

Environmental determinants of healthy eating in Western Sweden

**From food marketing to pandemic
restrictions**

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ABSTRACT

Purpose: The overall purpose of this thesis was to examine selected food environments in relation to healthy diets in Western Sweden. Specifically, we investigated food marketing and pandemic policy restrictions as environmental factors that can impact diet and lifestyles.

Methods: Study I employed a quantitative content analysis of weekly supermarket advertisements. Food promotions were categorized by healthfulness according to the Nordic Nutrition Recommendations and linked to store locations stratified by a socioeconomic index. Categorical data were summarized using frequencies, percentages, and 99% confidence intervals [CI]. Logistic regression analyses assessed the association between area-level disadvantage and the promotion of unhealthy foods. Study II is a qualitative study involving semi-structured interviews with youth participants from the Swedish IDEFICS/I.Family cohort. Topics included diet, physical activity, sleep, and general well-being. Interviews were transcribed verbatim and analyzed using reflexive thematic analysis.

Results: In Study I, a total of 488 advertisement sheets were collected over four weeks, comprising 29,958 individual food promotions. Of these, 66.7% were classified as either ‘unhealthy’ or ‘most unhealthy.’ Food items promoted in less advantaged areas had 25% higher odds of being ‘most unhealthy’ (OR 1.25; 99% CI: 1.17–1.33). However, the association was attenuated when adjusting for clustering at the chain. In Study II, fourteen youths aged 15–21 participated. The thematic analysis generated three key themes: *Living off the clock – disrupted routines* indicate that youths’ organized activities contribute to a daily structure which were disrupted during the pandemic and led to more irregular lifestyle habits. *Disconnected yet digitally connected – the remote life paradox* reflects that youths spent more time online during the pandemic and became socially disconnected from others than their family members.

Increased household impact on the health of meals refers to how the availability of food in the youths' living environment changed during the pandemic, which affected their eating habits.

Conclusion: These studies highlight how structural factors, such as food marketing practices and pandemic-related disruptions, operate across societal levels, shaping peoples' food environments, and potentially counteracting healthy eating at the individual level. Further research is warranted to explore how these determinants interact within the Swedish context and to identify leverage points for promoting healthier dietary behaviors.

Keywords: Food environment, food advertising, nutrition guidelines, supermarket, socioeconomic area, qualitative, interview, COVID-19, well-being, lifestyle, healthy diet, youth, Sweden

SAMMANFATTNING PÅ SVENSKA

Syfte: Det övergripande syftet med denna uppsats var att undersöka utvalda matmiljöer i relation till hälsosamma matvanor i Västsverige. Mer specifikt studerade vi livsmedelsmarknadsföring och restriktioner under COVID-19-pandemin som miljöfaktorer som kan påverka kostvanor och livsstil.

Metoder: I Studie I genomfördes en kvantitativ innehållsanalys av livsmedelsbutikernas reklamblad. De annonserade matvarorna kategoriserades efter deras hälsosamhet i enlighet med de Nordiska näringsrekommendationerna och livsmedelsbutikernas geografiska områden stratifierades med ett socioekonomiskt index. Kategoriska variabler summerades med frekvens, procentandel och 99% konfidensintervall [KI]. Logistisk regressionsanalys användes för att uppskatta associationen mellan olika områdens socioekonomi och marknadsföring av ohälsosam mat. Studie II är en kvalitativ studie där semistrukturerade intervjuer genomfördes med unga från den svenska IDEFICS/I.Family-kohorten. Ämnena som utforskades var kost, fysisk aktivitet, sömn, och allmänt välbefinnande. Intervjuerna transkriberades ordagrant och analyserades med reflexiv tematisk analys.

Resultat: I Studie I samlades 488 reklamblad in under fyra veckor som inkluderade 29,958 annonserade matvaror. Av de klassificerades 66,7% som 'ohälsosamma' eller 'mest ohälsosamma'. Annonserade matvaror i områden med lägre socioekonomi hade 25% högre odds att vara 'mest ohälsosamma' (OR 1,25, 99 % KI 1,17, 1,33) men associationen försvagades när justering gjordes för de kedjor som livsmedelsbutikerna tillhör. I Studie II deltog 14 personer i åldrarna 15-21. Den tematiska analysen resulterade i tre teman: *Att leva utan klocka – rubbade rutiner* handlar om att de ungas organiserade aktiviteter bidrar till en daglig struktur som rubbades under pandemin, vilket ledde till mer oregelbundna livsstilsvanor. *Frånkopplad men digitalt uppkopplad – distanslivets paradox* indikerar att ungdomar tillbringade mer tid online under pandemin och blev socialt frånkopplade från personer andra än deras familjemedlemmar. *Hushållens ökade inflytande på måltiders sundhet* handlar om att tillgången på mat i de ungas livsmiljö förändrades under pandemin, vilket påverkade deras matvanor.

Slutsats: Studierna belyser hur strukturella faktorer, som livsmedelsmarknadsföring och pandemirelaterade restriktioner, influerar flera samhällsnivåer, formar människors matmiljöer, och potentiellt motarbetar en hälsosam kosthållning på individnivå. Mer forskning behövs för att undersöka hur dessa determinanter interagerar i en svensk kontext och identifiera hävstångspunkter för att främja hälsosamma matvanor.

LIST OF PAPERS

This thesis is based on the following studies, referred to in the text by their Roman numerals.

- I. Mjöberg, M., Lissner, L., Hunsberger, M. Supermarket promotions in Western Sweden are incompatible with Nordic dietary recommendations and differ by area-level socioeconomic index.
BMC Public Health. 2023;23: 795.
- II. Mjöberg, M., af Geijerstam, A., Wolters, M., Lissner, L., Hunsberger, M. Perceived COVID-19 related lifestyle changes among Swedish youth: a qualitative study.
(Manuscript)

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ABBREVIATIONS

ALLEA	All European Academies
BMI	Body mass index
COVID-19	Coronavirus disease 19
DeSO	Demographic statistical areas
GBD	Global Burden of Disease
HIC	High-income country
IDEFICS	Identification and prevention of dietary- and lifestyle-induced health effects in children and infants
I.Family	IDEFICS Family
LMIC	Low- and middle-income countries
NCDs	Non-communicable diseases
NNR	Nordic Nutrition Recommendations
OR	Odds ratio
PA	Physical activity
RegSO	Regional statistical areas
RTA	Reflexive thematic analysis
SEI	Socioeconomic index
VGR	Region Västra Götaland
WHO	World Health Organization

1 INTRODUCTION

In recent decades, food environments have undergone significant changes, shaped by globalization, urbanization, and economic growth (1). In many high-income countries [HICs], urbanization has created a physical and social distance between consumers and food production sites. Urban residents typically have access to a wide array of foods through supermarkets and restaurants, which operate year-round and offer relatively low-cost options. While this increased availability may appear to enhance food choice, it is often accompanied by the widespread presence and marketing of unhealthy foods; factors known to influence consumer behavior and dietary patterns (1, 2). Although there is a motivation to buy healthy foods among some consumers, unhealthy options can be difficult to resist and consequently bought on impulse (3, 4). Promoted foods should therefore be safe, nutritious, and offer enough variability to satisfy consumers' cultural preferences (1, 5). They should be available, accessible, and affordable to all age groups, and unhealthy options the contrary (6-8).

1.1 IMPACT OF UNHEALTHY DIETS GLOBALLY

The marketing of unhealthy foods and the structure of our current food environments can present significant challenges to maintaining a healthy diet throughout the life-course. A healthy diet, characterized by a diet rich in fruits, vegetables, and dietary fiber, is crucial in preventing non-communicable diseases [NCDs] and addressing malnutrition, including underweight and obesity. However, dietary patterns often fall short of nutritional recommendations. Many individuals consume diets high in processed foods, which are typically energy-dense and contain excessive amounts of unhealthy fats, sugars, and salt, while being low in essential nutrients (9).

If diets become healthier, there is the potential to prevent approximately one in five deaths globally (10), primarily by reducing the burden of NCDs such as cardiovascular disease, diabetes, and certain cancers. However, achieving this goal necessitates a comprehensive understanding of the complex interplay between environmental and personal factors that influence food choices (10, 11).

Seven of the top ten causes of death in 2021 were NCDs, all of which have increased steadily since 2000. Ischemic heart disease, stroke, and type 2 diabetes are among the leading causes of death (12), which can be partly explained by unhealthy diets (5). Globally, the leading risk factor for premature mortality was high systolic blood pressure in 2019. Among the major risk factors for NCDs worldwide, high body mass index [BMI], high systolic blood pressure, and high fasting plasma glucose have remained the same or increased since 1990, according to the Global Burden of Disease [GBD] (13).

By disaggregating the top ten causes of death by country income group (low-, lower-middle-, upper-middle-, and high-income) there is a clear social health gradient, with NCDs becoming more prevalent and infectious diseases less prevalent as income level increases (12). At the same time, the most rapid increase in recent decades has been observed in low- and middle-income countries [LMIC], and among groups with lower socioeconomic status. Between 1999-2022, an increase in diet-related ill-health has also been observed among children and adolescents, such as overweight and obesity, type 2 diabetes, dental problems, and mental illness (14, 15). This is problematic as an unhealthy weight in childhood tends to persist into adulthood, increasing the risk of lifestyle-related diseases later in life (15).

Unhealthy diets have consequences that extend beyond human health. Modern food production and consumption contribute significantly to environmental degradation (16), making current dietary patterns a threat to both human and planetary health. Obesity, undernutrition, and climate change have been described as a global syndemic—a set of interconnected pandemics driven by common underlying factors (17). These include political and economic interests shaping government and corporate actions, a market-consumer dynamic that reinforces unsustainable supply and demand, and food and transport systems that strain environmental resources (17).

Currently, obesity is estimated to cost the global economy approximately 2.8% of gross domestic product, primarily due to healthcare expenses and lost productivity (17). Investing in effective strategies to prevent obesity would require only a fraction of the projected costs. However, if both public and private sectors remain inactive, the burden will escalate, falling disproportionately on LMIC, despite HICs having higher obesity rates (17, 18). These negative global impacts call for country-specific measures that target healthy lifestyles.

1.2 WHAT CONSTITUTES A HEALTHY LIFESTYLE?

Although there is no universally accepted definition of *lifestyle*, health-related research often frames it as a combination of behaviors that pose either risks or offer protection for health. Some scholars argue that lifestyle also includes an internal dimension, rooted in individual values and attitudes, that shapes outward behavior. In this view, lifestyle is both shaped by and expressed through choices and habits that may be either stable or temporary, evolving, and influenced by cultural and social contexts over time (19).

According to an early definition, the World Health Organization [WHO] described a healthy lifestyle as one that reduces the risk of premature morbidity and mortality, typically through behaviors such as a nutritious diet, regular physical activity [PA], and the avoidance of tobacco and harmful alcohol use (20). More recently, the WHO has provided more detailed recommendations that focus on diet and PA (21).

A healthy lifestyle, therefore, emerges from the dynamic interaction between the individual and their environment (19). While individuals actively make choices and engage in lifestyle behaviors, their environment, through social, economic, and structural conditions, can either enable or constrain those choices (22).

1.2.1 LIFESTYLES SHIFTED IN RESPONSE TO COVID-19

During the coronavirus disease 19 [COVID-19] pandemic, many countries worldwide tried to prevent high morbidity and mortality rates by adopting lockdown measures such as school closures, enforced home quarantine, and social distancing. Consequently, adults' and youths' mobility was restricted substantially, which led to more time in the home environment (23, 24). Further, pupils' access to nutritious school meals decreased that might have been more problematic for youths living in low-income households (25). Less frequent food shopping has also been observed during COVID-19, which decreased access to fresh foods at home, such as fruit and vegetables (26). Studies have reported that children's and adults' dietary patterns have been affected both positively and negatively by the pandemic. However, the

majority seem to have been snacking more, eating more junk food, and an increased quantity of food overall (24, 26-28).

Human behavior and the factors that influence it are complex, even more so when unplanned events occur, such as COVID-19 (29), which may exacerbate risk factors for childhood obesity (30). COVID-19 and the restrictions imposed have shown that various aspects of people's usual lifestyle behavior have been disrupted. Although the effects have been shown to differ, dietary patterns have been observed to move in a more unhealthy direction in terms of the type and amount of foods consumed (31), as well as decreased PA, changes in intensity levels, and increased sedentary time (31).

1.2.2 DEFINING A HEALTHY DIET

A healthy diet is rich in essential vitamins, nutrients, dietary fiber, and beneficial fats, particularly polyunsaturated and monounsaturated fats, which should form the foundation of daily intake. Key food groups include vegetables and legumes, fruits and berries, whole grains, fatty fish, nuts and seeds, and plant-based oils. In contrast, the consumption of red and processed meats, as well as foods high in saturated fats, salt, and added sugars, should be minimized (16). While these are general dietary recommendations, the ideal composition of a healthy diet can vary depending on individual factors such as age, gender, and other lifestyle behaviors (9).

The authors of the GBD Study 2019 (14) identified 15 components of diet quality, which they combined into a composite dietary risk indicator. This risk indicator includes insufficient intake of fruits, vegetables, legumes, whole grains, nuts and seeds, dairy, fiber, and polyunsaturated fatty acids, alongside excessive consumption of red and processed meats, sugar-sweetened beverages, trans fats, and sodium. In 2019, the dietary risks captured by this composite indicator were among the top three global contributors to death for both men and women (13).

Based on the data from the 195 participating countries, the GBD Study further found that high sodium intake, along with low intake of fiber and fruits, emerged as the leading dietary risk factors for global deaths and disability-adjusted life years in 2017 (10), a measure that captures years lost due to premature mortality and morbidity (32). People generally ate too little of all healthy food components, especially nuts and seeds, dairy, and whole grains, compared to what would be optimal levels. At the same time, they ate more

than the recommended amount of all unhealthy food components, especially sugary beverages, sodium, processed and red meat (10).

1.2.3 PHYSICAL ACTIVITY RECOMMENDATIONS

According to WHO, all types of body movement produced by skeletal muscles that result in energy expenditure can be defined as PA (33). Performing PA at both lower and higher intensity levels is beneficial for health and well-being at all ages, and reduces the risk of NCDs such as cardiovascular diseases, several types of cancer, and type 2 diabetes (33, 34). Currently, approximately 30% of adults and 80% of adolescents globally are less active than recommended by WHO (33).

Children and adolescents aged 5-17 years are recommended to do at least 60 minutes of moderate to vigorous intensity PA per day, with at least three days per week of more vigorous-intensity activity. Adults are recommended to be physically active for at least 150 minutes per week of moderate-intensity activity and at least 75 minutes per week of vigorous-intensity activity. At the same time, sedentary time should be limited (35).

1.3 ECOLOGICAL MODELS – MULTILEVEL INFLUENCES ON HEALTH BEHAVIOR

Ecological models emphasize the multi-level influences on individual health behaviors. They reinforce that these influences must be supportive to achieve long-term behavior change at the population level (36, 37). Structuring influencing factors or determinants at multiple levels specifically shows the interconnected relationship between the environment and individual behavior, where policy and general environmental conditions are included as top levels of health influence (37).

An ecological framework differs from many commonly used behavioral theories and models in public health, which often focus on individual characteristics as the central driver of behavior, with limited attention to external influences. In contrast, the ecological approach challenges interventions that primarily target individuals with information and resources, while overlooking the broader living environment. This has been a frequent shortcoming of past public health strategies aimed at promoting healthy diets. (37).

1.3.1 AN ECOLOGICAL FRAMEWORK OF ENVIRONMENTAL DETERMINANTS AND THEIR IMPACT ON EATING PATTERNS

Story et al. (38) designed an ecological framework that depicts the most influential environmental determinants of individual eating patterns at multiple societal levels. These determinants can be found at the macro level (sectors), in physical environments (settings), social environments (networks), and at the individual (personal) level. This framework illustrates the complexity of factors that influence eating behaviors. For details, see Figure 1.

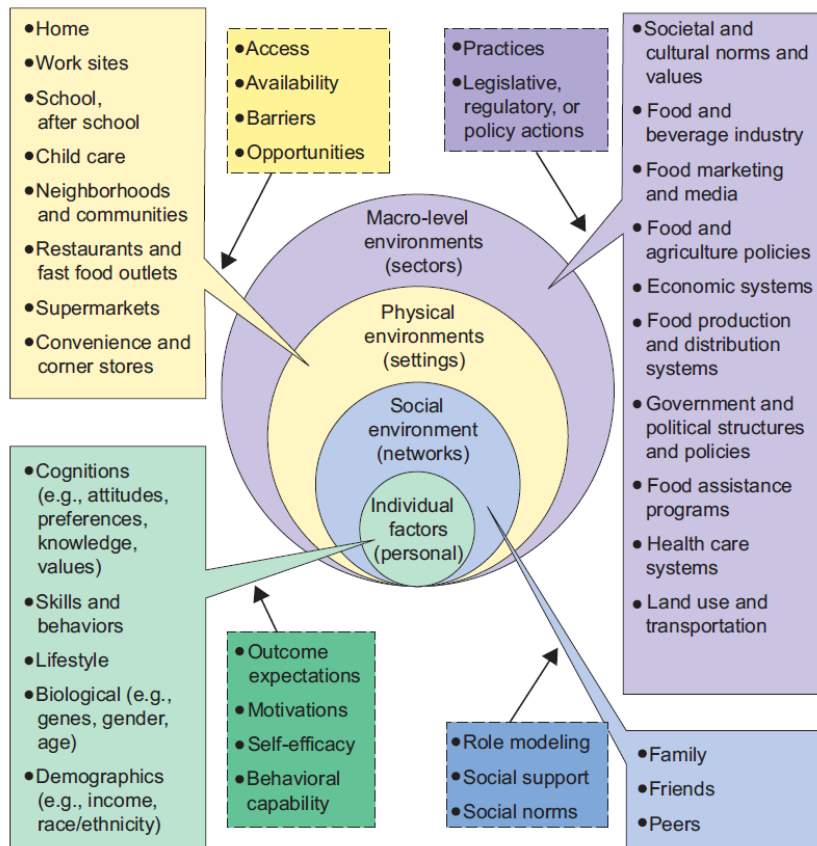


Figure 1 An ecological framework depicting the multiple influences on what people eat. Story et al. (39) Published in *Creating Healthy Food and Eating Environments: Policy and Environmental Approaches 2008*: pages 253-272. Reprinted with permission.

Macro-level environmental determinants include, e.g. societal and cultural norms and values related to food and eating, food marketing and social media influence, food system activities and policies, and government and political structures. These determinants have an indirect but vigorous effect on eating patterns at the population level, and more research is needed to understand this association (38).

The physical environment and its determinants specifically include different types of food environments (38). These are, by definition, settings where consumers engage with structural, societal, and cultural factors to choose which foods to purchase, prepare, and consume (40). The health of food environments is both a result of the functioning of food systems, as well as a driver of public food choices (41). According to the framework, these environments include e.g., home, work, and school, which have also been called the organizational environment (7). Other food environments are neighborhoods and communities, as well as common food outlets such as supermarkets and restaurants (38).

In food environments, mechanisms such as availability, accessibility, affordability, types of grocery stores, and the quality of foods sold appear to have a major impact on food choices (42). For example, a high prevalence of unhealthy food outlets in an area has been reported to contribute to obesity in children and adults, especially in more deprived areas (43, 44). However, the effect has been shown to differ across contexts where, among others, food prices can differ, which in turn may affect actual consumption (45).

Another level of influence is the social environment. Here, determinants include social interaction with family members and friends who can provide social support, role modelling, and contribute to social norms, all of which can influence individual eating behavior. In the home, the person responsible for shopping and preparing the food eaten is considered to have further influence on the family's food consumption, especially children (7). Home food availability appears to be important for the development of children's food preferences (6). In addition, other factors that can influence food consumption at home are several. They include parents' education level, weight status, attitudes, behaviors, and feeding styles, portion sizes served, and meal structure. The social situation around the meal also has an impact, for example, whether one eats in front of the television or socializes with family members (46-48).

Lastly, individual-level determinants that influence food choices and eating are numerous and interconnected, e.g. culture, gender, age, lifestyle, ethical values, skills, and knowledge (11, 38, 42, 49). They are strongly related to a

person's identity formation and are dynamic as they differ across the lifecourse and in different contexts, for instance, depending on where one eats or with whom (50, 51).

1.4 FROM A GLOBAL TO LOCAL PERSPECTIVE – THE SWEDISH SETTING

Over the past two decades, the proportion of overweight and obesity among adults in Sweden has risen from 46% to 54%. The most significant increase has occurred among young adults, while the highest overall prevalence is found in the oldest age groups (52). According to the Swedish Food Agency, the dietary habits of both adults (53) and adolescents (54) fall short of national recommendations (55). Disparities in healthy eating behaviors are evident from an early age, particularly between boys and girls, and between socioeconomically advantaged and disadvantaged groups (54, 56-59).

Since 2014, research on various dimensions of food environments in Sweden has grown steadily. At the same time, food environments are becoming increasingly digital, with a rise in online food marketing and media influence (60). These digital forces can shape consumer behavior across physical settings, social networks, and personal decision-making (49), steering food preferences and choices in both healthier and unhealthier directions (7). Media and digital advertising may also shift perceptions of established determinants of eating behavior, such as the availability and accessibility of foods and food outlets (49, 60, 61). As the food environment continues to evolve rapidly, there is a pressing need for more context-specific knowledge in the Swedish setting.

1.4.1 SUPERMARKET FOOD PROMOTIONS

Supermarkets and restaurants are usually the most common food outlets in a given area, and what they offer probably reflects what is available in other environments. They have been suggested as priority food environments as they offer researchers many measurable influences, such as strategies and types of foods marketed. Increased knowledge about their impact on food consumption may have broad public health implications (7).

Several Swedish studies have investigated the retail food environment in different ways. The majority investigated promotion strategies in-store and how these affected consumers perceptions and demand, e.g. labelling (62-65), packaging (64) product placement (66), and usage of audio (65). One study

analyzed the nutrient content in market baskets (67) and another investigated changes in neighborhood population density between 2000-2013 and the physical distance to grocery stores (68). Only one study from 2015, where Sweden was included among 12 countries, has investigated the healthiness of supermarket advertisements. A supermarket in Stockholm city was included and they found that the supermarket devoted almost 35% of their advertisements to discretionary foods (69). The healthiness of foods marketed by supermarkets in Sweden is a largely understudied area that merits further research.

1.4.2 THE EFFECT OF COVID-19 ON LIFESTYLES

Sweden's strategy during COVID-19 was to focus on mitigation, whereby the negative effects of the pandemic should be limited (70). However, it has been observed that especially young people in the ages 16-29 in Sweden were negatively affected, where they, e.g., decreased their level of PA and increased their consumption of unhealthy snacks (71). Even children under the age of five appear to have been negatively affected. During the pandemic, this age group experienced a temporary 16% increase in the prevalence of overweight and obesity. Although rates returned to near pre-pandemic levels afterward, they remained elevated among children from socioeconomically disadvantaged groups, including those with parents with low education levels, single parents, and families with a foreign background (72).

The strategy in Sweden was relatively permissive compared to many other countries, and therefore, several studies have examined the pandemic's impact on lifestyles. Most studies are quantitative and have investigated changes in multiple behaviors among an adult population. The majority included PA (29, 73-77) and sedentary behavior (29, 75, 76, 78), while three studies included sleep (74, 76, 78), alcohol (75, 76, 78), mental health (74, 76, 78) and diet (75, 78, 79). Two studies investigated smoking (75, 76), one examined screen time (73), and included the pandemic's impact on social life (78). Among the studies investigating diet, only one examined change in food consumption in more detail, with a particular focus on the intake of fruits and vegetables, and ultra-processed foods (79). Only two qualitative studies have been conducted to explore perceived changes. In one study, school nurses were interviewed about how they perceived students' well-being during the pandemic (80), and in another study, parents of children with overweight and obesity were interviewed in three different countries, including Sweden (81). However, to the author's knowledge, no study has qualitatively explored how young people

themselves perceived that COVID-19 affected their lifestyle behaviors, with more focus on dietary changes.

2 AIM

The overall purpose of this thesis was to examine selected food environments in relation to healthy diets in Western Sweden. Specifically, we investigated food marketing and pandemic policy restrictions as environmental factors that can impact diet and lifestyle.

Aims that have been addressed in the two studies are:

- I. To investigate the health quality of supermarkets' weekly food promotions with attention to more and less advantaged socioeconomic index areas.
- II. To explore how Swedish youth perceive that changes to their environment during the COVID-19 pandemic altered their diet and other lifestyle behaviors.

3 METHODS

3.1 OVERVIEW OF STUDIES I AND II

Study I has a cross-sectional design where weekly supermarket advertisements were analyzed in relation to the Nordic Nutrition Recommendations [NNR] (55) and socioeconomic characteristics of the store areas. The healthfulness of foods that large supermarkets promote to consumers is considered an important environmental determinant at the macro-level. We hypothesized that supermarket promotions were not aligned with NNR and that more unhealthy foods would be promoted in store areas with lower socioeconomy. Advertisements were collected during a one-month period in 2020 and analyzed using quantitative content analysis as well as descriptive and analytical statistical methods.

Study II is a qualitative investigation that selected participants from the Swedish part of the IDEFICS/I.Family cohort. It was designed to complement a longitudinal study conducted in Sweden and Germany that examined changes in health behaviors and well-being before and during the COVID-19 pandemic (manuscript under review). How young people in Sweden perceive that their diet and other lifestyle behaviors were affected by the pandemic restrictions is considered another important environmental factor at the macro-level to explore, that potentially has had multiple health impacts. Data were collected through semi-structured interviews with youth and analyzed using reflexive thematic analysis [RTA].

See Table 1 for more information.

Table 1 Overview of the main characteristics of Studies I and II

Study	Aim	Data source	Data collection and analysis
I	To investigate the health quality of supermarkets' weekly food promotions with attention to more and less advantaged socioeconomic index areas	All weekly online advertisement sheets published by seven supermarket chains across VGR between 2–29 March in year 2020 488 ad-sheets containing 29,958 individual food promotions	Quantitative content analysis and logistic regression
II	To explore how youths in Sweden perceive the impact of COVID-19 on their lifestyle behaviors and to identify the main drivers behind these changes	14 youths from the Swedish IDEFICS/I.Family cohort	Semi-structured interviews and reflexive thematic analysis

3.2 SETTING

The geographical setting for both studies is Region Västra Götaland [VGR], a large region in Western Sweden. VGR is one of Sweden's 21 regions (82) comprising 49 municipalities, with Gothenburg as its largest, and a population of 1.6 million. Like all Swedish regions, VGR is governed by democratically elected politicians and holds responsibility for the areas of healthcare, culture, and public transport (83). One challenge in the region is the growing inequalities between groups with lower and higher incomes and educational levels. This has contributed to growing polarization where fewer areas exist with socioeconomic diversity (84).

3.3 DATA COLLECTION

3.3.1 STUDY I

3.3.1.1 SUPERMARKET CONGLOMERATES, CHAINS AND INDIVIDUAL STORES (STUDY I)

For Study I, six supermarket conglomerates were selected based on their market share [MS] reported between 2017 and 2019, along with all or a selection of their supermarket chains, also chosen based on MS. Seven chains

were included, with a total of 122 individual supermarkets in VGR identified using Google Maps. Weekly online advertisements for each supermarket were collected over one month. Due to acquisition of two chains, the six conglomerates are now only four, with the three largest accounting for more than 90% of the MS (85, 86).

3.3.2 STUDY II

3.3.2.1 IDEFICS AND I.FAMILY (STUDY II)

Identification and prevention of dietary- and lifestyle-induced health effects in children and infants [IDEFICS] is a longitudinal population-based cohort study conducted in Belgium, Cyprus, Estonia, Germany, Hungary, Italy, Spain, and Sweden. Countries were selected to represent different geographical regions of Europe (87). The primary objectives were to investigate diet- and lifestyle-related health determinants among school children in Europe, and to reduce the incidence of lifestyle-related diseases and disorders (87). The design follows the ecological framework of Story et al. (38) as the health determinants investigated in the study operate at multiple levels in society, from the environmental to the individual level (87).

The IDEFICS study was conducted between 2006-2012 where 16,228 children aged 2-9 years were eligible for inclusion at the baseline examination in 2007-2008. In Sweden, children were recruited to the IDEFICS cohort through kindergartens and primary schools geographically located in three municipalities in VGR, Alingsås, Mölndal, and Partille. Two years after baseline, a follow-up examination (FU1) was conducted with so called index children, i.e. children who had participated at the first examination, as well as newly recruited children.

Between 2013-2014, the IDEFICS Family study [I.Family] started in all countries where a questionnaire (FU3) was distributed to participants who had completed the baseline and FU1 assessments. The questionnaire included items on family demographics, parenting style, family meal habits, children's and adolescents' food and beverage preferences, PA and sleep habits, media use, and well-being. Siblings of similar age and parents were invited to participate, which further expanded the cohort. At baseline, FU1, and FU3, other measurements were collected to complement the questionnaires. For further details, see Ahrens et al. (88). Around 2015, subgroup examinations, or so-called contrasting groups, were conducted in the cohort, selected based on

weight status and changes in BMI z-score. Examinations focused on sleep quality, taste perceptions, and the gut microbiome, among others (88).

In 2020, a web-based follow-up survey (FU5) was sent out to the IDEFICS/I.Family cohort in nine European countries, with Poland as the new ninth research center. The initial survey was distributed at the beginning of the COVID-19 pandemic. To capture potential lifestyle changes resulting from the pandemic, a second survey was sent out in 2021/2022. The primary topics addressed included diet, PA, sleep, screen time, and general well-being. All individuals in the cohort aged 12-23 years at the time of recruitment were invited to complete the FU5 questionnaires, with no additional inclusion or exclusion criteria. Sweden was the only participating country to conduct supplementary interviews as part of the FU5 follow-up survey. See Figure 2 for more information on the longitudinal design of IDEFICS and I.Family studies and the related examinations from 2007-2021.

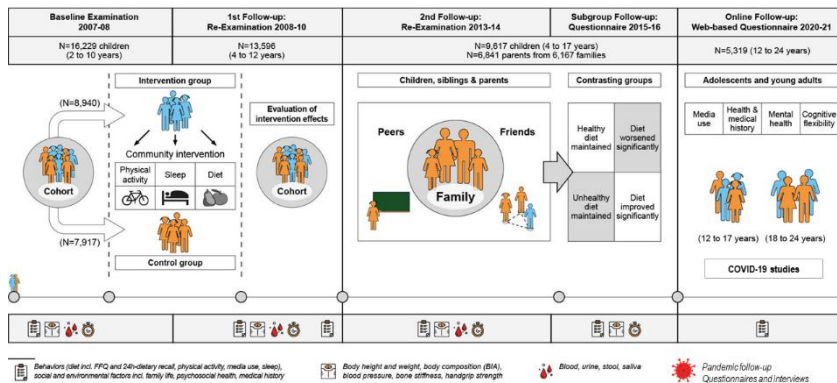


Figure 2 Overview of examination waves/surveys and overall design of IDEFICS/I.Family cohort. Adapted from Ahrens and Pigeot (89) to include COVID-19 data collection. Published in *Risk Factors Of Childhood Obesity: Lessons From The European IDEFICS Study*. Reprinted with permission.

3.3.2.2 SEMI-STRUCTURED INTERVIEWS

A semi-structured interview guide was developed to explore participants' perceived lifestyle changes during the COVID-19 pandemic. The guide was informed by the core aims of IDEFICS/I.Family, focusing on diet, PA, sleep, and general well-being for the purpose of capturing concepts that our longitudinal surveys may have failed to capture.

The semi-structured design ensured consistency across interviews while allowing flexibility to explore individual experiences in greater depth. Each topic area featured preformulated, open-ended questions, which encouraged participant-led narratives and enabled the interviewer to ask follow-up questions as the conversation unfolded. This approach was chosen to elicit rich, nuanced data and capture the subjective meanings and lived experiences of participants (90). Individual interviews were conducted via Zoom (91), and both video and audio recordings were collected to ensure accurate transcription and analysis.

3.4 DATA ANALYSIS

3.4.1 STUDY I

3.4.1.1 REGSO AND SOCIOECONOMIC INDEX

Once the 122 individual supermarkets were identified using Google Maps (92), they were recorded in Microsoft Excel (93) along with the municipality name and code, regional statistical areas [RegSO] name, individual store name and socio-economic index [SEI]. RegSO was chosen over demographic statistical areas [DeSO] as many DeSO areas lacked supermarkets. Therefore, RegSO was better in size and they often contained only one or a few supermarkets.

Statistics Sweden has developed DeSO and RegSO to make it possible to obtain demographical statistics across Sweden, where the regions are divided into smaller units of analysis. There are 6,160 DeSO areas and 3,363 RegSO areas in Sweden (94, 95). RegSO areas are aggregated DeSO units with a population of between 650-23,000 people per area. It is common for municipalities to be divided into 5-9 RegSOs, although the number can be smaller or larger. RegSO and DeSO were developed specifically to facilitate the work of studying segregation, its occurrence, and development (95).

Each RegSO area has a SEI between 0-100%. It is a sum based on the proportion of people living with a low economic standard, who have not completed upper secondary school, and who have had financial support for ten months or more. The higher the SEI, the more deprived an area is (96).

3.4.1.2 NORDIC NUTRITION RECOMMENDATIONS

The first version of NNR was published in the 1980s, with the sixth edition released in 2023. These guidelines are used across the Nordic and Baltic

countries to inform national nutrition recommendations, food labeling, and public meal planning. The latest edition of the NNR marks a departure from previous versions by incorporating considerations for both human and planetary health, aligning with global sustainability efforts (97).

To analyze the data for Study I, a reference table from the fifth edition of the NNR, published in 2012 (55), was used. The table outlines food groups that should be increased, exchanged, or limited in the general population's diet. Additional details are provided in Figure 3.

Increase	Exchange	Limit
Vegetables Pulses	Refined cereals → Wholegrain cereals	Processed meat Red meat
Fruits and berries	Butter → Vegetable oils Butter based spreads → Vegetable oil based fat spreads	Beverages and foods with added sugar
Fish and seafood	High-fat dairy → Low-fat dairy	Salt
Nuts and seeds		Alcohol

Figure 3 Dietary changes that potentially promote energy balance and health in Nordic populations. Nordic Council of Ministers (98). Published in Nordic Nutrition Recommendations 2012: page 23. Reprinted with permission.

The food groups in the fifth edition are similar to those presented in the sixth edition 2023, but differ in some respects. Potatoes and whole grains are now classified under the 'increase' category. Processed foods have been added as a food group within the 'exchange' category, while in the 'limit' category, beverages and foods with added sugar has been expanded to include a broader range of processed foods high in fats, salt, and sugar (97), p. 98.

3.4.1.3 QUANTITATIVE CONTENT ANALYSIS

The analysis of supermarket advertisements followed principles similar to those used in content analysis, as described by Neuendorf (99), although the procedure was not applied in a strict step-by-step manner. Variables of interest were conceptualized and operationalized in a coding scheme, with food items categorized as 'most healthy', 'healthy', 'unhealthy', or 'most unhealthy' based on the NNR 2012 framework (55). Inclusion criteria for each food group and category were drawn from the Swedish Food Agency's Keyhole criteria for nutrient content per food group (100).

As some advertised foods did not align with the NNR 2012 food groups, additional categories were adapted from the WHO Regional Office for Europe nutrient profile model (101). These included ‘white meat and eggs’, ‘low- and high-fat sauces, dips, and dressings’, and ‘less and more nutritious ready-made and convenience products and composite dishes’. One researcher performed the coding using a customized Excel spreadsheet containing all relevant variables.

The essence of using content analyses as a research method is to process text, images and other symbolic material in an organized way (102, 103). It can be used in both qualitative and quantitative research and is therefore different from many other research methods. Quantitative content analysis is a numerical process where the aim is to summarize a selected set of messages, rather than describe them in detail. Important characteristics are that the process is systematic, objective, and replicable, where valid inferences are made about the manifest message content (99). However, since quantitative content analysis involves processing non-numerical materials, such as an image or text, it will always contain a qualitative element (102).

There are clear differences between quantitative and qualitative content analysis. They differ in philosophical assumptions, objectives, research design, data collection, and analysis. Qualitative content analysis can focus on both manifest and latent content, but the interest lies in exploring a complex phenomenon that is often seen as a construct from human experience. While the focus is also on words, images, actions etc., the process is more subjective, focusing on capturing the voices of a few people, and the aim is not to generalize the results to a larger population (104).

3.4.1.4 STATISTICAL ANALYSIS

In Study I, the data were analyzed using descriptive and analytical statistical methods. All analyses were performed using IBM SPSS Statistics 27 (105). Categorical variables were described in terms of frequency, percentage and 99% confidence interval [CI]. These were promoted food categories (e.g. vegetables and pulses, processed meat) and promoted foods per health group (i.e. most healthy, healthy, unhealthy, most unhealthy). The proportion of promoted food by health groups was compared overall with how their proportions conformed to NNR 2012 and how they differed between more and less advantaged areas in VGR. To test for differences in food promotions between more and less advantaged areas, Pearson’s Chi-square was used.

Binary logistic regression was used to test whether there were higher odds that foods belonging to the ‘most unhealthy’ group were promoted in more disadvantaged areas. In addition, multivariable logistic regression was used to include chain as a covariate that could confound the association, and $P < 0.01$ was chosen as a conservative significance level. Sensitivity analysis was carried out where one chain was removed as it had no stores placed in the more disadvantaged areas.

3.4.2 STUDY II

3.4.2.1 REFLEXIVE THEMATIC ANALYSIS

In Study II, recorded interviews were manually transcribed verbatim by two individuals, following a transcription guide by Tracy (106). Although the analysis focused solely on participants’ spoken words, the use of a guide helped to understand how statements were delivered as the symbols were used with consistency in the transcripts. For example, the symbols indicated when it was unclear what the participant was saying, when words were emphasized, interruptions, and laughter by either the interviewer or interviewee.

To analyze the transcripts, an inductive RTA by Braun and Clarke was conducted. Their approach was first published in 2006 (107) but has since then been developed to include reflexivity as an essential part of the analytical process (108). Reflexivity recognizes the researcher’s integral role in the knowledge-generating process, emphasizing the importance of continuously reflecting on and interrogating the own influence on the research material (107, 109).

The RTA by Braun and Clarke (107) consists of six phases that was followed during the analytical process. These include: 1) Familiarization with the dataset, 2) Coding, 3) Generating initial themes, 4) Developing and reviewing themes, 5) Refining, defining and reviewing themes, and 6) Writing up (108). According to Braun and Clarke (108) these phases should be seen as guidelines rather than steps or rules, and can therefore be incorporated into a research process with some flexibility. In Study II, all phases were followed step-by-step, but to maintain accuracy throughout the analysis process, some phases were repeated several times as the analysis was refined.

Peer debriefing was integrated into the analysis process at three time points. Initially, two independent researchers extracted meaning units, applied codes, and generated preliminary themes. They met twice to compare and discuss

their interpretations, with the second meeting focusing on deeper analytical reflections. A third debriefing occurred at the end of the final analysis when the same peer reviewed all meaning units, codes, and themes to identify any potential discrepancies.

3.5 ETHICAL CONSIDERATIONS

Research is about systematically carrying out a process to obtain new knowledge of societal relevance. It involves formulating contemporary research questions and using appropriate methods for empirical data collection (110). In accordance with the Declaration of Helsinki (111), all research involving human participants should follow ethical principles, in which the health and rights of all participants must be protected. The potential research benefits must outweigh any harm that the research may cause (111). All European Academies [ALLEA] emphasise that research must respect all living beings, not just research participants, as well as our society, and ecosystems (110).

As Study I did not involve humans but supermarket chains, stores, and advertised foods, ethical approval was not required. Study II involved qualitative data collection from human participants who were both younger and older than 18 years of age. A primary ethics application for the full survey was approved by the Swedish Ethical Review Authority, ref: No. 176-18. An amendment to the application was later approved, ref: No. 2021-03211.

According to the Swedish Ethical Review Authority, a guardian needs to provide written or informed consent for participants under 15 years of age (112). All participants in Study II were over 15 years of age and considered to have a good understanding of what their participation entailed. If they wanted to participate, they had to give a verbal consent before the interviews started. However, a guardian also had to approve participation if they were below 18 years of age as it was part of the data collection procedure from the primary ethics application.

According to both ALLEA (110) and the Swedish Research Council (113), the four ethical principles *reliability*, *honesty*, *respect*, and *accountability* must be followed in order to conduct good research practice. These have guided the research process in both studies I and II, where each has been planned as carefully as possible to utilize resources in a responsible manner and improve the quality of the research results. Senior researchers have advised the PhD

student throughout both projects and reporting the research has been done according to the ALLEA principles (110).

4 SUMMARY OF RESULTS

Studies I and II examine determinants in selected and diverse food environments in VGR. Study I objectively describes how advertising issued by leading grocery store chains predominantly promotes unhealthy foods and further shows that unhealthy foods are disproportionately promoted in more disadvantaged areas compared to more advantaged areas. Study II explores how youths perceived that the COVID-19 restrictions affected their diets and other lifestyle behaviors.

4.1 STUDY I

4.1.1 THE MAJORITY OF FOODS IN SUPERMARKET ADS WERE UNHEALTHY

In Study I, 488 advertisement sheets were collected over four weeks and 29,958 individual food promotions were included in the final analysis. Of the advertised foods, 66.7% belonged to the ‘unhealthy’ and ‘most unhealthy’ groups, which according to NNR should be consumed in limited quantities and preferably replaced with healthier alternatives (55). The most advertised food category was ‘beverages and foods with added sugar’, 22.8% of the advertised foods belonged to this category. ‘Processed meat’ was the second most promoted food category (11.7%) and ‘vegetables and pulses’ (10.4%) the third most promoted category. See Figure 4 for more information on the proportion of advertised foods belonging to the four health groups.

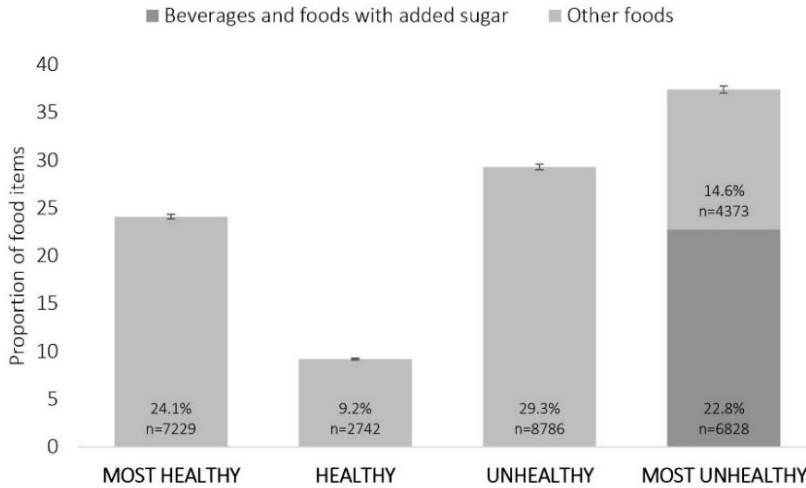


Figure 4 Proportion of advertised foods belonging to the four health groups. Adapted from Mjöberg et al. (114) to remove corresponding NNR recommendations. Published in Supermarket promotions in Western Sweden are incompatible with Nordic dietary recommendations and differ by area-level socioeconomic index 2023.

A greater proportion of foods classified as ‘most unhealthy’ were promoted in less advantaged areas (40.0%) compared to more advantaged (34.9%). There were 25% higher odds (odds ratio [OR] 1.25, 99% CI 1.17, 1.33) of an advertised food being from the ‘most unhealthy’ group if it was promoted by a store in a less advantaged area. However, the association was attenuated after adjusting for chain (OR 1.00, 99% CI 1.00, 1.01), which may indicate that some supermarket chains that promote more unhealthy foods locate their individual stores in less advantaged areas. See Table 2 for more details.

Table 2 Promotions of most unhealthy foods differ by socioeconomic store index. Adapted from Mjöberg et al. (115) to remove details from regression models. Published in Supermarket promotions in Western Sweden are incompatible with Nordic dietary recommendations and differ by area-level socioeconomic index 2023.

Socioeconomic index of the stores	Most unhealthy promotions n (%)	All other promotions n (%)	Total n (%)
More advantaged store areas	5294 (34.9)	9895 (65.1)	15,189 (50.7)
Less advantaged store areas	5907 (40.0)	8862 (60.0)	14,769 (49.3)
Total	11,201 (37.4)	18,757 (62.6)	29,958 (100.0)

4.2 STUDY II

4.2.1 HEALTHY LIFESTYLE HABITS ARE SHAPED AROUND DAILY ACTIVITIES THAT COVID-19 DISRUPTED

Out of the 24 individuals invited, 14 participants aged 15-21 agreed to participate, 10 of whom were women and the rest men. Only two participants were employed, the rest were engaged in school at various levels. Of all participants, 9 had at least one organized sport. The majority (10) lived at home with their parents, while the others lived alone or with a partner. The interviews resulted in three themes which are summarized below.

4.2.1.1 LIVING OFF THE CLOCK – DISRUPTED ROUTINES

This theme indicated that school, work, and organized activities seem to contribute to a daily structure for youths where their lifestyle habits are shaped. When school and work became more or entirely remote during COVID-19 and major adjustments or cancellations were made in their organized activities, it led to more irregular lifestyle habits. In particular, what and when they eat, their exercise and sleep. Disrupted routines seem to have affected the youths in different ways. While some started to eat healthier or exercise more, others were affected in opposite ways. In addition, some reported feeling more stressed and anxious.

4.2.1.2 DISCONNECTED YET DIGITALLY CONNECTED – THE REMOTE LIFE PARADOX

This theme is about youths being more digitally oriented during the pandemic as everyone's school, work, and leisure activities could continue remotely. In addition, many kept in touch with friends via social media, started following online fitness programs, and shopped for groceries online. However, as youths spent more time online, they became socially disconnected and spent most of their time with people they lived with.

4.2.1.3 INCREASED HOUSEHOLD IMPACT ON THE HEALTH OF MEALS

The content in this theme is more specifically about how the availability of food in the youth's living environment seems to affect their food consumption, and how this changed before and during remote school or work. When they attend school as usual, they are not allowed to eat snacks during lessons, but fast food and discretionary food are readily available to some in school cafeterias, supermarkets, and fast food restaurants near school. Depending on how healthy the food environment around their school premises is, some reported that they ate more nutritious food during remote school. Others said that as they can eat during digital lessons and have foods readily available at home, they are able to snack more. Depending on the type of food available at home, their snacks may be more or less healthy.

5 DISCUSSION

The overall purpose of this thesis was to examine selected food environments in relation to healthy diets in Western Sweden. Study I provides an objective analysis of the degree of healthfulness of food advertising in supermarkets, while Study II offers a deeper exploration of how youths perceived the impact of pandemic policy restrictions in Sweden on their lifestyle behaviors, with a particular focus on dietary habits. Drawing on the ecological framework by Story et al. (38) both studies investigate environmental determinants at the macro level, specifically, food marketing and pandemic policy restrictions. The findings highlight how these selected determinants influence food environments at various levels, which may either support or hinder healthy eating and other lifestyle behaviors at the individual level. Further research is needed to better understand the relationship between individual eating patterns and environmental determinants in the Swedish context.

5.1 RESULTS DISCUSSION

5.1.1 STUDY I

The results of Study I indicate that the largest supermarket chains in Sweden publish advertisements with discounted foods every week. The majority of the promoted foods are considered unhealthy compared to Nordic nutrition recommendations (55). Furthermore, the food categories most frequently promoted were sugary beverages and food as well as processed meat, both of which belonged to the ‘most unhealthy’ group. A positive result is that vegetables ranked as the third most promoted category.

Although similar studies are lacking in Sweden, several studies have been conducted in other countries and found similar results. Six are from the USA (116-121), two from the Netherlands (122, 123), two from Australia (124, 125), and one from Brazil (126). The majority found that a large proportion of promoted foods in the supermarket advertisements were classified as unhealthy, ranging from 41% to 71% (117, 119, 121-123, 125, 126). Many of the studies defined foods as more or less healthy based on their processing degree (116, 117, 121, 122, 126). Several studies also found that red meat was among the most promoted food categories (118, 120, 122, 123, 126), followed by sweets and vegetables (122, 123). A few studies found that unhealthy foods were more often discounted or more commonly featured as multibuy offers,

i.e. discounts conditional on purchasing multiple units (122-124). We did not investigate this but future research should.

The results of Study I also indicate that advertising of unhealthy foods was even more prominent in less advantaged areas. The fact that the association became weaker after adjusting for the chain the stores belonged to may be due to business decisions made by supermarket chains or their conglomerates. Two studies in the USA examined the healthiness of supermarket advertisements, comparing areas that differed in socioeconomic characteristics or obesity prevalence. One study (116) found that supermarkets in low-income areas promoted more foods in general than in high-income areas, and a greater proportion of processed foods, carbohydrate-rich foods, and cereal products. In high-income areas, instead, fiber-rich foods, meat, fish, dairy, and eggs were more commonly promoted (116). The second study collected data from supermarkets in all states and the capital, and found that sweets were more frequently advertised in regions with the highest obesity rates (120).

5.1.1.1 FOOD MARKETING BY STORES LIKELY TO AFFECT SEVERAL PHYSICAL ENVIRONMENTS

Although all advertisements in Study I were collected in VGR, two chains were observed to use the same advertisements nationally. In addition, the selected supermarkets have advertisements that are available to consumers in both physical and digital formats. Since conglomerates, chains, and individual stores were selected based on their market shares, there is reason to believe that both their advertisements and store campaigns have a wide reach. In Sweden, there were approximately 3090 stores nationally in 2023 (127), all belonging to the leading conglomerates in the country. Since 2017, the number of newly established stores has increased by approximately 6%, while the number of retailers with limited sales volume are much fewer and has declined since 2021 (127).

5.1.1.2 SEVERAL MACRO-LEVEL DETERMINANTS MAY IMPACT CONSUMER PURCHASES AT THE INDIVIDUAL LEVEL

Story et al. (38) argue that both the public and private sectors have a responsibility to shape macro-level environmental determinants, such as food marketing and media, to support healthy diets (49). In Sweden, there is a high level of market concentration, with a few conglomerates dominating most of the food market (128). This market concentration is common in many European countries. Although there is a wide variety of supermarkets in Europe, market concentration tends to increase within European countries,

with four conglomerates typically dominating (129). It is also common across Europe that pastries, dairy products, processed meat and fish, and confectionery are often marketed by supermarkets (129).

High market concentration does not have to be negative for consumers and can even lead to lower food prices if there is an effective market competition (128). In Sweden, four conglomerates dominate at national level, but market concentration is usually even higher at municipal level. In a third of Sweden's 290 municipalities, only one or two conglomerates have established stores from which consumers can choose. Furthermore, in 102 municipalities, there are no food stores offering lower food prices than the general retail market. The presence of so-called discount stores in an area can lead to lower food prices for consumers (128).

Food marketing in this thesis has been defined as a determinant in the macro-level environment, following the ecological framework by Story et al. (38) The food market concentration is potentially related to the determinants 'food and beverage industry', 'economic systems', and 'food production and distribution systems' (38) at both national and international levels. Furthermore, the Russian invasion of Ukraine and COVID-19 have increased the prices of input goods in Sweden, which has caused higher food prices for consumers in the recent years (128). This may affect several determinants at the personal level, such as the motivation to buy certain foods (38). For example, between 2016-2023, sales in Sweden of the food group soda water, juice and soft drinks have increased by more than 15%, and sweets by more than 8%. During the same period, sales of fish have decreased by more than 15%, vegetables by more than 8%, and fruit by more than 6% (127). This indicates a negative development, which may be partly related to rising food prices in Sweden. It also underlines the responsibility of supermarkets in promoting healthy and sustainable diets.

5.1.2 STUDY II

5.1.2.1 THE PANDEMIC RESTRICTIONS AFFECTED SEVERAL PHYSICAL FOOD ENVIRONMENTS WHICH DISRUPTED YOUTHS LIFESTYLE BEHAVIORS

The results from Study II indicate that youths experienced disruptions to their daily routines as schools and workplaces transitioned to remote solutions in response to pandemic-related restrictions. According to Story et al. (38), schools, leisure activities, and workplaces are considered physical food

environments, all of which can influence individual diets. A previous qualitative study (130) found that many children and adolescents needed parental support, online school classes, and organized leisure activities to sustain a daily structure during COVID-19. It was also reported that individuals with overweight or mental health problems found it more difficult to structure their days (130). While some families reported temporary improvements in their diet and lifestyle during the pandemic, many reverted to pre-pandemic habits once restrictions were lifted, whereas newly adopted unhealthy behaviors were harder to reverse (130).

Participants in Study II reported that engagement in organized PA facilitated their activity levels. In addition, regular PA was described as beneficial for appetite and supporting regular meal patterns. Unfortunately, many participants reported a decrease in their PA levels during the pandemic, although a few said it increased.

Other Swedish studies investigating changes in PA during the pandemic have found conflicting results. A cohort study (73) observed that children's PA level remained the same or increased during the pandemic, especially if they were members of a sports club (73). Another cohort study (74) examined lifestyle changes in adolescents who reported a perceived decrease in, among others, the amount of moderate to vigorous PA and sleep. A qualitative study (80) found that while children played more outdoors, adolescents took more walks. Furthermore, the closure of organized sports seemed to reduce their levels of PA (80). Another study (29), which instead included adults 18-79 years, found that the largest perceived reductions in PA were among the youngest and oldest age groups, but that half of the study population decreased their levels of PA. In turn, more people appeared to have increased their non-organized PA and decreased their organized PA (29). As the participants in Study II were between 15-21 years old, they might have been at an age where their PA levels are more sensitive to external influences, such as bad weather and cancellation of their organized sport. Many participants mentioned taking walks, both as a form of exercise and to socialize with friends.

5.1.2.2 AVAILABILITY AND ACCESSIBILITY OF HEALTHY FOODS IN THE HOME ENVIRONMENT ESPECIALLY IMPORTANT

Most youths interviewed in Study II reported having to adapt to a remote work or school situation for extended periods during COVID-19 and therefore spent more time at home. This changed the usual availability and accessibility of food in their physical environments, from a work or school setting to the home

and neighborhood. In the ecological framework by Story et al. (38), the home is considered a physical food environment, and access as well as availability are two potential mechanisms that can influence people's eating.

A study that collected meal pictures from school age children in Sweden and Greece (79) found that the proportion of ultra-processed foods decreased during the pandemic, while vegetables and fruit increased. The increase was observed among both girls and boys in Greece, but only among boys in Sweden. This change may be due to different exposures in their food environments before and during COVID-19, as more ultra-processed foods may have been available in their environments previously (79). The observed increase in fruit and vegetable consumption among Swedish boys, but not girls, may reflect girls' already higher baseline intake (54).

Youths in Study II did not report eating more fruit and vegetables, as this was dependent on what was available at home. However, the longitudinal IDEFICS/I.Family study observed that self-reported fruit and vegetable consumption decreased during the pandemic in both Sweden and Germany, with a larger decrease in vegetable consumption in Sweden (manuscript under review). This may be partly explained by Sweden's free school lunches, which are often served with a salad bar and are available to all pupils aged 6-16 years, and most pupils up to the age of 19 (131). During the pandemic in Sweden, school lunches were not available to most pupils. Instead, youths reported eating more home-cooked meals that are quick to prepare, including leftovers. Therefore, meals at home may not have the same variety of foods compared to what is served in school restaurants.

In a qualitative study from the Netherlands (130), where children and adolescents aged 4-18 years and their families were interviewed, food availability was mentioned to influence their eating in a healthier or unhealthier direction. They reported eating more fruit and vegetables at home during the pandemic, and some families improved their eating habits overall (130). In a systematic review (132) and a multicenter study (31) representing quantitative results from different countries, children and adolescents reported being more likely to eat unhealthily, more frequently, larger meals, snack between meals, eat late in the evenings, and be less likely to consume alcohol (31, 132). At the same time, consumption of fast food and soft drinks decreased (132). This is partly consistent with the results of Study II, particularly that snacking and eating more frequently were reported to have increased with more time at home

and a decrease in alcohol consumption, as this is usually consumed during social events.

5.2 METHOD DISCUSSION

5.2.1 AN EVALUATION OF THE ECOLOGICAL FRAMEWORK

The ecological framework by Story et al. (38) has been used in this thesis to define different food environments and how determinants at different levels influence individual eating patterns. The holistic approach offered by these models can be seen as both a strength and weakness. It is difficult to address all determinants simultaneously and it does not specify which determinants are most influential. As the framework is complex, it could have been combined with a more specific theory or model (37).

The framework is more targeted at the general population and not specifically at youths, which is the study population in Study II. Furthermore, the framework is not specifically suited to explaining determinants of lifestyle behaviors other than diet, which is also explored in Study II. The determinants may therefore differ for other lifestyle behaviors.

Different ecological models exist in relation to eating patterns, such as the Model of Community Nutrition Environments by Glanz et al. (7) and a conceptual analytical framework of food choice by Fernqvist et al. (11). In both of these ecological frameworks, food marketing would be a part of the physical food environment and not a macro-level determinant as it has been referred to in this thesis.

5.2.2 STUDY I

A strength of the study is the use of NNR and WHO Europe's nutrient profile model to classify the food advertisements into food categories and health groups. As these two are internationally recognized and evidence-based guidelines, it facilitates comparability with other studies using similar categorization systems. Moreover, the categories derived from NNR 2012 and the first version of WHO Europe from 2015 are similar to the updated versions of both guidelines released in 2023 (97, 133). This suggests that the categorization used in the study are based on solid evidence that seems to be stable over a longer time period. Stable evidence increases both the study's internal validity and reliability (134).

The data were collected over a relatively short time period, which does not capture potential seasonal or holiday-related variations in food advertising. During the data collection period, Easter was approaching, which is a holiday typically associated with an increased consumption of confectionery, eggs, fish, and red meat (135). Additionally, data collection took place at the beginning of COVID-19. It is difficult to determine to what extent the Easter holiday or the emerging pandemic were reflected in the supermarket promotions. Furthermore, advertisements were collected from only one region in Sweden and not all supermarkets in VGR were included, only selected conglomerates, chains, and their stores. Choosing other types of grocery stores instead, e.g. with less MS, probably would have influenced the results. These aspects limit the results' external validity, i.e. generalizability (134).

The advertisements were coded by one single individual. Therefore, consistency across coders was not assessed, which limits the reliability of the results (134). In quantitative content analysis, a common method to evaluate the consistency and level of objectivity in the analysis process is to calculate the intercoder reliability between two or more coders (99). However, coding was consistently discussed with supervisors when ambiguities arose.

The advertisements' influence on consumer behavior was not evaluated in this study. Therefore, we cannot conclude that a disproportionate amount of unhealthy promotions lead to healthier food purchases.

5.2.3 STUDY II

According to Braun and Clarke (108), several universal quality criteria can be found in qualitative research. Here, it is important as a researcher to reflect on the foundations of these different criterias in relation to the chosen method and the ontological and epistemological standpoints. For example, using participant checking in order to confirm that subjective bias has not influenced the study results is not in line with the chosen RTA approach, as researcher subjectivity is viewed as a natural part of the analysis. Instead, reflexive techniques can be used to enhance the researcher's openness throughout the research process (108).

The trustworthiness of qualitative research results can be evaluated using the criteria *credibility*, *dependability*, and *transferability* (136). Credibility concerns the quality of the data collection and analysis process in relation to the study's objectives (136). To support reflexivity and strengthen the

credibility of the results, questions developed by Braun and Clarke (108) were used to assess the researcher's preconceptions, positionality, and assumptions.

According to Braun and Clarke (108), ensuring good quality throughout the research process involves accurate and detailed transcription, systematic and thorough development of codes and themes, and an actual analysis and interpretation of the data (108). One consideration about this is the PhD student's limited research experience that may have influenced the quality of the data collection and analysis. However, the student had previous experience from earlier projects that provided practical training in interview techniques, transcription, and analysis. Additionally, the PhD student consulted more experienced senior researchers during the process and peer debriefing was conducted on three occasions, both at the beginning and end of the analysis. The peers differed both in training and professional interest, which enriched the discussions. Discussing the data with others can help to further deepen the analysis and interpretation (108, 136).

How participants are selected is another aspect that can affect the results' credibility (136). In Study II, only youths who had participated in all previous IDEFICS/I.Family cohort investigations in Sweden were recruited, which may have led to a more homogenous group, potentially offering fewer perspectives relevant to the study's aims (136). In addition, a previous assessment has shown that there is a potential selection bias in the Swedish part of the IDEFICS cohort. Recruited families with low education level, income, foreign background, and with a single parent are underrepresented in the cohort (137). This implies that the cohort is relatively homogenous concerning certain demographic and socioeconomic characteristics compared to the general Swedish population, a limitation that likely also applies to the participants included in Study II.

In preparation for the interviews, the interview guide was pilot-tested on a research team member, which limits the credibility of the results. Testing the guide on an individual with similar characteristics to those of the study population could have led to further refinement of the interview questions, and enhanced the quality of the collected data.

Dependability refers to the consistency of the research process over time, particularly in relation to data collection and analysis, while transferability concerns the extent to which the results can be applied to other populations or contexts (138). In Study II, the relatively short data collection period and the

use of the same interview guide for all participants facilitated consistency throughout data collection (136). However, whether the results are transferable to other settings is determined by the reader (136). To ensure transparency and facilitate assessment of the study's transferability, the COREQ checklist (139) was used when reporting the process in the manuscript for Study II.

6 CONCLUSION

The results of Study I show that the largest supermarket chains in Sweden devote more space to unhealthy foods in their weekly advertisements, especially in disadvantaged areas. This can be explained by conscious strategies that certain supermarket chains or their conglomerates have. The included advertisements do not comply with Nordic nutrition recommendations for a healthy diet and risk to further widening health gaps between more and less advantaged societal groups. Large supermarkets have a responsibility in promoting healthy population diets.

The results of Study II indicate that youths in Sweden experienced their diet and other lifestyle behaviors as both positively and negatively affected by the pandemic policy recommendations issued nationally. To maintain healthy lifestyles, organized activities seem to be facilitators. Despite Sweden's relatively mild restrictions, the results are similar to those from countries with stricter pandemic policy strategies. This study can inform public health interventions aimed at promoting healthy lifestyles among young people, but also policy strategies during health crises such as the COVID-19 pandemic.

Together, these studies highlight how structural factors, such as food marketing practices and pandemic-related disruptions, shape the environments in which people make their food choices. These environmental influences operate across societal levels, potentially undermining individual efforts to maintain healthy eating. Further research is warranted to explore how these determinants interact within the Swedish context and to identify leverage points for promoting healthier dietary behaviors.

7 FUTURE PERSPECTIVES

7.1 STUDY I

There are many research ideas that could be developed in the close future. The promotions were analyzed with a clear focus on health and social sustainability. Other guidelines could have been used to address additional sustainability dimensions, in particular environmental and economic aspects. Furthermore, objective measures such as quantitative content analysis, geospatial or market-based evaluations could be combined with more subjective ones, such as interviews, participatory methods, or observations (i.e., mixed methods). By exploring consumers' own experiences, we can gain information about how effective the ads are in the Swedish setting, if they impact consumers' food purchases, and what they consume at home. Questionnaires exist that aim to investigate how consumers perceive their food environment and could potentially be validated in Sweden. Media in general is an interesting area to explore as an important food environment, as well as to evaluate the effects of government regulations on specific foods.

7.2 STUDY II

The results could inspire different types of research as the pandemic restrictions affected many aspects of youths' lives. An interesting project would be to explore the long-term consequences of the pandemic, especially using qualitative methods or mixed methods. It would also be interesting to gain a deeper understanding of which societal structures are important for promoting healthy lifestyle behaviors among young people, especially children and households that are at higher risk of developing unhealthy patterns. Different time points could be considered, such as after school, during weekends, or longer holidays. Strategies at the policy level, in schools, workplaces, and at home, could also be developed in preparation for similar events as COVID-19, e.g. to promote home exercise, healthy eating, and social interaction.

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