away from home on payment. The averages and standard deviations were computed using survey weights. Note that the sample size for some areas is relatively low. We only report one aggregate value for Delhi.

Metropolitan area		MPCE			Processed food exp share			Number of meals on payment		
Name	**# of HH**	**Mean**	**Std**	**CV**	**Mean**	**Std**	**CV**	**Mean**	**Std**	**CV**
Agra	96	1504.9	1117.8	0.7	3.9	2.4	0.6	0.0	0.3	16.4
Ahmedabad	318	2316.3	1906.3	0.8	4.8	3.1	0.7	1.0	7.3	7.0
Allahabad	63	1455.1	1046.0	0.7	4.2	2.5	0.6	0.2	1.0	4.3
Amritsar	192	2291.3	2305.7	1.0	4.0	2.7	0.7	0.3	1.7	6.0
Aurangabad	96	1843.2	1326.8	0.7	4.9	4.0	0.8	0.7	6.3	8.6
Bangalore	447	2737.5	1696.7	0.6	7.4	5.5	0.7	8.4	17.1	2.0
Barddhaman/Asansol	256	1563.2	1490.0	1.0	4.4	3.5	0.8	2.7	11.6	4.2
Bhopal	124	3439.1	2752.5	0.8	14.2	11.7	0.8	18.4	27.4	1.5
Chandigarh	273	4841.9	5766.1	1.2	6.4	12.1	1.9	15.5	32.4	2.1
Chennai	351	2772.3	1967.1	0.7	4.0	2.6	0.6	8.4	23.4	2.8
Coimbatore	312	2055.2	1593.0	0.8	4.2	3.1	0.7	7.8	22.8	2.9
Delhi	842	2528.9	1832.9	0.7	7.7	7.4	1.0	10.0	22.2	2.2
Dhanbad	96	1435.9	764.8	0.5	5.0	3.9	0.8	4.5	14.7	3.3
Durg/Durg-Bhilainagar	96	1831.0	2172.3	1.2	4.1	9.4	2.3	0.1	0.5	9.3
Ernakulam/Cochi	249	3727.8	7646.4	2.1	4.2	3.6	0.9	4.4	13.7	3.1
Faridabad	160	1832.9	1260.1	0.7	3.9	3.0	0.8	0.2	2.5	11.0
Ghaziabad	95	2274.7	1423.1	0.6	5.6	2.3	0.4	0.2	0.9	5.2
Gwalior	64	1558.5	673.4	0.4	5.8	3.4	0.6	0.0	0.0	
Hyderabad	504	2557.6	1876.9	0.7	6.2	5.5	0.9	7.4	19.5	2.6
Indore	123	2335.9	1336.0	0.6	2.2	2.0	0.9	0.3	2.6	9.0
Jabalpur	57	2256.6	2568.5	1.1	4.4	3.9	0.9	0.0	0.0	
Jaipur	278	3994.2	18266.3	4.6	4.9	4.3	0.9	2.7	11.6	4.3
Jodhpur	64	1419.6	676.1	0.5	3.9	2.7	0.7	0.0	0.3	6.9
Kannur	256	1978.8	3205.9	1.6	3.8	2.9	0.8	2.4	8.4	3.5
Kanpur Nagar	128	1821.5	1305.4	0.7	4.5	3.1	0.7	0.2	2.6	10.3
Kolkata	480	2666.0	2322.3	0.9	9.9	8.4	0.9	8.5	19.8	2.3
Kollam	96	1980.0	1710.5	0.9	3.0	1.9	0.6	5.8	17.1	3.0
Kota	64	1710.7	1299.7	0.8	3.6	2.5	0.7	3.2	13.4	4.2
Kozhikode	256	1584.3	1503.5	0.9	4.1	2.4	0.6	10.8	25.0	2.3
Krishna/Vijayawada	160	1904.6	1047.4	0.5	6.3	5.6	0.9	1.6	8.4	5.2
Lucknow	128	2312.9	2376.6	1.0	5.5	4.6	0.8	0.1	0.4	6.0
Ludhiana	254	1855.7	1185.6	0.6	3.9	3.5	0.9	3.0	12.3	4.1
Madurai										

Malappuram	96	1605.0	1269.5	0.8	5.3	3.5	0.7	0.8	2.9	3.5
Meerut	95	3226.1	1638.4	0.5	2.3	2.5	1.1	29.8	29.9	1.0
Mumbai										
Mumbai (Suburban)	766	3269.1	4015.5	1.2	6.6	4.7	0.7	8.5	20.0	2.3
Nagpur	253	2025.4	1556.4	0.8	3.8	3.4	0.9	3.7	13.2	3.6
Nashik	192	1608.4	1143.0	0.7	3.2	2.4	0.7	0.7	5.5	8.2
Palghar-Thane/Vasai-virar	564	2957.3	2695.1	0.9	6.4	4.7	0.7	4.9	15.1	3.1
Pashchimi Singhbhum/Jamshedpur	93	1581.4	1231.9	0.8	3.1	2.4	0.8	10.8	22.4	2.1
Patna	128	1641.4	1166.6	0.7	4.3	4.1	1.0	3.4	9.8	2.9
Pune	415	3262.1	5163.9	1.6	5.3	4.8	0.9	5.7	16.0	2.8
Raipur	96	1415.3	1084.0	0.8	2.7	3.1	1.2	0.1	2.3	18.5
Rajkot	160	1922.1	1046.9	0.5	3.6	2.4	0.7	1.7	9.4	5.6
Ranchi	96	2541.0	2724.3	1.1	4.8	3.0	0.6	0.2	2.7	12.5
Srinagar	376	1326.7	608.5	0.5	2.2	1.5	0.7	0.0	0.2	12.4
Surat	244	2239.6	1273.4	0.6	3.7	2.9	0.8	0.4	4.8	10.8
Thiruvananthapuram	223	5705.9	23437.1	4.1	4.9	5.6	1.1	5.6	16.1	2.9
Thrissur	191	2244.6	3115.3	1.4	4.4	3.6	0.8	4.2	15.7	3.8
Tiruchirappalli	128	1916.2	3104.6	1.6	3.5	1.7	0.5	3.4	11.2	3.3
Vadodara	158	2449.0	3328.5	1.4	4.5	2.7	0.6	1.2	5.5	4.5
Varanasi	95	1250.2	910.0	0.7	3.7	2.6	0.7	0.1	1.0	14.6
Visakhapatnam	224	2738.5	2665.3	1.0	9.9	8.1	0.8	11.9	22.4	1.9