

Inside the Black Box: Pathways Between Food Security and Household Composition in Urban China

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Abstract

The relationship between household composition and food security has been extensively studied, yet findings remain divergent, and the mechanisms linking the two are rarely made explicit. This leaves the relationship in something of a “black box.” This paper addresses three indirect pathways that may mediate the relationship: food affordability, household time constraints, and family food skills. Drawing on a citywide household survey of 1,210 households in Nanjing, China, and using generalized structural equation modelling, the study tests whether the link between household composition and food insecurity is mediated by these three variables. The analysis of food security focuses on the quality and cultural desirability of food, dimensions poorly captured by universalizing metrics such as the FIES but especially salient in Chinese cities. The results confirm that all three pathways are significantly associated with food insecurity and reveal that different household types are exposed to different mechanisms. Unaffordability heightens risk for single-person households and childless couples; the presence of a homemaker or pensioner is strongly protective, particularly in multigenerational and intergenerational households; and limited food-preparation capacity compounds vulnerability among single-person households. By disaggregating these pathways, the study shows that household composition shapes food security both directly and indirectly, and offers a transferable framework for research in other urban contexts in low- and middle-income countries.

Keywords

time constraints, unaffordability, food skills, food security, household composition

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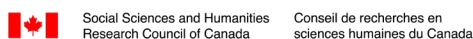
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Cover Image

Family members at a restaurant in Nanjing. Photo credit: Jonathan Crush

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Introduction

The relationship between household composition and food security has been a recurring focus in recent food studies literature. Some report that household structure is a critical determinant of household food security (Creedon et al., 2021; Owoo, 2018; Sharafkhani et al., 2010), while others find no statistically significant association between the two (Miller et al., 2014; Morales et al., 2021). One challenge in comparing such divergent results is that household composition and food security are defined and measured in variable ways. The standard, oft-cited definition of food security comes from the FAO (1996), which defines it as existing when “all people, at all times, have physical and economic access to sufficient safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life.” From this definition, four main dimensions of food security are commonly identified: (a) the physical availability of food; (b) economic and physical access to food; (c) food utilization, including dietary diversity and nutrient intake; and (d) the stability of the other three dimensions over time. This familiar definition and typology of food security seem completely at odds with Candel’s (2014) opinion. He made a case for approaching food security as a “wicked problem” (p. 285) whose definition and measurement remain “ill defined, ambiguous, contested and highly resistant to solutions” (p. 297). There are, in fact, major ongoing disagreements in the literature about what food security means, for whom, and how it should be measured. One of the key divides is between studies reliant on objective biomedical indicators (such as caloric intake, stunting, and BMI) and more subjective, experiential measures with short recall periods (Cafiero et al., 2014; Jones et al., 2013). Another point of contention is the appropriateness of metrics developed and validated in rural communities for capturing the levels and experiences of food insecurity among urban populations, or translocal households split between rural and urban nodes and different countries (Crush et al., 2024; Haysom & Tawodzera, 2018).

The definition and measurement of household composition have similarly generated debate and a multiplicity of typologies. In many empirical food security studies, household composition is often represented by a set of constructed variables rather than a single typology, typically combining household size, number of adults, and number of children, number of elderly members, and dependency ratio (Balistrieri, 2018; Ziliak & Gundersen, 2016). A second strand of work employs life-cycle or family-stage typologies, distinguishing, for example, young single-adult households, households with young children, households with school-age children, empty-nest households, and elderly-only households (Menashe-Oren et al., 2023; Swann, 2017). A third strand proposes typologies based either on combinations of the above variables or on head-of-household characteristics such as gender, marital status, and relationship to other household members (Dunga, 2020; Olumba et al., 2023). Each of these approaches has strengths and weaknesses. Variable-based analyses exhibit specificity but obscure interactions among household features. Life-cycle typologies can capture important transitions but impose arbitrary age

cutoffs, while headship-based classifications can overlook shifting cultural norms regarding household authority and economic responsibility.

For Silva et al. (2016), “given the complexity of the concept of food security, objective indicators have proven to be insufficient to capture all pathways to food insecurity.” Their reference to pathways to food insecurity suggests that identifying the specific ways in which household composition (re)shapes food security would be a fruitful exercise. Failure to identify the character and strength of these pathways risks leaving the relationship between household type and food insecurity in a black box. In effect, when statistically significant associations are identified, the mechanisms underlying them are left implicit or unexplored. There are three main research gaps in the existing literature on the relationship between household composition and food security. First, few studies have explored the pathways that mediate the relationship between household composition and food security. Second, the role of factors such as affordability, time resources, and food skills in shaping the relationship between household composition and food security has not been studied together. Third, insufficient attention has been paid to the nature of the relationship between household composition and food security outside the Global North. This paper aims to address these gaps by using Nanjing, China, as a case study and applying path analysis to examine the mechanisms that mediate the relationship between household composition and food security in that setting.

Literature Review

Food Security Metrics

Maxwell et al. (2014, p. 107) argue that different measures of food security are “often used interchangeably, without a good idea of which dimensions of food security are captured by which measures, resulting in potentially significant misclassification of food insecure populations.” Some suggest that there has been too much focus on measuring food accessibility at the expense of dimensions of availability, utilization, and stability (Calloway et al., 2022, 2023). Others maintain that a four-dimensional typology fails to capture all of the elements of the classic definition (Clapp et al., 2022). For example, Coates (2013) replaces this typology with a five-dimensional alternative: food sufficiency, nutrient adequacy, cultural acceptability, safety, and certainty and stability. Pérez-Escamilla (2024) further suggests that food security is a construct with six dimensions: quantity, dietary quality, food safety, suitability, psycho-emotional, and social acceptability.

Various studies have reviewed and critiqued the most commonly used measures of food security and insecurity (Barrett, 2020; Cafiero et al., 2014; Carletto et al., 2013; Coates, 2013; Jones et al., 2013; Leroy et al., 2014; Pérez-Escamilla et al., 2017; Sumsion et al., 2018, 2023). More recently, dissatisfaction with existing metrics has led to a series of proposals for new measures, adding to an already overcrowded field (Al-Ansari et al., 2025; Calloway et al., 2022, 2023; Gu et al., 2023; Manikas et al., 2023; Shang et al., 2025). In an effort

to bring order to the chaos, the FAO proposed adopting a single global measure of food security in 2013: the Food Insecurity Experience Scale (FIES) (Ballard et al., 2014; Cafiero et al., 2018). The FIES rapidly became the “gold standard” for governments and international organizations, offering a standardised, cross-nationally comparable measure of food insecurity (Amir & Khan, 2024; Smith et al., 2017). However, critics note that its reliance on self-reported experience captures only the access dimension of food security, obscures intra-household variation, and does not adequately account for cultural and contextual specificity (Saint Ville et al., 2019; Sheikomar, 2021; Wambogo et al., 2018).

Many other food security metrics also explicitly aim to capture a universal set of characteristics common to all geographies and cultures and, in doing so, effectively erase socio-cultural specificity as an integral element of food security (Alonso et al., 2018; Deitchler et al., 2010; Moffat et al., 2017; Renzaho et al., 2010; Swindale & Bilinsky, 2006). The cultural dimensions of food security, such as ethnic and religious food preferences, access to traditional foods, and food’s role in identity and belonging, are structurally invisible to mainstream measures, which embed a set of Eurocentric norms while presenting themselves as acultural and universal (Bikesh & Surag, 2020; Britwum & Demont, 2022; Juriedini et al., 2025). As Singh (2026, p.9) concludes in relation to India,

Measuring hunger is a complex methodological challenge that cannot be adequately addressed through the application of a one-size-fits-all tool like the Food Insecurity Experience Scale (FIES) without appropriate contextualization ... its application in India requires significant adaptation to reflect the country’s diverse socio-cultural, dietary, and economic contexts.

A similar case can be made for China. The FIES and similar measures are blunt instruments for capturing the main forms of food insecurity in Chinese cities.

The FIES was designed to detect severe deprivation of food quantity, including skipping meals, going hungry, and going a full day without eating. These conditions are relatively uncommon in major Chinese cities, where rapid economic growth has largely resolved the problem of caloric insufficiency. Urban Chinese populations are far more likely to experience food insecurity in the form of poor diet quality, inadequate access to nutritious, diverse, and fresh foods, over-reliance on processed foods, and lack of economic access to culturally desirable foods rather than insufficient food per se (Han et al., 2024; Li et al., 2018; Si & Zhong, 2018; Wang et al., 2022). By focusing on whether people have enough to eat rather than on whether they have access to food that is culturally and socially desirable, the FIES systematically underestimates urban food insecurity and overlooks the food security dimensions most relevant to Chinese cities. Rather than framing food insecurity as a monolithic concept, it needs to be deconstructed into well-defined metrics that are sensitive and most relevant to particular socio-cultural contexts.

Household Composition

The UN Statistics Division defines a household as a small group of persons who share the same living accommodation, pool some or all of their income and wealth and consume goods and services collectively, mainly housing and food. Households are most often classified in the literature by marital status and intergenerational relations. As Menashe-Oren et al. (2023, p. 6) note, household structure is “about the presence of multiple generations, and the extent of nucleation.” As with food security, there have been various efforts to devise and operationalise a standardised typology. Eurostat (2025) adopts a four-part classification: (a) couples with children, (b) couples without children, (c) single parents with children, and (d) single adults without children. Martin-Fernandez et al. (2013) follow the five-fold classification of the French National Bureau of Statistics: (a) single-person households, (b) single-family households, (c) two-or-more family households, (d) single-parent households, and (e) unrelated-persons households. The household dependency ratio (the number of children and the elderly divided by the number of working-age adults) has also been used as a measure of household type or composition. Morales et al. (2021), for example, categorise households by the number of children, adults, and children enrolled in school. Although household members under 15 and over 64 are usually viewed as dependents, the latter can still be economically productive, generating income or providing childcare so that parents can earn.

In Africa, Crush et al. (2012) identify four categories of households: (a) female-centred households (a female head with no male partner, with or without children); (b) male-centred households (a male head with no female partner with or without children); (c) nuclear family households (couples with or without children); and (d) extended family households (couples with or without children plus other blood relatives). In China, Wang (2006, 2013) and Xia & Xu (2017) identify five types of household structure: (a) single-person households; (b) nuclear families including a couple with or without unmarried children or a single parent with unmarried children; (c) stem (multi-generational) families comprising a two- or more generation unit with one or two parents with one married child and their children, the parents’ unmarried children (standard), and three or more generations living together with unmarried siblings in the same household (extended); (d) combined extended family households of two married siblings and their families living together; and (e) extended families including stem standard and extended, combined extended, as well as grandparents with grandchildren without the middle generation. Table 1 shows significant differences in the household structure of rural and urban Chinese families at the time of the 2010 Census. One-generation families were far more common in the cities (40% versus 28%), while households with three or more generations were more common in rural areas (23% versus 12%). Two-generation households were equally common in urban and rural areas (at 48% each).

	Urban (%)	Rural (%)
One-generation households	40.2	29.1
Single-person households	17.0	11.8
Only-couple households	21.2	16.6
Other one-generation households	2.0	0.7
Two-generation households	47.9	48.4
Parents and unmarried children	35.6	31.1
Single parent and unmarried children	2.3	3.2
Separated parent and unmarried children	2.7	3.4
Other two-generation nuclear households	0.4	0.5
Parents and married children	2.9	3.4
Grandparents with grandchildren	1.2	3.0
Other two-generation households	2.8	3.8
Three-generation or more households	12.1	22.5
Three-generation households	11.3	20.3
Other expanded households	0.8	2.2

Source: Adapted from Hu & Peng (2015)

A number of studies have tracked changes in the nature and relative importance of household structures over time. Hu & Peng (2015) and Zeng & Wang (2018), for example, show that in Chinese cities between 1980 and 2010, there was a rapid increase in the number of one- and two-person households, a decline in average household size, and a marked decline in households with four or more members (Table 2). The average household size declined from 3.5 to 2.7 persons between 1990 and 2010. The proportion of one-person households more than doubled from 7.1% to 18.0%, while the proportion of two-person couple households rose from 13.9% to 27.8%. The proportion of households with four or more persons declined significantly from 44% to 21%.

Households with a higher dependency ratio generally face a higher risk of food insecurity (Lamidi, 2019). However, Sharafkhani et al. (2010) found no significant association between food security and the household dependency ratio. Some studies report that households with young children are more likely to experience food insecurity (Santos et al., 2023), while others suggest that school-aged children may reduce reliance on fast food and improve food security (Bell et al., 2024). In a study in Paris, single-family households were more food-insecure than other households, although households without children were less food-insecure (Martin-Fernandez et al., 2013). Findings on the impact of elderly household members are less definitive. Leung et al. (2024) found that households with older adults in Brazil experi-

enced higher food insecurity, whereas in other households, retirees contributed to household income, mitigating food insecurity (Palmeira et al., 2022). Denney et al. (2017) focus on the difference between single-parent and two-parent families in food security outcomes. In some low-income contexts, nuclear households with two wage-earners have lower odds of experiencing severe food insecurity than other household types (Collings et al., 2016; McCordic & Abrahamo, 2019). However, Creedon et al. (2021) found that two-parent households were actually more food insecure than single-parent, grandparent-caregiver, or multigenerational households. Female-headed households with single mothers are also more likely to have low incomes, putting the children at increased risk of food insecurity (Denney et al., 2020; Felker-Kantor & Wood, 2012; Haque et al., 2017). Finally, Ziliak & Gunderson (2016) suggest that multigenerational households face a higher risk of food insecurity.

These findings suggest that the linkages between household composition and food security are context-specific, but the precise mechanisms remain unclear. In this paper, we hypothesise that the relationship is mediated by three variables: (a) food affordability, (b) time constraints, and (c) food skills. First, regarding food affordability, numerous studies have shown that higher-income households are at lower risk of food insecurity than low-income households (Banaie et al., 2023; Crush et al., 2014; Eten et al., 2019; Loopstra & Tarasuk, 2013; Omotayo et al., 2018; Swann, 2017; Wight

Year	1-person (%)	2-person (%)	3-person (%)	4-person (%)	5+ person (%)	Avg. size (persons)
2010	18.0	27.8	33.2	12.1	9.0	2.7
2000	10.7	21.6	40.2	15.8	11.7	3.0
1990	7.1	13.9	34.8	22.9	21.3	3.5

Source: Adapted from Hu & Peng (2015)

et al., 2014). The single most important factor behind the massive increase in food insecurity during the COVID-19 pandemic was unemployment, income loss and rising food prices (Arndt et al., 2020; Das Shuvo et al., 2022; Mehmood et al., 2023). However, higher income is not a guarantee of food security. In the US, for example, as many as 20% of food-insecure households are in middle- to high-income brackets (Nord & Brent, 2002). Further, affordability is not simply a function of disposable income. Food price inflation also plays a major role in making certain foods unaffordable (Bai et al., 2021; Cattaneo et al., 2023).

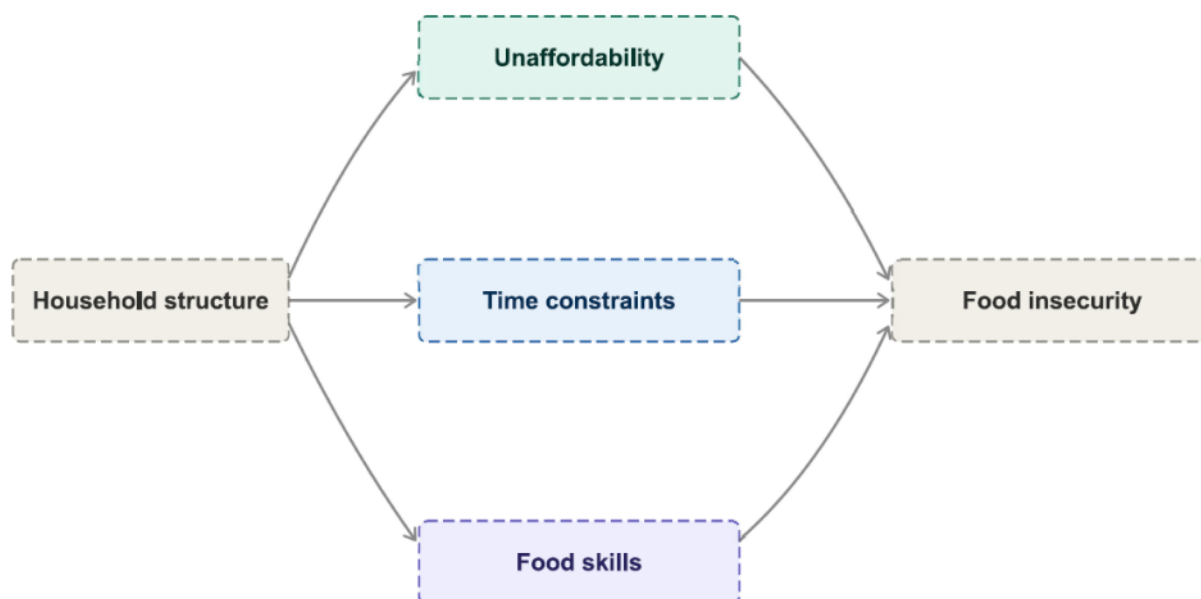
Second, regarding time constraints (sometimes labelled time poverty), Beatty et al. (2014, p. 66) report that “a significant relationship exists between time spent on food-related activities and food insecurity.” Bell et al. (2024) suggest that individuals under greater time constraints seek ways to minimise the time spent on grocery shopping and meal preparation. This limitation increasingly leads to greater reliance on processed, convenience, and fast foods, which, if consumed to excess, reduce dietary diversity and worsen food security outcomes. Insufficient time for food-related tasks can, more generally, contribute to household food insecurity, particularly among vulnerable households (Fiese et al., 2016). In the USA, Mancino & Newman (2007) show that working full-time and being a single parent have a larger impact on time allocated to food preparation than an individual’s earnings or household income. Another study in India found that male circular labour migration increased women’s work responsibilities in rural households and created time poverty, leading to food insecurity through skipped and irregular meals (Choithani, 2025). In Ghana, Maryet & Koomson (2025) show that time poverty induced by unpaid work worsens food insecurity, while time poverty from paid work reduces it. Seymour et al. (2019) found that in Bangladesh, time poverty has different food security impacts than income poverty, although being “doubly poor” (in both income

and time) is associated with worse household and child nutrition outcomes. Households with children are theoretically more likely to experience food-related time constraints than those without children. Conversely, households with members facing fewer time restrictions may achieve greater food security and dietary diversity.

Third, the absence of food-related skills (including the ability to procure, prepare, and consume food effectively) has been linked to household food security (Spotts et al., 2024; Terragni et al., 2020). Households with members possessing strong food skills (sometimes labelled food literacy) are thought to be less likely to experience food insecurity (Pamumbo et al., 2019). Research on food preparation, for example, indicates that households and individuals with stronger food skills are more likely to have more diverse diets and better nutrition than those without (Begley et al., 2019; Lavelle et al., 2021). Further, as Begley et al. (2019) note in their study of food literacy in Australia, “behaviours related to planning and management, shopping, preparation, and cooking were all statistically independently associated with food insecurity.” Better food skills also enable households to select higher-quality foods and reduce waste, thereby contributing to greater food availability and security (Carroll et al., 2021; Lins et al., 2026; Monteza-Quiroz et al., 2025; Park et al., 2019).

Despite the growing literature on the links among all three variables and various food security outcomes, few if any studies have systematically examined whether and how both are related to household composition or structure. In this paper, we treat food affordability, time constraints, and food skills as pathways linking household structure and food insecurity (Figure 1) and test the robustness of these relationships in the specific context of a Nanjing, China, case study. Should the analysis hold, the framework and methodology should be transferable to other geographies and socio-cultural contexts.

Figure 1: Conceptual Framework

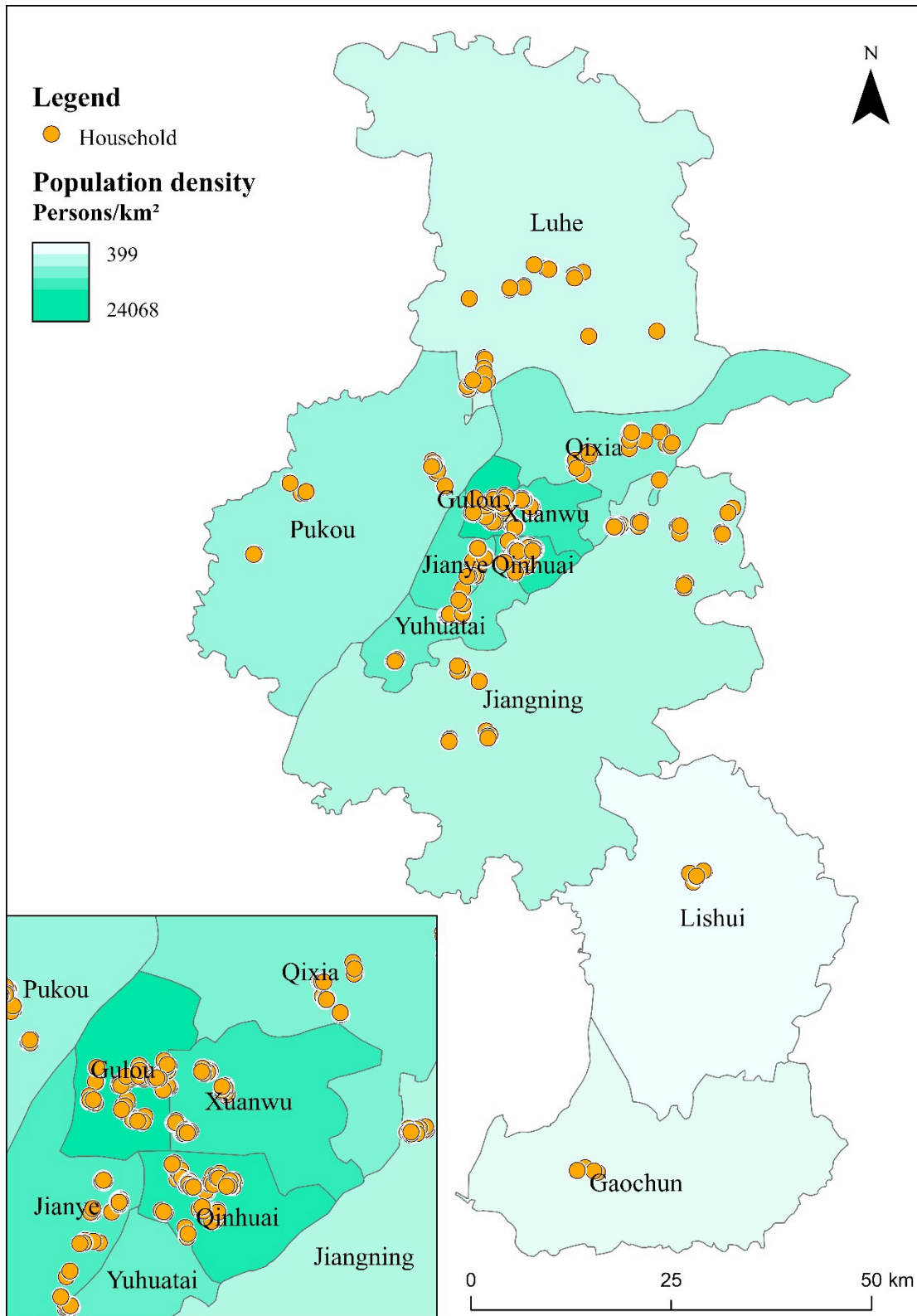


Methodology

The data for this case study were collected through a city-wide household food security survey in Nanjing, China, conducted in 2015 (Figure 2). A four-stage sampling strategy was used to obtain a sample of 1,210 households. The target sample was proportionally distributed across Nanjing's

11 districts based on population size. Within each district, sub-districts were randomly selected proportional to each district's number of sub-districts. A total of 100 residential neighbourhoods were identified through stratified sampling, and the target number of households in each neighbourhood was randomly selected for interview.

Figure 2: Location of Surveyed Households in Nanjing



Household Structure: The typology adopted in this study is grounded in established approaches to classifying household structure, as reviewed above, and is based on marital status, intergenerational relations, and dependency (Gri-maccia & Naccarato, 2022; Martin-Fernandez et al., 2013; Menashe-Oren et al., 2023):

- Single-person households (variable label *singleh*)
- Couples without children or whose children do not reside with them (*coupleh*)
- Nuclear family households that have two parents living with their children (*nuclearh*)
- Multigenerational families with three or more generations living together (*multipleh*)
- Intergenerational families refer to grandparents living with their grandchildren, with the parents absent (*interh*)
- Other (*otherh*)

Household Food Security: The analysis focused on satisfaction with local food quality (*Fquality*) and used three frequency-of-occurrence questions adapted from Swindale & Bilinsky (2006): (a) Were you or any household member unable to eat the kinds of foods you preferred because of a lack of resources? (b) Did you or any household member have to eat a limited variety of foods because of a lack of resources? (c) Did you or any household member have to eat foods you really did not want to eat because of a lack of resources to obtain other types of food? The recall period was 4 weeks, and the binary frequency options were as follows: Yes = 1; Otherwise = 0.

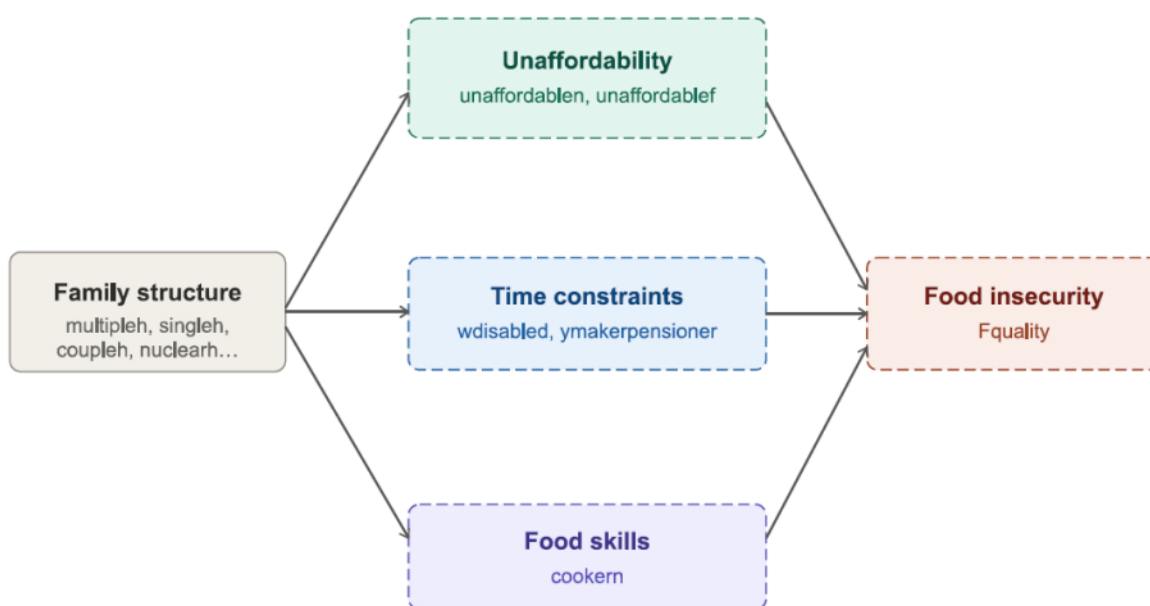
Food Affordability: To capture food affordability, two questions were posed: (a) Over the past six months, have you or your household gone without certain types of food because of increased food prices, i.e., it was unaffordable (*unaffordablef*)? Values ranged from 1 to 5, reflecting increasing unaffordability; and (b) Which types of foods have you or your household gone without? (*unaffordablen*). Respondents selected from 12 food groups. Values ranged from 0 to 12, with a higher value indicating lower food affordability.

Time Constraints: Households with homemakers or retirees are likely to experience fewer time constraints in managing food-related activities. To account for time availability, a binary variable *ymakerpensioner* was constructed to indicate whether a household included at least one homemaker or retiree. In contrast, the presence of household members with disabilities who are unable to work could increase caregiving demands and reduce the time available for food-related tasks. To capture this time constraint, a binary variable *wdisabled* was created to indicate whether any member was unable to work due to disability or medical unfitness. This variable can influence food security indirectly through its impact on food affordability (*unaffordablef* and *unaffordablen*).

Food Skills: Food preparation is closely associated with both decision-making and food purchasing behaviours. The variable *cookern* was created to represent the number of household members regularly involved in preparing food. A higher count suggests a greater distribution of food skills within the household, more effective food management, and higher dietary quality.

The next section of the paper presents the study findings, first focusing on descriptive statistics and then on the results of generalised structural equation modelling.

Figure 3: Conceptual Framework With Variables



Findings

Descriptive Statistical Results

The sample of 1,105 households is dominated by three household types that together account for over three-quarters of all observations (Table 3). The two most common household types were couples without children and nuclear families (both at 26.7%). Multigenerational families comprised another 22.8% of households, while single-person households made up 7.8% of the total. The distribution of household types differs from the national urban pattern reported by Hu & Peng (2015) for 2010 in three respects. First, single-person households are underrepresented (7.8% vs 17.0%). Second, couples without children are better represented in the Nanjing sample (26.7% vs 21.2%), reflecting the ageing profile of this group and the empty-nest phenomenon as the one-child policy cohort reaches adulthood. Third, multigenerational households account for 22.8% of the Nanjing sample compared with 11.3% nationally.

Table 4 cross-tabulates household structure by food quality and suggests that although single-person households make up less than the national average in Nanjing, they are most vulnerable to deprivation on all three metrics: inability to eat preferred foods (31.4%), eating a limited variety of foods (31.4%), and being forced to consume undesirable foods (14.0%). Intergenerational families are comparatively rare in the sample but experience the second-highest levels of inadequate food quality. Couples without children, nuclear families, and multigenerational families experience similar levels of inadequacy across all three metrics, although the proportion forced to eat foods they do not want is relatively small (under 4%).

Food insecurity, as measured by the food quality domain (*Fquality*), has a mean of 0.20, indicating that one in five

households experienced inadequate food quality during the recall period. Regarding household structure, couples without children and nuclear families each account for 27% of the sample. The low mean values for *unaffordablen* (0.49) and *unaffordablef* (1.44) suggest that food unaffordability events were relatively infrequent, though more significant for a subset of households. In terms of the time constraint variables, more than half of the households (58%) included a homemaker or pensioner (*ymakerpensioner*), while disability was rare (1.5%). The average number of household members regularly engaged in food preparation (*cookern*) was 1.42, indicating that these responsibilities are concentrated in one or two members.

Table 6 cross-tabulates unaffordable food items by household structure and shows that meat, fish, and fruit were the least affordable across all household types. Single-person households were most likely to find all of these food items most unaffordable.

Generalised Structural Equation Modelling (GSEM)

Table 7 presents four GSEM models estimated with different combinations of variables. Across all four models, the coefficients for the variables *unaffordablen*, *unaffordablef*, *ymakerpensioner*, and *cookern* are statistically significant, indicating that unaffordability, time constraints, and food skills are all related to food insecurity. For the unaffordability pathway, both variables are positively and significantly associated with food insecurity across all models (*unaffordablen*: $\beta = 1.00$, $p < 0.001$; *unaffordablef*: $\beta = 0.47$, $p < 0.001$). This finding suggests that unaffordability is an important mediator of food insecurity in this sample. On the relationship between household structure and the two unaffordability measures, the model shows that three household types have significant effects: single-person households ($\beta = 0.44$, $p < 0.001$), couples without children ($\beta = 0.23$, $p < 0.05$), and

Household type	N	%
Couple without children	295	26.7
Nuclear family	295	26.5
Multigenerational	252	22.8
Single-person	86	7.9
Intergenerational	24	2.2
Other	153	13.9
Total	1,105	100.0

	Unsatisfied food preferences (% yes)	Limited variety of foods (% yes)	Undesirable foods (% yes)
Single-person	31.4	31.4	14.0
Intergenerational	16.7	29.2	12.5
Couple without children	14.7	17.5	3.1
Nuclear	14.5	12.9	3.8
Multiple-generation	11.9	12.4	2.8
Other	17.8	17.9	3.9
Total	15.8	16.5	4.4

Table 5: Descriptive Statistics of Study Variables					
Variable name	N	Mean	Std. dev.	Min	Max
Food security					
<i>Fquality</i>	1,187	0.2039	0.4030	0	1
Family structure					
<i>singleh</i>	1,105	0.0778	0.2680	0	1
<i>coupleh</i>	1,105	0.2670	0.4426	0	1
<i>nuclearh</i>	1,105	0.2670	0.4426	0	1
<i>multipleh</i>	1,105	0.2281	0.4198	0	1
<i>interh</i>	1,105	0.0217	0.1458	0	1
<i>ortherh</i>	1,105	0.1385	0.3455	0	1
Food affordability					
<i>unaffordablen</i>	1,210	0.4893	0.8885	0	7
<i>unaffordablef</i>	1,188	1.4360	0.7669	1	5
Time constraints					
<i>ymakerpensioner</i>	1,095	0.5790	0.4939	0	1
<i>wdisabled</i>	1,095	0.0146	0.1200	0	1
Food skills					
<i>cookern</i>	1,098	1.4180	0.7880	0	5

Table 6: Unaffordable Food Items by Household Composition							
Food items	Single person	Couples without children	Nuclear	Multiple-generations	Inter-generational	Other	Total
Meat	33.7	21.7	18.0	20.2	20.8	20.9	21.2
Fish	16.3	13.6	14.2	11.9	4.2	13.1	13.3
Fruit	11.6	8.1	6.1	4.4	4.2	8.5	7.0
Vegetables	3.5	3.1	2.4	2.8	0.0	4.6	3.0
Milk	7.0	3.4	1.4	1.6	0.0	2.6	2.5
Beans	1.2	0.3	2.0	0.8	0.0	2.6	1.3
Grain	0.0	0.3	0.7	0.4	0.0	1.3	0.5
Eggs	0.0	0.7	0.7	0.4	0.0	0.7	0.5
Condiments	1.2	0.3	0.3	0.4	0.0	0.0	0.4
Oil	0.0	0.3	0.3	0.4	0.0	0.0	0.3
Tubers	0.0	0.0	0.0	0.0	0.0	1.3	0.2
Sugar	0.0	0.0	0.0	0.0	0.0	0.7	0.1

other household types ($\beta = 0.26$, $p < 0.05$) for *unaffordablen*. By contrast, none of the household structure variables are significant in the *unaffordablef* equation.

On the time-constraints pathway, the presence of a homemaker or pensioner in the household is significantly associated with food insecurity ($\beta = -0.39$, $p < 0.01$), indicating that households with members facing fewer time constraints achieve better food security outcomes. Given that *ymakerpensioner* characterises 58% of the sample, this is an important finding. By contrast, *wdisabled* is consistently non-significant across all models and equations. All household types are significantly more likely than nuclear households to include a homemaker or pensioner, with the effect increasing markedly across household types, including single-

person households ($\beta = 0.76$, $p < 0.001$), couples without children ($\beta = 1.63$, $p < 0.001$), multigenerational households ($\beta = 2.33$, $p < 0.001$) and intergenerational households ($\beta = 2.42$, $p < 0.001$). These results suggest that the presence of less time-constrained members in households constitutes a protective mechanism against food insecurity. The indirect effects in Table 6 confirm significant pathways from all five non-nuclear household types to food insecurity via *ymakerpensioner*, with the strongest protective effects for multigenerational ($\beta = -0.92$, $p < 0.01$) and intergenerational households ($\beta = -0.95$, $p < 0.05$).

Finally, the household food skills pathway, measured by *cookern*, is negatively and significantly associated with food insecurity in the models ($\beta = -0.23$, $p < 0.05$), indicating that

stronger food preparation capacity within the household is associated with lower odds of being food insecure. The effect is modest in magnitude relative to the unaffordability coefficients but consistent and robust. The relationship of household structure to *cookern* is variable in nature. For example, single-person households have substantially fewer members engaged in food preparation than nuclear

households ($\beta = -0.64, p < 0.001$), while multigenerational households have significantly more ($\beta = 0.17, p < 0.01$). Single-person households also face an indirect pathway to food insecurity via reduced food skills (*singleh* \rightarrow *cookern* \rightarrow *Fquality*: $\beta = 0.15, p < 0.05$), while the equivalent pathway for multigenerational households is non-significant (Table 7).

Dependent: Fquality	Model-1	Model-2	Model-3	Model-4
<i>Unaffordablen</i>	0.9989***	1.0023***	0.9989***	1.0023***
<i>Unaffordablef</i>	0.4668***	0.4655***	0.4668***	0.4655***
<i>Ymakerpensioner</i>	-0.3953**	-0.3926**	-0.3953**	-0.3926**
<i>Wdisabled</i>	0.6052		0.6052	
<i>Cookern</i>	-0.2306*	-0.2299*	-0.2306*	-0.2299*
Constant	-2.3316***	-2.3263***	-2.3316***	-2.3263***
Unaffordablen				
<i>Singleh</i>	0.4383***	0.4383***	0.4418***	0.4418***
<i>Coupleh</i>	0.2123*	0.2123*	0.2261*	0.2261*
<i>Multipleh</i>	-0.0491	-0.0491	-0.0457	-0.0457
<i>Interh</i>	-0.3449	-0.3449	-0.3359	-0.3359
<i>Ortherh</i>	0.2284*	0.2284*	0.2586*	0.2586*
<i>Wdisabled</i>			0.3389	0.3389
Constant	-0.8872***	-0.8872***	-0.8963***	-0.8963***
Unaffordablef				
<i>Singleh</i>	0.4021	0.4021	0.3713	0.3713
<i>Coupleh</i>	0.1953	0.1953	0.2063	0.2063
<i>Multipleh</i>	-0.0794	-0.0794	-0.0806	-0.0806
<i>Interh</i>	-0.2697	-0.2697	-0.2643	-0.2643
<i>Ortherh</i>	0.1499	0.1499	0.1883	0.1883
<i>Wdisabled</i>			0.3369	0.3369
Ymakerpensioner				
<i>Singleh</i>	0.7585***	0.7585***	0.7585***	0.7585***
<i>Coupleh</i>	1.6256***	1.6256***	1.6256***	1.6256***
<i>Multipleh</i>	2.3333***	2.3333***	2.3333***	2.3333***
<i>Interh</i>	2.4167***	2.4167***	2.4167***	2.4167***
<i>Ortherh</i>	0.7532***	0.7532***	0.7532***	0.7532***
Constant	-0.8073***	-0.8073***	-0.8073***	-0.8073***
Cookern				
<i>Singleh</i>	-0.6425***	-0.6425***	-0.6425***	-0.6425***
<i>Coupleh</i>	-0.1043	-0.1043	-0.1043	-0.1043
<i>Multipleh</i>	0.1713**	0.1713**	0.1713**	0.1713**
<i>Interh</i>	-0.1301	-0.1301	-0.1301	-0.1301
<i>Ortherh</i>	-0.1052	-0.1052	-0.1052	-0.1052
Constant	0.3861***	0.3861***	0.3861***	0.3861***
N	1104	1104	1099	1099
Log likelihood	-4454.6998	-4455.0170	-4439.6610	-4439.9780
AIC	8983.4000	8982.0330	8957.3230	8955.9560
BIC	9168.6470	9162.2740	9152.4070	9146.0380

Note: * represents significant at 10%-level, ** represents 5%-level, ***represents 1%-level.

Table 8 reveals a complex pattern of mechanisms that varies by household type. For single-person households, three indirect pathways are identified: (a) a positive pathway via unaffordability; (b) a positive pathway via reduced food skills, and (c) a negative pathway via time constraints. However, the net effect is positive because the risk-enhancing effects of unaffordability and food skills deficits outweigh the protective effect of time availability. For couples without children, a positive unaffordability pathway (driven by the older age profile of this group) is partially offset by a negative time-constraints pathway, yielding a mixed but measurable net effect on food insecurity. For multigenerational and intergenerational households, only the negative time-constraints pathway is significant, indicating that the presence of time-available household members is the dominant mechanism shaping food security outcomes in these households. For other household types, a positive unaffordability pathway and a negative time-constraints pathway operate in opposite directions, with the negative effect dominant in the preferred models.

Discussion

This paper makes a substantive conceptual and methodological contribution to the growing literature on the relationship between household composition and food security. We hypothesised that household type influences food insecurity through the interconnected pathways of affordability, time poverty, and food skills. Unlike previous research that treats the relationship between household composition and food security as direct, this study offers a new perspective by demonstrating that multiple indirect pathways exist. Therefore, the overall impact of household composition on food security depends on the relative strength of these effects. Using descriptive data from a citywide household survey in Nanjing, China, and generalised structural equation modelling, we identified both risk-enhancing and protective mechanisms associated with different household living arrangements. The quantitative analysis confirmed that household composition has both positive and negative effects on food insecurity, providing new insights into this relationship.

With regard to the unaffordability pathway, both variables are positively and significantly associated with food insecurity, which indicates that unaffordability is an important mediator of food insecurity in Nanjing. Further, going without certain foods was statistically significant for certain types of households. For example, couples without children have a positive and statistically significant association with food unaffordability. This is a counterintuitive finding, since couples without children are often thought to have more disposable income. However, the average age of household heads in this group is 61 and 80% of these households had a head aged 50 or older, with 59% having a head aged 60 or older. Elderly couples without children in the household are likely to have greater food affordability challenges. None of the household types showed a significant association with whether food was unaffordable due to rising prices. The data show that household type is associated with the breadth of foods households forgo, but not to the extent to which households attribute unaffordability specifically to rising prices. This conclusion adds nuance to the existing literature on food affordability by focusing on how unaffordability manifests differently across household types.

The time constraints pathway examines how time poverty may compromise food-related behaviours and whether the presence of household members not constrained by formal employment is associated with better food quality. The presence of a homemaker or a pensioner in the household is significantly associated with better outcomes, and all non-nuclear household types are significantly more likely than nuclear families to include a homemaker or pensioner. The strength of this association increases as households become larger and more complex. This pattern may reflect a life-cycle position rather than a direct effect of household structure. For example, in Chinese nuclear households, both parents are typically employed. By contrast, intergenerational and multigenerational households are likely to have at least one adult household member, such as a retiree grandparent, present who is not engaged in paid employment and devotes their time to provisioning food for the household as a whole. This is consistent with reciprocity norms in Chinese urban families, where grandparents take on domestic

Table 8: Indirect Effects of Household Structure

Path	Model-1	Model-2	Model-3	Model-4
<i>singleh</i> → <i>unaffordablen</i> → <i>Fquality</i>	0.4378***	0.4393***	0.4413***	0.4428***
<i>coupleh</i> → <i>unaffordablen</i> → <i>Fquality</i>	0.2121*	0.2128*	0.2259*	0.2267*
<i>ortherh</i> → <i>unaffordablen</i> → <i>Fquality</i>	0.2281	0.2289	0.2583*	0.2592*
<i>singleh</i> → <i>ymakerpensioner</i> → <i>Fquality</i>	-0.2998*	-0.2978*	-0.2998*	-0.2978*
<i>coupleh</i> → <i>ymakerpensioner</i> → <i>Fquality</i>	-0.6426**	-0.6382**	-0.6426**	-0.6382**
<i>multipleh</i> → <i>ymakerpensioner</i> → <i>Fquality</i>	-0.9224**	-0.9161**	-0.9224**	-0.9161**
<i>interh</i> → <i>ymakerpensioner</i> → <i>Fquality</i>	-0.9554*	-0.9488*	-0.9554*	-0.9488*
<i>ortherh</i> → <i>ymakerpensioner</i> → <i>Fquality</i>	-0.2978*	-0.2957*	-0.2978*	-0.2957*
<i>singleh</i> → <i>cookern</i> → <i>Fquality</i>	0.1482*	0.1477*	0.1482*	0.1477*
<i>multipleh</i> → <i>cookern</i> → <i>Fquality</i>	-0.0395	-0.0394	-0.0395	-0.0394

Note: * represents significant at 10%-level, ** represents 5%-level, ***represents 1%-level.

responsibilities, including food shopping and meal preparation, for working-age children and grandchildren (Cao & Qian, 2024; Chen et al., 2011; Gruijters & Ermisch, 2019).

Food skills are important mediators between household structure and food security; this pathway is significantly associated with food insecurity. However, only single-person households show a significant indirect pathway to food insecurity. In single-person households, the absence of other household members to share food procurement and preparation responsibilities clearly compounds the disadvantages already identified. As a result, they face heightened vulnerability to food unaffordability and reduced capacity to procure and prepare food. At the same time, this may be an artifact of the variable choice, which asked how many people in the household are involved in food preparation. This limitation highlights other ways the findings need to be qualified.

First, while strong statistical associations are suggestive of a plausible narrative in which these three pathways link household composition and food security, they are not evidence of causal relationships. Structural equation modelling provides a statistical framework consistent with a causal narrative, but it is not proof of causation. Second, we assume that reverse causation is not a plausible alternative for some paths. However, food insecurity could itself affect food skills or reported time constraints, not just the other way round. Also, household composition is treated in the analysis as an exogenous driver because we assume that it shapes affordability, time constraints, and cooking skills rather than the reverse. Third, the choice of proxy measures for time constraints and food skills is relatively crude and therefore may not fully capture the intended constructs. Fourth, the sample underrepresents single-person households relative to the national average. Since the sampling procedure was methodologically robust, we assume that Nanjing's demographic composition, for reasons warranting further exploration, diverges from the norm.

Conclusion

While the definitions of food security and household composition are relatively uncontroversial, the best ways to quantify them remain the subject of considerable debate. This study accepts the standard definition of the four basic pillars of food security. However, the emphasis in the literature on measuring availability and accessibility means that food utilization has been relatively neglected. The pathways selected for this study, therefore, focus on both accessibility (the affordability of food) and utilization (time constraints and food skills). One consequence of the search for universal, decontextualised metrics of food security is the relative neglect of geographical and cultural specificity and difference. A consequence of this approach, best exemplified by the FAO's FIES, is the focus on whether households have enough food to eat rather than whether they have access to and consume food that is culturally and socially preferable. Recent literature on cultural food security provides an important corrective, showing how cultural preferences

and tastes are essential to the subjective experience of food insecurity (Alonso et al., 2018; Bikesh et al., 2020). In Chinese cities such as Nanjing, there is no lack of food and households score well on quantitative food security metrics (Zhong et al., 2019, 2023). However, this misses the qualitative food security dimension of food quality and desirability and whether households are satisfied, culturally and otherwise, with the food they consume. This study, therefore, focuses on whether households can access and consume the foods they actually prefer.

Rather than treating household structure as a uniform risk factor and the links between it and food (in)security as a black box, the study's findings reveal a more complex landscape in which certain pathways can intensify or ameliorate food insecurity through distinct intermediary channels. Moreover, the findings highlight that different household types face distinct challenges, with key mediators varying in their influence on food security. The conceptual framework and statistical model utilised in this case study also provide a template for future research in other urban contexts in low- and middle-income countries. In this way, it would be possible to determine whether the important empirical findings are unique to this city or reproducible in other geographical contexts. Future research should also employ longitudinal and multi-site approaches, along with more refined indicators of food-related capacities and constraints. Nonetheless, the evidence presented underscores that household structure or composition is associated with different food security outcomes, both directly and by shaping the affordability, time allocation, and food preparation skills that determine how people access and prepare food in everyday life.

The potential pathways linking household composition to food security are certainly not confined to the three considered in this study. For example, social capital and informal food-sharing networks constitute one possibility, since some types of households are likely more deeply embedded in reciprocal food-related and other exchange relationships than others (Kaiser et al., 2020; Nostratabadi et al., 2020). The local food environment is a second potential pathway, as household types might differ in their physical capacity to access wet markets and supermarkets (Bezerra et al., 2024; Smith et al., 2020). A third candidate is nutritional knowledge, which may vary systematically across household types according to age and educational profiles (Spronk et al., 2014; Wang et al., 2020). A fourth possibility is the gendered division of food-related labour. Food provisioning, shopping, and preparation are strongly gendered activities, falling disproportionately on women, and different household types distribute this burden in different ways (Ashagidigbi et al., 2022; Hunag et al., 2023). Each of these examples is a plausible additional channel through which household composition could be associated with food security. The three-pathway framework advanced in this study is therefore meant as a constructive point of departure rather than an exhaustive exploration of the mechanisms inside the black box.

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