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What are “dark kitchens”? A consensus definition from public, local authority, business and academic stakeholders in the United Kingdom

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Abstract

Background

“Dark kitchens” are an innovative and potentially disruptive addition to the global food environment with potential implications for policy, practice and public health. In the UK, dark kitchens currently represent approximately 15% of all food retailers across the three major online food delivery platforms in England (e.g., Just Eat, Deliveroo, Uber Eats), contributing significantly to the digital food environment. To date, dark kitchens have been poorly defined, under researched and their wider impact poorly understood.

Aim

Therefore, the aim of this work was to coproduce a consensus definition of dark kitchens to be used across multiple disciplines.

Methods

A series of consultations took place with stakeholders including consumers, local authority representatives, academics, dark kitchen employees and national governing bodies to understand knowledge and currently used definitions of dark kitchens. Mixed method approaches were used involving questionnaires, interviews, focus groups and workshops.

Results

The stakeholder consultation process provided a robust methodology through which a consensus definition of dark kitchens was agreed. Each project group provided a definition which was scribed and annotated to understand the key components of importance within the definitions, whilst additional and unique components were discussed and debated before being accepted or rejected. In addition, short- and long-term benefits of such a definition were outlined for all stakeholder groups. Following peer-review from local authority, industry and governing body stakeholders, a final definition was produced.

Conclusion

The adoption of a consensus definition of dark kitchens is pivotal to the cross-sectoral work and understanding of many stakeholder groups. The definition allows for transparency and improved communication between dark kitchen stakeholders and provides the opportunity to drive public health agendas at multiple points within the food system.

Background

So called “dark kitchens” are an innovative international phenomenon and potentially disruptive addition to the global food environment ^{1, 2}, although to date they are poorly defined, under researched and poorly understood ³. The term “dark kitchens” is evolving and is experiencing rapid evolution and interpretation, with room for more nuanced understanding. In the UK, dark kitchens are supported by online food delivery platforms which gained traction during the COVID-19 pandemic ², and currently represent approximately 15% of all food retailers across the three major online food delivery platforms in England (e.g., Just Eat, Deliveroo, Uber Eats) ⁴. The introduction and proliferation of dark kitchens poses both positive and negative implications for policy, practice and public health. Whilst the focus of this paper is on the UK, it is intended that the resulting definition and commentary be internationally applicable.

It is acknowledged that the food environment impacts both public health and health inequalities ⁵. While dark kitchens offer clear benefits to businesses operating in predominantly urban areas (e.g., industrial estates), with lower overheads than high street retailers, and with potentially wider delivery ranges ^{6, 7} – they pose a potential risk to broad public health priorities through the incentivisation of online takeaway food retail, increased availability and greater consumption of high fat, salt or sugar (HFSS) food, increased delivery traffic and noise disturbance, and to the economic vitality of existing high streets ^{6, 8}. Of particular concern is the widespread availability of HFSS foods and their frequent consumption, both of which are linked to the development of obesity and non-communicable disease ⁹. Takeaway food outlets (“takeaways”) are a key source of HFSS foods and are well established within the food environment ¹⁰. Greater exposure to takeaways on online food delivery platforms has already been associated with more frequent use of these types of food outlets ¹¹, with higher density of takeaways and food delivery services linked with greater odds of developing obesity ¹²⁻¹⁴. Areas of greater socioeconomic deprivation also often have a greater density of takeaways ^{10, 15}, which may be contributing to inequalities in diet and health outcomes. Furthermore, there is growing concern that takeaway food consumption has become a habitual behaviour, largely because of the COVID-19 pandemic ^{16, 17}, which has strengthened social, cultural and environmental norms that are difficult to change ¹⁸.

Broadly, dark kitchens have been described as delivery-only virtual commercial spaces with no customer-facing storefront that predominantly operate via third-party online food delivery platforms ¹⁹⁻²². This incorporates a wide range of business types and sizes, including premises that are transient (e.g., pop-ups) through to large scale dark kitchen operators (e.g., Deliveroo Editions). The food environment is constantly evolving and has changed at a faster pace than regulatory processes, requiring local and national policy to adapt to the dynamism of the food environment ²³. In the UK, food production spaces such as restaurants, cafés and takeaways are regulated and monitored by planning, environmental health and public health departments within local authorities (local authorities are local government organisations responsible for a range of services, including health and social care, education and business support in the UK). However, the variety of descriptions and lack of consensus definition for dark kitchens has led to confusion, mixed practice and lack of regulatory process within and between local authorities. One such example is that the English planning system has no specific land use category for dark kitchens ²⁴ and therefore they can operate under various planning regulations between and within local authorities. Therefore, despite attempts to monitor and manage the changing food environment, planning and environmental health systems are relatively ill-equipped, and systems are not fit for purpose ²⁵. As a result, dark kitchens are less visible to local authorities than conventional food businesses ²². Moreover, while traditional takeaways can be regulated by

local authorities using spatial planning policy, dark kitchens are not currently subject to such interventions. For example, place-based interventions such as takeaway management zones around schools, which can reduce takeaway proliferation and improve public health ^{26,27}, do not currently affect dark kitchens and may be undermined by their delivery radius. Additionally, the visibility of dark kitchens to consumers is also low ²⁸.

There is currently no agreed or precise definition of dark kitchens which may also be referred to as 'cloud' or 'virtual' kitchens. Without a clear definition of what a dark kitchen is, it will not be possible to fully understand their risks to public health ²². For local authorities who may seek to monitor and regulate dark kitchens, inadequate definition presents a challenge to public health, environmental health, and planning teams, who are also working in a context of increasingly limited resources. Additionally, there is little consensus on how dark kitchens are identified and managed in line with relevant legislation, with different practices observed across local authorities ²⁹. This is compounded by lack of clarity in what dark kitchens are and how they differ from other food businesses. In their recent report, Food Active ³⁰ – a healthy weight programme delivered by the Health Equalities Group and commissioned by local authority public health teams, NHS organisations, and Public Health England teams at both regional and national level – set out several recommendations for national and local government. This included a recommendation for local authorities to increase awareness of dark kitchens amongst relevant departments and to explore how existing policies can be applied to them, or be undermined by dark kitchens ³⁰. The aim of this paper is to promote a clearer understanding among local and national government stakeholders of what a dark kitchen is, how they compare to current food outlets, and how they can be better regulated under existing legislation and processes.

Methods

To develop a robust and implementable definition of dark kitchens, we proposed a consensus definition through stakeholder consultation. This consultation took place through multiple strands of research across the UK, funded by the National Institute for Health and Care Research (NIHR) between February and August 2024. The methods for consultations amongst the projects have been reported in detail elsewhere ³¹⁻³⁴, but involved a range of online surveys, questionnaires, face-to-face and online interviews and focus groups with members of the public, those working in local authorities (planning, environmental health and public health teams), those in the dark kitchen industry, and UK academics. During the consultations, each stakeholder group was asked to describe their current knowledge and experience of dark kitchens and provide a definition. After this stakeholder consultation process, academic project representatives from all four projects took part in a series of consensus definition workshops hosted in person and online. The aim of the workshops was to generate ideas and build consensus regarding the definition of dark kitchens. Workshop team members consisted of academics from the following disciplines: nutrition (n=5), food industry and food safety (n=3), epidemiology (n=1), public health (n=2), business and marketing (n=1). Each project group provided a definition which was scribed and annotated to understand the key components of importance within the definitions. Where there was consensus across the teams of components of importance, they were agreed upon, whilst additional and unique components were discussed and debated before being accepted or rejected. Appropriate wording which was relevant to all audiences was also considered and a draft definition was produced. A final session was used to confirm the definition. The definition was then sent out to external representatives from industry, local authority and national governing bodies for review. The team communicated by e-mail to tweak and finalise the definition based on external peer-review feedback.

Results and Discussion

Our consensus definition is shown in Figure 1. As part of this process of reaching agreement, we considered and agreed on types of businesses that do not qualify as dark kitchens (shown in Figure 2). We agreed that restaurants and takeaways who deliver food directly from their in-house menus where there is a customer ordering point, home delivery services such as ‘meals on wheels’ that provide food tailored to vulnerable groups or that require a regular subscription, and home bakers or caterers where ordering is required in advance and/or who deliver their produce directly to consumers, should not be considered to be dark kitchens. Similarly to Hakim et al. 35, we found a number of dark kitchen types which we considered in the formation of the definition. We recognised two specific dark kitchen sub-types: “ghost kitchens” which could encompass single independent operators, clusters of single businesses or multi-franchises operating from one building; and “shadow kitchens” which sell the same or similar cuisine targeted at different consumer groups under different virtual brands. However, defining sub-types was not the priority of this group and other use the terms interchangeably 6,36 validating the need for a consensus definition. The final definition was sent out for final stakeholder review (including members of the public, local authority employees, national governing board members, dark kitchen representatives) and was amended based upon comments received to incorporate the word ‘primarily’ rather than ‘mainly’ for additional clarity.



Figure 1: The agreed consensus definition of dark kitchens from stakeholder workshops



Figure 2: Considerations for defining what is, and is not a dark kitchen

Whilst we acknowledge that the term “dark” itself is problematic, with potentially misleading and/or derogatory connotations (e.g., poor food safety and hygiene practices), we have adopted this term because of its existing “currency” among all stakeholders involved. As others have argued²⁸, we take the term “dark” to refer to the lack of visible physical presence to the consumer only.

Our intention is that this definition is accepted into policy, practice and academic contexts to better support research, surveillance and regulatory processes of the dark kitchen sector. We believe it will allow for clearer communication between stakeholders, and that it will provide clarity for consumers who have little insight into their changing food environment³. Fundamentally, a definition of dark kitchens which is universally adopted will allow for a consistent approach to the identification of relevant premises. Table 1 demonstrates some worked examples of how the consensus definition allows for dark kitchens to be identified quickly. In turn, this could support the development of more appropriate surveillance in support of public health, environmental health and planning agendas, improve awareness and trust in contemporary technology-enabled business models on a commercial scale and due to better regulation of food safety practices, and provide guidance for the sustainability of dark kitchens. Based on our consultations with stakeholders, we further clarify these multiple predicted cross-sectoral benefits in Table 2 according to short and long-term benefits.

Table 1: Worked examples of how to use the definition as a checklist for identifying dark kitchens

Outlet	Definition checklist (A 'yes' response to all criteria is required to be defined as a dark kitchen).		Is it a dark kitchen?
Home baker	Is it a food business/kitchen?	Yes	No – this is not a dark kitchen as the food is ordered in advance of the requested delivery time.
	Is it operating commercially?	Yes	
	Is it tech-enabled for food ordering? i.e., online menus, ordering and customer communication platform	Yes	
	Is the business catering primarily for delivery? i.e., very few (if any) customer collections	Yes	
	Is it remote? i.e., no seating or dine-in option	Yes	
	Is it providing food for immediate, on-demand consumption?	No	
Pub which also delivers its menu through online third-party aggregator sites	Is it a food business/kitchen?	Yes	No – this is not a dark kitchen as the same menu is delivered on site to customers. This is a dine-in restaurant which also provides takeaway food.
	Is it operating commercially?	Yes	
	Is it tech-enabled for food ordering? i.e., online menus, ordering and customer communication platform	Yes	
	Is the business catering primarily for delivery? i.e., very few (if any) customer collections	No	
	Is it remote? i.e., no seating or dine-in option	No	
	Is it providing food for immediate, on-demand consumption?	Yes	
Virtual brand which operates out of a commercial kitchen	Is it a food business/kitchen?	Yes	Yes – this is a dark kitchen. The food from this kitchen is only available through remote delivery and is not available to purchase or collect in person by a consumer.
	Is it operating commercially?	Yes	
	Is it tech-enabled for food ordering? i.e., online menus, ordering and customer communication platform	Yes	
	Is the business catering primarily for delivery? i.e., very few (if any) customer collections	Yes	
	Is it remote? i.e., no seating or dine-in option	Yes	
	Is it providing food for immediate, on-demand consumption?	Yes	
External event caterers	Is it a food business/kitchen?	Yes	No – this is not a dark kitchen as there is an option to ring and speak to someone to tailor your
	Is it operating commercially?	Yes	
	Is it tech-enabled for food ordering? i.e., online menus, ordering and customer communication platform	Sometimes	

	Is the business catering primarily for delivery? i.e., very few (if any) customer collections	Yes	order, and you have to order in advance of the event.
	Is it remote? i.e., no seating or dine-in option	Yes	
	Is it providing food for immediate, on-demand consumption?	No	
Well-known high street brand which is producing food in premises with no customer collection or dine in site.	Is it a food business/kitchen?	Yes	Yes – this is a dark kitchen. The food from this kitchen is only available through remote delivery and is not available to purchase or collect in person by a consumer.
	Is it operating commercially?	Yes	
	Is it tech-enabled for food ordering? i.e., online menus, ordering and customer communication platform	Yes	
	Is the business catering primarily for delivery? i.e., very few (if any) customer collections	Yes	
	Is it remote? i.e., no seating or dine-in option	Yes	
	Is it providing food for immediate, on-demand consumption?	Yes	
Meals on Wheels	Is it a food business/kitchen?	Yes	No – meals on wheels orders are received in advance and are booked, planned and subscribed to in advance. They do not provide on-demand food.
	Is it operating commercially?	Yes	
	Is it tech-enabled for food ordering? i.e., online menus, ordering and customer communication platform	Yes	
	Is the business catering primarily for delivery? i.e., very few (if any) customer collections	Yes	
	Is it remote? i.e., no seating or dine-in option	Yes	
	Is it providing food for immediate, on-demand consumption?	No	
Prepared ingredient meal kit boxes	Is it a food business/kitchen?	Yes	No – food ingredient meal kit boxes require a subscription in advance and need to be prepared by the consumer.
	Is it operating commercially?	Yes	
	Is it tech-enabled for food ordering? i.e., online menus, ordering and customer communication platform	Yes	
	Is the business catering primarily for delivery? i.e., very few (if any) customer collections	Yes	
	Is it remote? i.e., no seating or dine-in option	Yes	
	Is it providing food for immediate, on-demand consumption?	No	

Table 2: Beneficiaries and benefits of a consensus definition of dark kitchens.

<i>Beneficiary</i>	<i>Short term benefits</i>	<i>Longer-term benefits</i>
Consumers	<ul style="list-style-type: none"> ● Better understanding and identification for high-risk groups (i.e., those living with food hypersensitivities and those who are immunocompromised) especially in relation to allergies and food safety. 	<ul style="list-style-type: none"> ● Increased awareness to enable informed decision making and better understanding of their food environment. ● Better understanding of employee rights and working conditions (which may be different in dark kitchens) which may inform purchase decisions.
Planning	<ul style="list-style-type: none"> ● Allows identification and follow up of businesses who register as restaurants and/or other primary uses (e.g. schools) but may operate as dark kitchens. ● Knowledge of what a dark kitchen is increases confidence and starts appropriate conversations. 	<ul style="list-style-type: none"> ● Improves informed consideration of transport and traffic planning associated with different business types. ● Supports/enables appropriate review of impact of different business types on, for example, litter and anti-social behaviour. ● Allows evidence-informed address of concerns around location e.g., loss of the high street caused by online businesses, appropriateness of business park locations. ● Potential to add a new category of 'dark kitchen' under business type during registration to ensure regulatory bodies know the business model of the food operator.
Public Health	<ul style="list-style-type: none"> ● Allows public health teams to have more awareness and respond and adapt to fast changing businesses. ● Allows for interventions (e.g., healthy takeaway award schemes) to be adapted or created to engage and support dark kitchens. ● Enables a more complete picture of the local food environment to be formed to support strategic working and action. 	<ul style="list-style-type: none"> ● Supports actions to monitor dark kitchens and their impact. ● Strengthens connections with other local authority departments (i.e., planning) to ensure the right questions are being asked based on a common understanding of the business model. ● Develops better and more targeted policy options to address the challenges to a healthy food environment posed by dark kitchens.

Environmental Health Officers (EHOs) and Trading Standards Officers (TSOs)	<ul style="list-style-type: none"> ● Enable EHOs and TSOs to identify the type, number and location of dark kitchen operators. ● Allows an understanding of how to inspect different premises and what specific questions may need to be asked for dark kitchens (i.e., food hygiene inspection and food allergen control of dark kitchens in shared units may pose different challenges due to shared spaces and/or equipment). ● Allows identification of dark kitchens before any issues or complaints arise. 	<ul style="list-style-type: none"> ● Provides opportunity for software and system upgrade to ensure all businesses registered to a premise are captured effectively (i.e., to overcome current system limitations). ● Produces more system-informed reporting, i.e., changing trade names, food poisoning outbreaks, food safety issues, etc. ● Allows local authority teams to maintain a database of businesses rather than premises (due to the potential for multiple businesses to run from one address).
Dark Kitchens	<ul style="list-style-type: none"> ● Improves the perceptions of dark kitchens as a business model. ● Helps to underpin standards for employee rights to attract more delivery drivers and grow businesses. 	<ul style="list-style-type: none"> ● Recognises and values dark kitchens' unique identity, characteristics and business quality and legitimacy. ● Builds trust and acceptance from wider stakeholders and consumers for market growth.
Online Food Delivery Services (OFDS)	<ul style="list-style-type: none"> ● Enables dark kitchen businesses to be 'flagged' to consumers for increased transparency. ● Increases transparency around allergen risk and the conditions food is prepared in (i.e., cross-contamination). 	<ul style="list-style-type: none"> ● Better supports the provision of services for onboarding dark kitchens. ● Highlights responsibility for delivery drivers, road safety and delivery hygiene. ● Builds trust, and brand loyalty between consumers and OFDS for market growth.
Researchers and Academics	<ul style="list-style-type: none"> ● Provides opportunity to assess impact of dark kitchens on a range of metrics relevant to e.g. health, environment, and inequalities therein. ● Increases ability to measure the growth and proliferation of dark kitchens. 	<ul style="list-style-type: none"> ● Enables evaluation, regulation and monitoring dark kitchens against planning policy and policy development. ● Enables exploration of food safety and allergen risk of online orders and delivery processes to improve consumer safety.

In summary, this work highlights the need for the adoption of a consensus definition of dark kitchens, as it is pivotal to the work and understanding of many stakeholder groups. The definition proposed here recognises the multiple perspectives of these stakeholders and offers benefits to cross-sectoral working. Our definition allows for transparency and improved communication between dark kitchen stakeholders and provides the opportunity to drive public health agendas at multiple points within the food system.

Author Contributions

Lucie Nield: Conceptualisation, Funding acquisition, Investigation, Project administration, Resources, Writing – original draft, Writing – review and editing. Thomas Burgoine: Investigation, Resources, Writing – review and editing. Amelia A. Lake: Investigation, Resources, Writing – review and editing. Helen J. Moore: Investigation, Resources, Writing – review and editing. Jan Soon-Sinclair: Investigation, Resources, Writing – review and editing. Jean Adams: Investigation, Writing – review and editing. Tom R. P. Bishop: Investigation, Writing – review and editing. Simon Bowles: Investigation, Writing – review and editing. Emma Boyland: Investigation, Writing – review and editing. Callum Bradford: Investigation, Writing – review and editing. Michael Chang: Investigation, Writing – review and editing. Steven Cummins: Investigation, Writing – review and editing. Jordan Duffy: Investigation, Writing – review and editing. Iain Ferris: Investigation, Writing – review and editing. David Harness: Investigation, Writing – review and editing. Yuru Huang: Investigation, Writing – review and editing. Zainab Laheri: Investigation, Writing – review and editing. Scott Lloyd: Investigation, Writing – review and editing. Helen Martin: Investigation, Writing – review and editing. Claire O'Malley: Investigation, Writing – review and editing. Jo Pearce: Investigation, Writing – review and editing. Chiara Rinaldi: Investigation, Writing – review and editing. Rachel Rundle: Investigation, Writing – review and editing. Nick Shaw: Investigation, Writing – review and editing. Emma Tindall: Investigation, Writing – review and editing. Tim Townshend: Investigation, Writing – review and editing. Claire Wall: Investigation, Writing – review and editing. Jordan D. Beaumont: Funding acquisition, Investigation, Project administration, Resources, Writing – original draft, Writing – review and editing.

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Statements and declarations

Ethical approval and informed consent

Ethical approval was provided by all 4 institutions for the research data collection. Informed consent was obtained for all participants for the final stakeholder workshops from Sheffield Hallam University's Research Ethics Council (ER61546845).

Declaration of conflicts of Interest

The authors declare no conflicts of interest.

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References

1. Jia SS, Raeside R, Sainsbury E, et al. Use of online food retail platforms throughout the COVID-19 pandemic and associated diet-related chronic disease risk factors: A systematic review of emerging evidence. *Obesity Reviews* 2024; 25: e13720. DOI: 10.1111/obr.13720.
2. Keeble M, Adams J and Burgoine T. Changes in Online Food Access During the COVID-19 Pandemic and Associations With Deprivation: Longitudinal Analysis. *JMIR public health and surveillance* 2023; 9: e41822. DOI: 10.2196/41822.
3. Nield L, Martin H, Wall C, et al. Consumer knowledge of and engagement with traditional takeaway and dark kitchen food outlets [version 1; peer review: 1 approved with reservations]. *NIHR Open Research* 2024; 4. DOI: 10.3310/nihropenres.13735.1.
4. Huang et al. Understanding the socio-spatial distribution of “dark retail” in England: development of a unique retail location dataset. under review.
5. Rutter H, Savona N, Glonti K, et al. The need for a complex systems model of evidence for public health. *The Lancet* 2017; 390: 2602-2604. DOI: 10.1016/S0140-6736(17)31267-9.
6. Rinaldi C, D’Aguilar M and Egan M. Understanding the Online Environment for the Delivery of Food, Alcohol and Tobacco: An Exploratory Analysis of Dark Kitchens and Rapid Grocery Delivery Services. *International Journal of Environmental Research and Public Health* 2022; 19: 5523. DOI: 10.3390/ijerph19095523.
7. Souza TSPd, Miyahira RF, Matheus JRV, et al. Food services in times of uncertainty: Remodeling operations, changing trends, and looking into perspectives after the COVID-19 pandemic. *Trends in Food Science & Technology* 2022; 120: 301-307. DOI: 10.1016/j.tifs.2022.01.005.
8. Keeble M, Adams J, Sacks G, et al. Use of Online Food Delivery Services to Order Food Prepared Away-From-Home and Associated Sociodemographic Characteristics: A Cross-Sectional, Multi-Country Analysis. *International Journal of Environmental Research and Public Health* 2020; 17: 5190. DOI: 10.3390/ijerph17145190.
9. Thapsuwan S, Phulkard S, Chamrathirong A, et al. Relationship between consumption of high fat, sugar or sodium (HFSS) food and obesity and non-communicable diseases. *BMJ Nutrition* 2024; 7: 78. DOI: 10.1136/bmjnp-2023-000794.
10. Public Health England. Fast food outlets: density by local authority in England. 2018.
11. Keeble M, Adams J, Bishop TRP, et al. Socioeconomic inequalities in food outlet access through an online food delivery service in England: A cross-sectional descriptive analysis. *Applied Geography* 2021; 133: 102498. DOI: 10.1016/j.apgeog.2021.102498.
12. Burgoine T, Sarkar C, Webster CJ, et al. Examining the interaction of fast-food outlet exposure and income on diet and obesity: evidence from 51,361 UK Biobank participants. *International Journal of Behavioral Nutrition and Physical Activity* 2018; 15: 71. DOI: 10.1186/s12966-018-0699-8.
13. Penney TL, Jones NRV, Adams J, et al. Utilization of Away-From-Home Food Establishments, Dietary Approaches to Stop Hypertension Dietary Pattern, and Obesity. *American Journal of Preventive Medicine* 2017; 53: e155-e163. DOI: 10.1016/j.amepre.2017.06.003.
14. Cummins S, Kalbus AI, Cornelsen L, et al. Social inequalities in the use of online food delivery services and associations with weight status: cross-sectional analysis of survey

- and consumer data. *BMJ Public Health* 2024; 2: e000487. DOI: 10.1136/bmjph-2023-000487.
15. Maguire ER, Burgoine T and Monsivais P. Area deprivation and the food environment over time: A repeated cross-sectional study on takeaway outlet density and supermarket presence in Norfolk, UK, 1990–2008. *Health & place* 2015; 33: 142-147. DOI: 10.1016/j.healthplace.2015.02.012.
 16. Moore H, Lake A, O'Malley C, et al. The impact of COVID-19 on the hot food takeaway planning regulatory environment: perspectives of local authority professionals in the North East of England. *Perspectives in Public Health* 2022; 144: 52-60. DOI: 10.1177/17579139221106343.
 17. Bradford CPJ, O'Malley CL, Moore HJ, et al. 'Acceleration' of the food delivery marketplace: Perspectives of local authority professionals in the North-East of England on temporary COVID regulations. *Nutrition Bulletin* 2024; 49: 180-188. DOI: 10.1111/nbu.12672.
 18. Fernqvist F, Spendrup S and Tellström R. Understanding food choice: A systematic review of reviews. *Heliyon* 2024; 10: e32492. DOI: 10.1016/j.heliyon.2024.e32492.
 19. World Health Organisation. *Slide to order: A food systems approach to meal delivery apps*. 2021.
 20. da Cunha DT, Hakim MP, Alves MM, et al. Dark kitchens: Origin, definition, and perspectives of an emerging food sector. *International Journal of Gastronomy and Food Science* 2024; 35: 100884. DOI: 10.1016/j.ijgfs.2024.100884.
 21. Deliveroo. Editions, our delivery-only 'dark' kitchens, <https://restaurants.deliveroo.com/en-gb/editions> (2024, accessed 15/11/2024).
 22. Food Standards Agency. *Food in the digital platform economy – making sense of a dynamic ecosystem*. 2022.
 23. Lake AA, Moore HJ, Cotton M, et al. Opportunities to improve population health: possibilities for healthier food environments. *Proceedings of the Nutrition Society* 2023; 82: 264-271. 2023/04/14. DOI: 10.1017/S0029665123002677.
 24. Public Health England. Addendum: Hot food takeaways use in the new Use Class Order. 2021.
 25. BBC News. Delays in food hygiene inspections a 'serious public health issue', <https://www.bbc.co.uk/news/articles/c1rr1qqqny0o> (2024, accessed 18/11/2024).
 26. Rahilly J, Amies-Cull B, Chang M, et al. Changes in the number of new takeaway food outlets associated with adoption of management zones around schools: A natural experimental evaluation in England. *SSM - Population Health* 2024; 26: 101646. DOI: 10.1016/j.ssmph.2024.101646.
 27. Rogers NT, Amies-Cull B, Adams J, et al. Health impacts of takeaway management zones around schools in six different local authorities across England: a public health modelling study using PRIMETIME. *medRxiv* 2024: 2024.2006.2011.24308755. DOI: 10.1101/2024.06.11.24308755.
 28. Hakim MP, Dela Libera VM, Zanetta LDA, et al. What is a dark kitchen? A study of consumer's perceptions of deliver-only restaurants using food delivery apps in Brazil. *Food Research International* 2022; 161: 111768. DOI: 10.1016/j.foodres.2022.111768.
 29. Beaumont JD, Pearce J, Rundle R, et al. Defining, identifying and regulating dark kitchens in the North of England: Perspectives from consumer, local authority and food business stakeholders. in preparation.
 30. Food Active. *Price and Placement Promotions on Meal Delivery Applications*. 2024.
 31. Nield L, Beaumont J, Martin H, et al. Exploring the scale and scope of dark kitchens in the north of England: addressing food safety and public health priorities. United Kingdom: National Institute for Health and Care Research, 2024.

32. Burgoine T, Keeble M, Bishop T, et al. Understanding population exposure to dark retail in the out-of-home and grocery markets in England: measuring socio-spatial distribution and exploring opportunities for policy intervention. United Kingdom: National Institute for Health and Care Research, 2024.
33. Soon-Sinclair J, Ferris I and McKeown M. 'Going dark' or under the radar? Challenges and opportunities for local authorities and dark kitchens in ensuring food safety for the public. United Kingdom: National Institute for Health and Care Research, 2024.
34. Moore H, Brown H, O'Malley C, et al. Monitoring and Evaluating the Impact of Dark Kitchens on the Food Environment: Understanding gaps in the data. United Kingdom: National Institute for Health and Care Research, 2024.
35. Hakim MP, Libera VMD, Zanetta LD, et al. Exploring dark kitchens in Brazilian urban centres: A study of delivery-only restaurants with food delivery apps: Food Research International, 2023.
36. Cai R, Leung XY, Chi, CG. Ghost kitchens on the rise: Effects of knowledge and perceived benefit-risk on customers' behavioral intentions: International Journal of Hospitality Management, 2022.