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Identifying notions of environment in obesity research using a mixed-methods approach

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Summary

The recent rise of computation-based methods in social science has opened new opportunities for exploring qualitative questions through analysis of large amounts of text. This article uses a mixed-methods design that incorporates machine reading, network analysis, semantic analysis, and qualitative analysis of 414 highly cited publications on obesogenic environments between 2001 and 2015. The method produces an elaborate network map exhibiting five distinct notions of environment, all of which are currently active in the field of obesity research. The five notions are institutional, built, food, family, and bodily environments. The network map is proposed as a navigational tool both for policy actors who wish to coordinate efforts between a variety of stakeholders and for researchers who wish to understand their own research and research plans in light of different positions in the field. The final part of the article explores how the network map may also initiate a broader set of reflections on the configuration, differentiation, and coherence of the field of obesity research.

KEYWORDS

Obesogenic environment, semantic analysis, visual network analysis

1 | INTRODUCTION

In the past two decades, obesity research has increasingly moved from studying isolated factors to adopting ecological views of the coherent complex of factors that may condition obesity.[1] A key role in this development was played by Swinburn et al[2] who in 1999 introduced the notion of *obesogenic environments*, which they defined in their words as "the sum of influences that the surroundings, opportunities, or conditions of life have on promoting obesity in individuals or populations." In addition to this encompassing definition, Swinburn et al proposed the ANGELO framework (analysis grid for environments linked to obesity)—a 4 × 2 grid that "dissects" the obesogenic environment into a number of factors. Along one dimension, the environment is split into four types: the physical, the economic, the political, and the socio-cultural. Along the other dimension, environments are dissected into two sizes: micro and macro.

Swinburn's notion of obesogenic environments has inspired significant research into obesity ecology, and it has turned attention to combinations of environmental factors such as the preponderance of motorized transport, sedentary occupation, and cheap and energy-dense food.[3] Among policymakers, especially in the United Kingdom, the concept of obesogenic environments has been used to frame obesity as a societal challenge requiring a broad coordinated effort.[4-7] In this context, the notion of obesogenic environment has become a vehicle for joining up government and research for collective effort.[8] In the wider world, the notion of obesogenic environment has also caught on as a way of grasping that the current rise in obesity rates is rooted in ways of life broadly rather, than with any particular factor.[9] In obesity research, Swinburn et al's notion of obesogenic environments is widely cited, and many authors define their work as contributing to a growing number of studies of obesogenic environments. Recently, Swinburn's notion and, more specifically, the ANGELO grid have been

used to review the field of obesity studies.[10] This particular review talks of an "explosion of obesogenic environment research" and identifies no less than 146 primary studies. But despite of this, it concludes that several cells in the ANGELO grid are sparsely covered.

The rise of ecological thinking in relation to obesity, as exemplified by the notion of obesogenic environments, may be indicative of a general willingness to collaborate and combine knowledge. But this does not mean that coherence and coordination are within easy reach. To the contrary, policy approaches to control or regulate aspects of such environments appear to be highly difficult to coordinate, since they involve a wide range of stakeholders.[11-17] It is not unlikely that policy actors and other stakeholders have very different ideas about the issue of obesity, despite common adherence to the idea of making a coordinated effort to make environments less obesogenic.

The recent review of obesity studies[10] also shows the coordination challenges that the field is facing; its basic finding is that the last decade of obesity research does not add up to a full coverage of the 4 × 2 types of environment in the ANGELO grid. So despite the relatively wide adoption of the term obesogenic environment, the growing field of obesogenic environment research field seems to have moved in modes and directions that cannot be summed up by Swinburn's original grid.

It is this situation that we take as our starting point. A good deal of obesity research has an ecological perspective, and some of it is directly inspired by the Swinburnian notion of obesogenic environment. But there is little reason to presume that all of the research on obesity and environment will adhere in a strict sense to Swinburn's original definition of an environment nor that it will conduct itself within types and levels proposed by the ANGELO grid. To understand how environment is dealt with in obesity research—and the degree to which this effort can be understood as coherent or coordinated—we therefore suggest a renewed empirical effort. The aim of the effort presented here is to explore systematically, qualitatively, and with a fine grain of detail what notions of environment are actually used by key actors in field of obesity research.

Our approach is as follows: From the abundant scientific literature on obesity-related issues, we collect a large number of highly cited articles that specifically address obesity and environments. Within this corpus of articles, we systematically explore the different ways in which the notion of environment is used, by developing and applying a mixed-methods design[18] that involves machine reading and semantic analysis of an extensive literature on obesogenic environments using a terms-extraction algorithm, visual network analysis of co-occurring terms, and qualitative analysis of the resultant network map.

The network map, we propose, is a navigational tool for researchers who want to understand their own research and research plans in light of a clear picture of the different positions in the field. We also believe the map will be of use to policy actors who wish to overview and coordinate efforts between a variety of differently positioned stakeholders. Finally, the map may be a starting point for broader reflections on the configuration, differentiation, and coherence of the field of obesity research.

2 | METHODOLOGY: A COMPUTATION-BASED MIXED-METHODS DESIGN

The mixed-methods design used to produce a map of discursive regions of obesogenic environment involved three specific goals. First, the method was designed to investigate the practices of the most influential authors in this scientific field. We therefore build on a dataset of recent and highly cited articles in the most widely recognized interdisciplinary publication databases. A second goal was to articulate the less visible qualitative differences among the influential authors in the field. We therefore used a quantitative word extraction algorithm that prioritizes differences rather than commonalities. Third, we aimed to explicate different notions of environment within this body of literature. We therefore investigated each of the discursive regions qualitatively to identify their underlying assumptions, and to determine the relationships between the clusters.

Our division of labour was as follows: Elgaard Jensen and Kleberg Hansen were responsible for the data preparation work (assessment of article relevance). Munk and Madsen were responsible for the quantitative data analysis and production of the network map. Elgaard Jensen, Kleberg Hansen, Ulijaszek, Hillersdal, and Jespersen were responsible for the qualitative analysis. All authors read and contributed to the final text.

2.1 | Building the dataset

The literature corpus comprised 500 highly cited papers on obesogenic environments between 2001 and 2015. The starting point of the interval, 2001, was chosen because the publication that coined the term obesogenic environments[2] began to play a role in the literature around this time. The end point of the interval, 2015, was chosen because publications in later years would not yet have gathered a sufficient number of citations. We settled for 500 papers because they represent, in our estimation (see below), roughly a third of the total volume of papers on obesogenic environments from that time period. We deemed it a reasonable assumption that the most cited third of this total volume would be able to provide us with an overview of the main themes in the field and how they have changed. The articles were sourced from Web of Science (WoS) and Scopus, which are by far the two largest and most widely recognized cross-disciplinary research publication databases in the English-speaking world. The two databases were chosen because we expected them to offer the best reflection of the practices of the dominant and most institutionally recognized actors in the field of obesity research.

We fully recognize that Scopus and WoS have a significant bias toward English-language literature and toward the fields of biomedical science, natural science, and engineering.[19] Despite these biases, the databases do in fact contain a large number of journals from social science and humanities, which also appear in our sample of highly cited articles. But again, we wish to emphasize that the "bias" of the databases should not merely be viewed as a source of error; the particular selection of articles in these prestigious databases is a resource that helps us discover the prevailing discourses among powerful actors in the field.[20]

In a similar way, our choice of selecting highly cited articles, rather than randomly sampled articles or a fixed number of articles from each year, reflects our intention of identifying a broad spectrum of the most influential and broadly recognized notions of obesogenic environment. We fully recognize that this sampling strategy works to the disadvantage of relatively small disciplines that have little influence on the field in general.

On a more pragmatic level, our data sampling had to take account of the differences in coverage between Scopus and WoS. Studies have shown that while both WoS and Scopus are stable enough in volume across journals and over time for cross-disciplinary and longitudinal comparisons,[21] their coverage has also been found to diverge, with Scopus generally covering more journals and disciplines in a less systematic way than WoS.[22,23] We therefore built the text corpus from a search of both databases in order to be as exhaustive as possible.

The search was carried out in February 2016. From WoS, we produced a ranked list of 1044 papers by querying the "topic" as *obesity* and the "title" as *environment* and restricting the search to *articles*. From Scopus, we produced a ranked list of 891 papers published between 2001 and 2015 by querying "article title, abstract or keywords" as *obes**, "article title" as *environment*, and "document type" as *article*. Since Scopus and WoS do not offer the same search interface, it was necessary to use different search strings to approximate the search results on the two platforms. As Scopus has a tendency to estimate a higher number of citations than WoS for the same article, we could not simply merge the two lists to retrieve the 500 most cited papers without skewing the selection in favour of Scopus results. Since we wanted full-text copies of the articles, we also had to work within the boundaries of the access granted by our library (Aalborg University Library). We therefore decided to retrieve the most cited fully accessible papers from each of the two lists, checking for and eliminating duplicates as we went along, until reaching a total of 500 papers.

Figure 1 shows the distribution of papers by year of publication. As expected, recently published papers were not yet widely cited and were therefore less prevalent in the set. The scarcity of papers between 2001 and 2005, however, can be both due to a lack of published material on the topic of obesogenic environments and a result of papers not being cited very much in that period. To ensure that all papers were on topic, we assessed them manually, reducing the corpus from 500 to 414 papers. This reduction of the set did not significantly alter the distribution of papers over time (Figure 1). In the final sample, the number of citations to each paper ranged between 17 and 800. A full list of the 414 articles included in our sample can be found in the Supporting Information for this article.

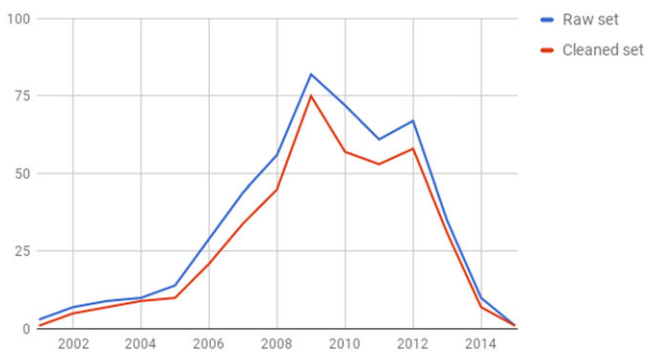

FIGURE 1 Distribution of papers before and after manual cleaning

2.2 | Semantic analysis of the corpus

We first used the open-source software CorTexT[22] to obtain a ranked list of multi-terms from the corpus through successive stages of semantic analysis. The first of these stages is known as part-of-speech (PoS) tagging. PoS tagging analyses the sentence structure to attribute a word class to each of the terms found in a sentence (noun, verb, adjective, adverb, etc). Having performed PoS on the corpus, we were able to build a list of all noun phrases (combinations of nouns and adjectives) found in the corpus (this process is known as chunking). After automatically correcting orthographical errors and lemmatizing each term to its stem, we merged noun phrases that are identical on the stem level. For instance, the phrases "diet quality," "quality diet," and "quality of the diet" were merged as "diet quality." If a shorter multi-term was nested in a longer multi-term, the longer multi-term was prioritized. For instance, if choosing between "diet quality" and "high diet quality" as a phrase, the latter would be prioritized. We set the maximum multi-term length at 4. This was a qualitative decision taken after reviewing the results of setting the length at 2 and 3, which turned out to force artificial cuts in many of the multi-terms, for example, "quality of the diet." We then proceeded with a ranking procedure aimed at prioritizing the terms that carry the most *specific* information about the research question. By specificity, we mean terms that appear with a high frequency in a small part of the sample—as opposed to generic terms that are used evenly in all parts of the sample. As we explain the following, the ranking according to specificity was based on the calculation of a so-called specificity score. The procedure was as follows: we first counted the frequency of each multi-term in the corpus and set a minimum frequency to reduce the list. Because we were interested in the discourse that is *particular* to a specific subset of papers on obesogenic environments rather than the discourse that is generic to all papers on obesogenic environments, we set the minimum frequency to three documents, indicating that a multi-term must be present in at least three different papers in order to be considered. We then calculated the specificity score of the remaining multi-terms.[23] Specificity presumes that terms generic to all papers will exhibit an unbiased distribution across the corpus and are therefore irrelevant while, conversely, the terms that are interesting to analyse are the ones that have a tendency to always occur in specific parts of the corpus. For instance, if "diet quality" occurs frequently in 50 papers but is never found in the rest of the corpus, it will receive a high specificity score, whereas if it occurs with equal frequency in all the papers, it receives the lowest specificity score. In this way, we calculated how much the distribution of each multi-term across the corpus deviated from its unbiased distribution (chi-squared) and ranked the multi-terms according to how much they deviated—that is, according to their specificity.

Finally, we produced a list of the top 500 most specific multi-terms. The size of the terms list (500 items) was chosen on the basis of several iterations in CorTexT with smaller and larger lists. The

number 500 was a pragmatic choice between shorter lists that appeared to leave out several relevant multi-terms (eg, "ecological models" and "food outlet density") and longer lists that appeared to include large amounts of superfluous terms (eg, "high levels" and "age and gender"). CorTexT allows the terms list, including the ways in which terms are stemmed and merged, to be edited. One significant artefact of our dataset was the names of authors and journals that figured prominently in the extracted list of high-specificity multi-terms. Given that this information is already contained as metadata associated with each paper and tells us little about the ways in which the topic of obesogenic environments is framed, we decided to filter out author and journal names from the terms list. We also manually cleaned out a small number of overly generic terms that were not captured by CorTexT's specificity filter (eg, "corresponding author," "email address," and "research agenda").

2.3 | Visual network analysis

To identify discursive patterns in the corpus (ie, specific styles in the way obesogenic environments are talked about), we produced a network of co-occurring multi-terms. Co-occurrence was defined as co-occurrence in the same article; if two different multi-terms were used in the same article, they would be connected by an edge (or a line, in everyday usage) in the network. The more frequently two terms co-occur, the heavier the edge becomes. A heavier edge is visually represented as a thicker line in the network. We filtered out the weakest edges to improve the clarity of the visualization. CorTexT facilitates this by a distributional measure that normalizes the weight of an edge on the global connections of its two nodes. Edges between nodes with a high likelihood of being connected (because they are already globally well connected) must thus be more heavy to be taken into account than are edges between nodes with a low likelihood of being connected.

The visual layout of the network (Figure 2) was obtained by spatializing the nodes with a spring-based (or force vector) algorithm.[24] This introduces a repulsive force between all nodes and allows the edges to act as springs holding connected nodes together. Heavier edges act as stronger springs, causing frequently co-occurring terms to be held more closely together than less heavy edges. Visual proximity between nodes can therefore be interpreted as their tendency to be used in the same contexts (in our case papers). Conversely, distance between nodes can be interpreted as the extent to which they are rarely (or never) used in the same context. Clusters of closely connected terms can be interpreted as a subset of papers with a tendency to frame discussion of the notion of obesogenic environments in the same way. These clusters are what we refer to as *discursive patterns*, because the presence of a cluster shows a recurrent practice of using particular terms together that are distinctive to a certain subset of papers in the dataset.

In order to aid the visual identification of clusters, community detection (ie, the search for interconnected clusters of co-occurring themes) was performed using the Louvain method.[25] This method explores different ways of partitioning the network until it finds the solution with the highest modularity score. A higher modularity score is obtained by minimizing the number of edges that cross between partitions. The nodes are coloured on the basis of this partition, and nodes of the same colour can thus be interpreted as belonging to the same community of frequently co-occurring terms.

The Supporting Information contains a zoomable overview map as well as magnified pictures of each of the clusters in the map.

2.4 | Qualitative analysis of the map

Each cluster in Figure 2 represents what we have termed a discursive region: a particular way of framing obesity as indicated by a tendency to use particular sets of terms. The aim of the qualitative analysis was to explicate these "ways" or more precisely the underlying notions of obesogenic environment—the figures of thought that appear to guide the researcher's choice of how to frame and speak about their research objects.

To structure our qualitative analysis, we posited that any particular notion of obesogenic environment could be characterized by describing three key elements: (a) the kinds of elements and processes that constitutes the environment, (b) the kind of "obesity object" that is believed to be contained and influenced by that environment, and (c) the presumed mechanisms of interaction between object and environment. This simple conceptualization was used both to guide our qualitative analysis and to summarize its results.

The qualitative analysis was conducted as a three-step-process. First, we assessed the terms in each cluster as they appeared on the map in order to generate preliminary descriptions of the environment, object, and mechanism of interaction specific to each cluster. Those preliminary descriptions were then checked against the underlying article corpus typical for each cluster. If confirmed, illustrative articles were searched for, to serve as examples in the description of clusters. Second, we compared the identified environment, object, and mechanism of each cluster with those of other clusters, clarifying how they differed from and/or were related to each other. In this comparison, the edges connecting the different clusters on the map were used as indications of the differing degrees of shared notions between the clusters. In some cases, the second step called for an iteration of step one. Third, the qualitative analysis was condensed into short descriptions focused on the notion of environment, the "obesity object," and the mechanism of interaction for each cluster.

In general, the qualitative analysis pursued an iterative approach in which the starting point was always the map and its clusters, terms, colours, and edges. Whenever the map needed further interpretation, or whenever preliminary assumptions needed to be substantiated, the underlying corpus of articles was consulted.

3 | RESULTS

Five notions of obesogenic environment were identified: institutional, built, food, family, and bodily (Figure 2 and Table 1).

3.1 | Institutional environment

The environment in this cluster consists of *institutions*—predominantly schools and other organizations providing childcare. The obesity

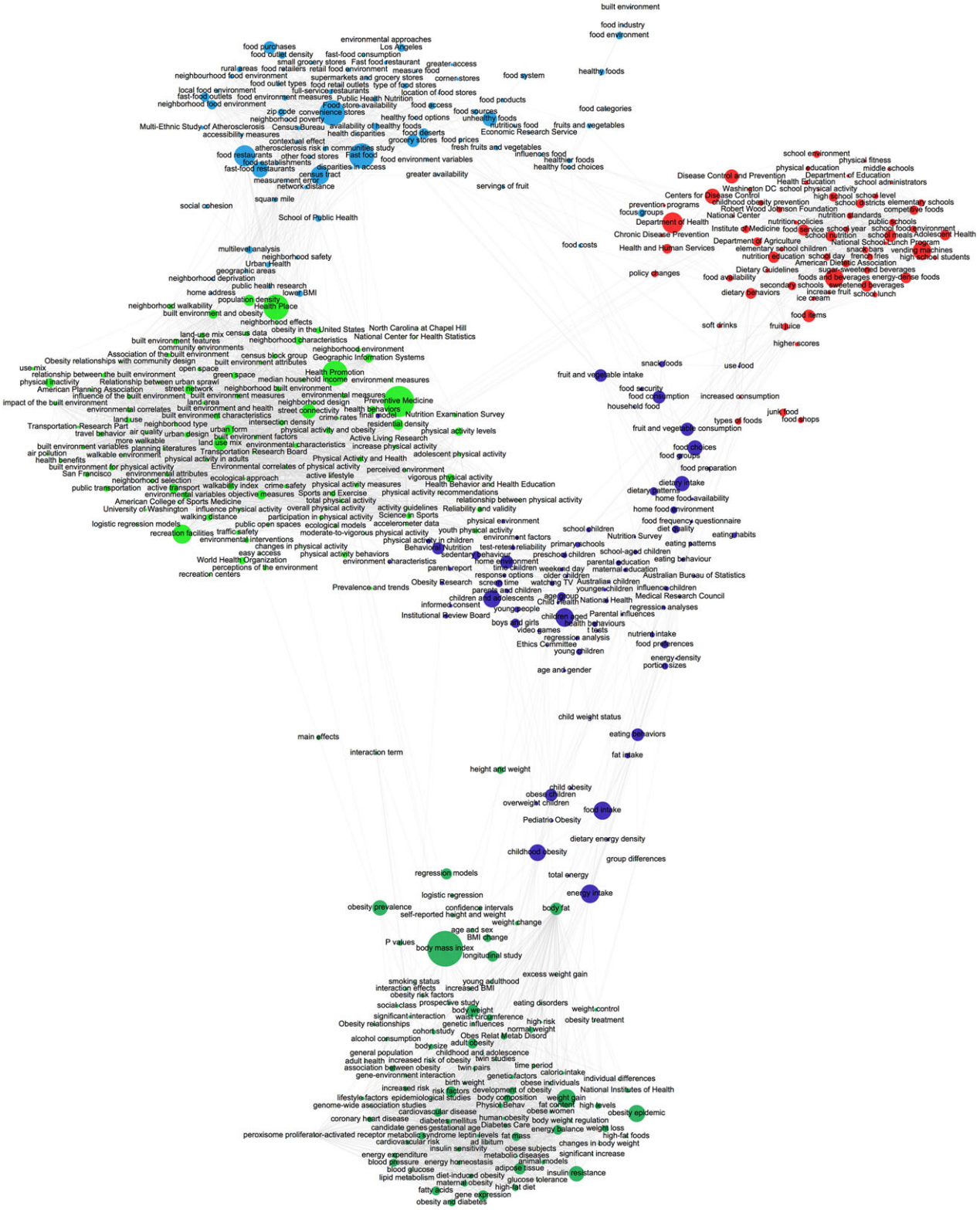

FIGURE 2 Network map of the discursive patterns in 414 articles related to environment and obesity research

object is *institutional food services* as these appear in regulated food environments, and the mechanism of interaction is *policies and their implementation*. The centre of concern and regulation is school lunches and to some extent other meals. Many of these studies originate in countries with state-funded or state-subsidized school meals (eg, Turner and Chaloupka[26]). Studies can examine both existent supply of and interventions into institutional food services.

Articles typical to this cluster contain a number of terms that specify the environment or the obesity object. The object is specified with terms such as "school meals," "vending machines," "sugar

TABLE 1 Five obesogenic environments, including their obesity objects and key mechanisms of interaction

Type of Environment	Obesity Object	Mechanism of Interaction	Colour of Cluster on Figure 2
Institutional environment	Institutional food services	Policies and their implementation	Red
Built environment	Population obesity	Energy expenditure	Light green
Food environment	Population obesity	Energy intake	Light blue
Family environment	Population obesity in children and adolescents.	Energy expenditure and intake	Purple
Bodily environment	Fat deposition in human or rodent organisms	Physiological processes, gene-environment interaction	Dark green

sweetened beverages," whereas the environment appears in the form of institutions and regulatory bodies such as "Department of Agriculture," "Department of Health," or "school districts," which are stakeholders in the making of institutional food policies. Specific policies (the mechanism of interaction) are also mentioned—for instance, "dietary guidelines."

The foods named are often calorie-dense highly processed products such as "french fries," "snack bars," and "ice cream," making them easy to single out as risk foods and targets for intervention. A smaller, less pronounced theme is that of "physical education," which also appears in this cluster. In all, the cluster points to policy efforts towards making schools and institutions into sites for obesity prevention.

3.2 | Built environment

The built environment cluster is concerned with the physical surroundings of humans—especially as designed and built and how this influences energy expenditure, which in turn influences population health (eg, Feng et al[27]). It differs from the institutional environment, which largely describes the regulatory context in which schools provide food for children. The key obesity object of the built environment cluster is *population obesity*, which is predominantly defined and measured by body mass index (BMI) and sometimes by other anthropometric measures such as skinfold thickness (eg, Lovasi et al[28]). The key mechanism of interaction is *energy expenditure* through physical activity.

The primary focus of this cluster is to define, measure, and test a number of different aspects of the built environment that might influence the level of physical activity of people in it. Studies included in this analysis either examine the existing outlay of environments or report from interventions into it. A common background assumption is that the current infrastructure planning has favoured passive modes of transport, such as cars, trains, and escalators (eg, Franklin[29]). This tendency to support sedentary behaviours may be counteracted if infrastructural features of neighbourhoods promote the integration of physical activity into everyday life activities—such as walking to the grocery store instead of driving. The articles featured in this cluster place emphasize on relationships between place and obesity as well as on place and health behaviours that might lead to obesity. An often-used research design is to compare "neighbourhood walkability" of cities as measured by built environment features such as "street connectivity," "recreation facilities," the availability of "green spaces," and the "air quality" or the "physical activity" of its residents (eg, Feng et al[27], Sigmundová et al[30], Saelens et al[31]). Other features of the urban environment, such as "traffic safety" and "crime safety," are also used as bases for comparative studies and as potential mediators of physical activity behaviour.

3.3 | Food environment

Articles typical to this cluster focus on themes related to the *food environment*, which differs from the institutional environment in that it is concerned with the general availability of food in noninstitutional contexts. It is assumed to interact with *population obesity*—the obesity object—through the interaction mechanism of *energy uptake*. Food environment is often measured in terms of the immediate availability of food in the near neighbourhood, as signified by terms such as "neighbourhood food environment" or "local food environment." Obesity is typically measured by BMI (eg, Stark et al[32]). These articles examine a broad range of phenomena, which are presumed to influence energy uptake. Calorie uptake is often not measured directly but rather indirectly assessed through studies of the availability, content, and quality of the food in the immediate neighbourhood environments, or by measuring the spatial accessibility to "fast food restaurants," "full service restaurants," types of "grocery stores," "convenience stores," and others (eg, Wang et al[33]). Other studies examine the availability of particular food items such as "fresh fruit and vegetables" (eg, Farley et al[34]). Neighbourhoods with notably poor availability of healthy foods or food outlets are sometimes described as "food deserts" with detrimental health outcomes (eg, Bridle-Fitzpatrick[35]). The food environment cluster includes a more predominant focus on socioeconomic status than the other clusters, which is indicated by terms such as "health disparity," "neighbourhood poverty," and "social cohesion" (eg, Zachary et al[36]). In general, the interaction mechanism of energy uptake plays a key role in most of the articles typical of this cluster.

3.4 | Family environment

This cluster is concerned with the environmental features defined by parental regulation and the family home. In this case, the obesity object is *population obesity in children and adolescents*, which is typically measured by BMI. The key mechanism of interaction is *energy expenditure and intake*, which is influenced by family practices such as eating habits, diet, physical activity, and sedentary behaviour. These

practices are indicated by terms such as "screen time," "home food environment," "parental influences," "food choice," and "fruit and vegetable intake." "Maternal education" maps alongside "parental education," there being no independent mapping for fathers. The cluster focuses on both supply and demand sides of energy balance, setting it apart from the clusters that only focus on supply (food environment) or demand (built environment). It shares a similar focus on children and youth as the institutional environment.

Within this cluster, there is an additional research interest in the long-term effects of early life on health outcomes in adulthood and old age. This life course perspective often informs obesity prevention policies that target family environments (Salsberry and Reagan[37]).

In sum, the articles typical of this cluster explore a broad range of family environment features that are assumed to influence energy uptake and expenditure, and consequently the production of obesity among the younger generation. As this particular subset of the population also comprises the future adult population, this cluster is concerned with interventions directed at existing obesity levels in children and adolescents as well as with long-term obesity prevention.

3.5 | Bodily environment

In this cluster, the environment is an internal physiological one, unlike all the other clusters. The obesity object is *deposition of fat in the human or rodent organism*, a process that can potentially lead to obesity. Fat deposition is influenced by several types of interactional mechanisms, including inner *physiological processes and gene expression*, which in turn may be influenced by a further set of environmental factors. The *bodily environment* is considered in both its normal and pathological functioning (eg, Schmidt et al.[38]).

A theme present in this cluster is the study of how the expression of particular genes increases the likelihood of obesity (eg, Koch and Britton[39]). The appearance of the terms "obese women" and "maternal obesity" in this cluster without any male, paternal, or parental counterparts points to a specific interest in the inner bodily environments of women and possible intrauterine effects on health (for an article from the sample discussing effects of heredity, intrauterine conditions, and post-natal environments, see Salsberry and Reagan[37]). Although it might seem as if this cluster shares an interest in long-term effects of nutrition on obesity with the food environment cluster, this similarity masks a vast difference in approach. While studies of food environment focus on large-scale food availability and population BMI, the studies in this cluster invariably address detailed processes in the inner bodily environment. Thus, the kinds of environment-gene interaction studied here point towards a configuration of environment less focused on how the environment impacts calorie input and output and more on how environmental factors might influence the expression of genes or the regulation of inner bodily mechanisms. In this sense, articles typical of this cluster draw on a notion of environment, which is significantly different from the other clusters.

When nutrition is of concern in this cluster, the focus is often on the risk of chronic disease. This focus on risky diets is indicated by terms such as "fatty acids" and "high-fat diets." Similarly, attention is paid to inner bodily mechanisms like "lipid metabolism" and "glucose intolerance." Chronic conditions often or normally associated with obesity appear prominently in the bodily environment cluster as indicated by terms such as "cardiovascular disease," "coronary heart disease," "diabetes," and "metabolic syndrome."

4 | DISCUSSION

The mixed-methods design in this study is able to identify clear discursive regions/notions of environment within the field of obesity research. The research field, as determined by the present analysis, currently works with five different notions of environment, namely institutional, built, food, family, and bodily environments. Each of these entails a different obesity object and a different set of mechanisms of interaction between object and environment. This observation raises a broader set of questions about the configuration of the field of obesity research. In what follows, we consider three possible interpretations of the network pattern identified here. These are as a pattern of simultaneous integration and disintegration, a partially coherent hierarchy, and/or a pattern of selective simplification and complexification.

4.1 | Interpretation 1: A pattern of simultaneous integration and disintegration

The first of these possible interpretations fastens attention on some of the physical properties of the map (Figure 2). While the five clusters are the most significant features of the map, and the clusters represent a large number of terms that relate closely to each other, some terms are related to more than one cluster. Where several terms are shared between two clusters, the individual clusters appear less tightly knit and the two clusters are drawn more closely together. If, on the other hand, a cluster is composed almost exclusively of its own terms, that cluster will appear more tightly knit and at a distance from the other clusters.

The question of strict separation vs rapprochement between clusters of research can be related to overall visions or normative ideas about how the field should do its work. The rise of ecological models of obesity[2] as well as broad-scale systemically oriented policy efforts such as the UK Foresight Report[4] are both indicative of ambitions to make the field as coherent and coordinated as possible.[8] In this view, more shared terms between the clusters read as a (positive) sign of greater integration, while tightly knit clusters might well be seen as reflecting more isolation. The map produced by our study shows evidence of both integration and isolation. For example, at the bottom of Figure 2, the bodily environment cluster is relatively tightly knit and disconnected from the others. In contrast, at the top of the map, the four other clusters (institutional, food, built, and family environments) are more interconnected and less tightly knit.

4.2 | Interpretation 2: A partially coherent hierarchy

Although all of the clusters define different objects, we could also attempt to look for more systematic connections between the obesity objects. One might note, for instance, that the sizes of these objects

may be fitted into a micro-to-macro series of levels ranging from matters that are physically small, such as adipose cells within an organism, to matters of a much larger magnitude, such as a nationwide system for the provision of school lunches. Pursuing this idea of levels, we might try to arrange these obesogenic environments by size. We might argue, for instance, that level 1 consists of minute processes within the individual organism (bodily environment), that level 2 is the family environment, and that level 3 consists of the food environments and the built environments that encompass entire neighbourhoods. Finally, we could argue that institutional environments, which often operate on a nationwide level, constitute a level 4, containing all of the previously mentioned objects.

While the idea of levels might work to some extent, the levels as represented by the clusters identified in this analysis are not discrete. For instance, a food environment is not perfectly contained within a policy environment, as many things other than policy influence the food environment (eg, climate change and cooking fashions). Similarly, the bodily environment is not perfectly contained within the family environment, as the bodies of children and adolescents are subject to many other influences beyond their families' patterns of energy intake and expenditure. In short, the five clusters do not add up to a single well-defined and well-described system. The clusters do not comply with the presumption of the ANGELO grid that obesogenic environments can be dissected into four types and two levels, leaving no residuals. Instead, the five clusters overlap, interpenetrate, and leave gaps. To depict the field of obesity research as a kind of levelled hierarchy would therefore require multiple caveats. At best, the field might be depicted as a somewhat fragmented and partially coherent hierarchy. Given this lack of unity, the field of obesity research resembles a broader pattern of "disunity," which has been described in several other fields.[40,41] One particularly well-described example is post–Cold War physics where subfields have been shown to engage in a complex pattern of interdisciplinary, mobile, and market-driven collaborations with a broad range of other sciences.[42] In this way, modern physics has moved beyond its earlier quest for positioning particle physics as the inevitable building block of all things and all sciences.[42] In a similar way, the field of obesity research seems to have a "disunited" character with its many simultaneous engagements rather than a single starting point from which everything else can be derived.

4.3 | Interpretation 3: A pattern of selective simplification and complexification

Rather than forcing the idea of a hierarchy based on the physical size of the obesity objects, a third possibility would be to view the five clusters on our map as a pattern of simultaneous simplification and complexification. Any research project begins with a choice of focus, and by implication, a choice of building on a number of pragmatically simplified assumptions.[43] In the present context, a study focusing on the obesogenic effect of institutional environments on thousands of school children might, for instance, build on the operational assumptions that obesity can be measured by BMI and that the food environment can be measured in terms of the prevalence of potentially obesity-encouraging objects such as vending machines. Other studies might draw on entirely different operational assumptions—for instance, a study of the obesogenic effects of an adverse prenatal environment might assume that these basic biological mechanisms can be identified by experimentally manipulating the food consumption of pregnant rats and their offspring and by measuring their blood pressure and a range of metabolic parameters.[44] The chosen operational assumptions that end up being taken for granted (and thus simplified) are not self-evident by any inherent quality but rather appear so because certain methods, metrics, or concepts have been preferred or agreed upon among a group of researchers, creating a path dependency effect. This applies to all research, including this study.

On this interpretation, what Figure 2 shows is not a series of obesity objects that more or less fit together; rather, it shows how the deployment of particular simplifications, assumptions, or standards has facilitated the development of complex understandings of particular obesity-related phenomena. In other words, what appears on the map is a consequence of the tools available for simplification. For example, researchers can learn more about the institutional environment because they can count the number of physical education lessons and soft drink vending machines in schools. They could alternatively learn more about the bodily environment because they can set up experiments with rodent models. They could also learn more about the food environment because they can relate BMI statistically with the average distance to the nearest fast food restaurants, and so on. Every step along the way, and regardless of the type of obesity object in question, a more complex understanding of obesity is made possible by the availability and deployment of particular kinds of simplification. The development and dynamism of the field are therefore not only a question of the findings made by obesity researchers but also a question of how they continually invent new standards, devices, and measurements that allow them to define new study objects. The five notions of environment in Figure 2 can therefore be seen as an outcome of currently available productive simplifications.

5 | CONCLUSION

Like other contemporary scientific fields, obesity research is characterized both by visions of unity and by practices of disunity. The mixed-methods design employed here give a systematic empirical analysis of the status and configuration of the field, as based on highly cited scientific literature on obesogenic environments. We have identified five distinct notions of environment (institutional, built, food, family, and bodily environments) in a broadly sampled dataset of 414 highly cited articles. We have also shown that these multiple notions of environments invite deeper inquiry into the status and the configuration of the interdisciplinary field of obesity research. The field can be interpreted variously as being simultaneously integrating and disintegrating, a partially coherent hierarchy, and/or a pattern of simplification and complexification. This study involved an analysis of 15 years of scientific publication in this field cross-sectionally; future analyses incorporating larger datasets and a longitudinal comparison should give further information on the merit of each of these three interpretations. The database for analysis might also be expanded with

government reports and other types of policy documents to explore the degree to which the same or different notions of environment inform policy and administrative discourses. Finally, we propose that a time lapse version of this map be generated, which would allow us to see how the field is changing, and aid the understanding of both how the field is configured and how its practice might be strategically altered to focus research where it might be most needed.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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