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ARTICLE

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Fast food outlets, physical activity facilities, and obesity among adults: a nationwide longitudinal study from Sweden

Kenta Okuyama[1,2] · Xinjun Li[1] · Takafumi Abe[2] · Tsuyoshi Hamano[2,3] · Paul W. Franks[4] · Toru Nabika[2,5] · Kristina Sundquist[1,2,6]

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Abstract

Background While neighborhood deprivation is a well-known predictor of obesity, the mechanisms behind this association are unclear and these are important to clarify before designing interventions focusing on modifiable neighborhood environmental factors in order to reduce obesity risk.

Objectives This study examined the longitudinal association between availability of fast-food outlets and physical activity facilities and the risk of obesity among adults.

Methods This study used multiple national register data from Sweden. During the 11-year follow-up period between 2005 and 2015, data from 1,167,449 men and 542,606 women, aged 20–55 years, were accessible for inclusion in this analysis. Incidence of obesity was identified based on a diagnosis of obesity during the follow-up period derived from clinical register data. Neighborhood availability of fast-food outlets and physical activity facilities were assessed in 2005 and Cox regression was used in the statistical analysis. Individual socio-demographic factors and neighborhood deprivation were used as covariates.

Results There were no meaningful associations between neighborhood fast-food outlets or physical activity facilities and obesity in men or women. Neighborhood deprivation was, however, consistently and strongly associated with incidence of obesity in both men and women.

Conclusions Availability of fast-food outlets and lack of physical activity facilities appear unlikely to cause obesity in Swedish adults. Other potentially modifiable environmental factors within specific social and cultural settings that may influence obesity risk should be examined in future studies.

Introduction

The prevalence of obesity has been consistently increasing since the 1970s, and it is a major global health challenge [1, 2]. Although obesity would not immediately bring negative health outcomes, it may lead to many chronic conditions, such as cardiovascular disease, stroke, type 2 diabetes, and some types of cancer [3]. Obesity was estimated to cause 3.4 million deaths and reduce life expectancy by 3.9% worldwide in 2010 [4].

Obesity emerges as a consequence of chronic positive energy imbalance, where energy intake exceeds energy expenditure [5]. According to obesity research focusing on biological mechanisms, a certain genotype may have a higher propensity to cause positive energy balance [6, 7]. Although the consequences of a positive energy balance are logical and easy to understand, it is unlikely that the consistent rise of obesity prevalence that has been observed during the last decades is caused by genetic factors alone. Environmental factors must play an important role in the obesity epidemic.

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✉ Kenta Okuyama
ko215ok@gmail.com

1 Center for Primary Health Care Research, Lund University, Malmö, Sweden

2 Center for Community-based Healthcare Research and Education, Shimane University, Shimane, Japan

3 Department of Sports Sociology and Health Sciences, Faculty of Sociology, Kyoto Sangyo University, Kyoto, Japan

4 Department of Clinical Sciences, Genetic and Molecular Epidemiology Unit, Lund University, Malmö, Sweden

5 Department of Functional Pathology, Shimane University School of Medicine, Izumo, Japan

6 Department of Family Medicine and Community Health, Department of Population Health Science and Policy, Icahn School of Medicine at Mount Sinai, New York, NY, USA

Socioeconomic status (SES) is one environmental factor extensively studied in relation to obesity [8]. In developed countries, higher obesity prevalence has consistently been observed among individuals with low SES compared with those with high SES in the population [9, 10]. Numerous strategies to modify individual diet and physical activities have been attempted in all population groups, yet they have been unsuccessful to lower the obesity prevalence in the long term and at the population level. A need of a more comprehensive approach to prevent obesity was described in the 1990s [11–13] including studies on environmental factors and their potential association with obesity.

Since the early 21st century, research has been extended to examine the association between neighborhood SES, i.e., neighborhood deprivation, and various health-related outcomes, and neighborhood deprivation was found to be independently associated with obesity [14]. It is well explained based on a socio-ecological model, which was developed and evolved in the late 20th century: human behaviors are determined to a great extent by neighborhood environments where individuals reside [15]. Focus of research has more recently also shifted toward what lies in the causal pathway between neighborhood deprivation and obesity [16]. In particular, modifiable environmental features, such as fast-food outlets, recreational gyms, which are amenable to change, have rendered a great interest among neighborhood researchers [17]. Much effort has been laid on examining whether the presence of fast-food outlets, and/or the lack of physical activity facilities, in socioeconomically deprived neighborhoods may be related to increased obesity rates. So far, however, evidence from previous studies has been inconclusive and it has not been possible to establish a firm and robust consensus on whether such associations exist [18, 19].

Given the obesity epidemic and hypotheses that environmental factors may play a significant role to affect obesity rates, policymakers may be interested in enacting environmental interventions. However, there has not been any noticeable success in implementing effective environmental interventions against obesity at the population level over the past 30 years [20, 21]. In order to achieve this, it is important to identify potential factors in people's environments that may be a target for interventions. From this background, this study aimed to examine the association between neighborhood fast-food outlets and physical activity facilities and obesity by using nationwide longitudinal data from both men and women.

Methods

Study samples

We used the unique Swedish personal numbers given to all Swedish citizens to combine multiple nationwide registries and healthcare datasets. All personal numbers were replaced with randomly generated serial numbers to preserve confidentiality before the data were provided to us from Statistics Sweden. The datasets used in this study include: the Total population Register, containing individual sociodemographic data; the Swedish Medical Birth Register, containing women's height and weight during pregnancy; the Military Conscription Register, information of all men who underwent conscription; the Swedish Cause of Death Register, containing causes and time of death; the Migration Register, containing time of migration from/to Sweden; the Swedish Hospital Discharge Register and Outpatient Register, containing information on clinical diagnoses based on the International Classification of Diseases 10 (ICD-10). Among all 1,169,595 men and 543,680 women, 2146 men and 1074 women were excluded as they had pre-existing obesity from 2003 to 2005, which resulted in 1,167,449 men and 542,606 women in our final study population.

Outcome

Clinically diagnosed obesity was identified within the Swedish Hospital Discharge and Outpatient Registries. We extracted the ICD-10 codes E65 and E66, denoting obesity as the main or secondary diagnosis during the study period.

Exposure

Two neighborhood environmental factors (i.e., fast-food outlets and physical activity facilities) were examined as primary exposure variables. Small Area Market Statistics (SAMS) areas were used as proxies for neighborhoods as has been done previously [22–24]. SAMS is defined based on homogeneous types of buildings and have natural boundaries defined by, e.g., highways or rivers. Each SAMS unit has an average of 1000 residents, and there are 9617 such units in the whole of Sweden. Geocodable point data of fast-food outlets (e.g., pizzerias and hamburger joints) and physical activity facilities (e.g., swimming pools, gyms, and ski facilities) provided by the Swedish company Teleadress-Bisnode were used to measure the density of them, i.e., the number of facilities and outlets which fell into each SAMS unit using geographic information system (GIS) [25]. Based on this density measure, if there is at least one outlet/facility within each SAMS unit, that neighborhood was defined as having an availability of fast-food outlets or physical activity facilities.

Covariates

Covariates included: gender, age, marital status, family income, educational attainment, immigration status, occupation, and neighborhood deprivation. A neighborhood deprivation index was constructed using the 2005 census data provided by Statistics Sweden. A summary index was used to determine neighborhood-level deprivation, which included the following four deprivation indicators for residents aged 25–64 (the socioeconomic active part of the population): low income (income from all sources, including that from interest and dividends, defined as <50% of the individual median income); unemployment (not employed, excluding full-time students, those completing compulsory military service, and early retirees); low educational status (<10 years of formal education); and social welfare recipient status [26]. A *z*-score for each indicator was calculated for each SAMS. Those *z*-scores were summed to create the index for each SAMS [27]. The index was categorized into the following three groups, where higher scores reflect more deprived neighborhoods and lower scores reflect more affluent neighborhoods: (1) low neighborhood deprivation (most affluent): below one standard deviation (SD) from the mean; (2) moderate neighborhood deprivation: within one SD of the mean; (3) high neighborhood deprivation (most deprived): above one SD from the mean [24, 28].

Statistical analysis

The study population was represented by a closed cohort and the follow-up started on January 1, 2005, and proceeded until registration for obesity, death, emigration, or the end of the study period on December 31, 2015. We used Cox proportional hazard models to derive hazard ratios (HR) and 95% confidence intervals (95% CI) for obesity incidence by the two neighborhood environmental factors controlling for all covariates. The proportionality assumptions were checked visually by plotting the incidence rates over time and by calculating Schoenfeld (partial) residuals and these assumptions were fulfilled. The person-years were calculated based on first registration for obesity, migration in and/or out of Sweden, or death during the 11 years' follow-up period available from different register data. We created separate models for men and women and also for the two neighborhood environmental factors, which resulted in four sets of analyses. In the first model of each analysis, we included only age as a potential confounding variable to examine the association between fast-food outlets or physical activity facilities and obesity. In the second model, we also included individual socio-demographic variables, i.e., family income, education, occupation, marital status, and immigration status. In the final model, we also added neighborhood deprivation. Interaction tests were performed between the neighborhood environmental factors and neighborhood deprivation.

As a sensitivity analysis, we categorized the availability of fast-food outlets and physical activity facilities into seven levels: 1, 2, 3, 4, 5, 6, and 7 or more, to examine potential dose–response relationships. In addition, we also used longitudinal BMI measures to define incidence of obesity ($BMI \geq 30\ kg/m^2$) (Table S2). This was conducted only for women based on information available in the Medical Birth Register. The BMI was calculated based on data collected in the beginning of the first pregnancy, adjusted for parity.

Results

Table 1 shows the basic characteristics of the study sample, the number of obesity events, as well as cumulative incidence of obesity by neighborhood deprivation. The proportion of obesity events was similar across age groups. There was a higher proportion of obesity among women compared with men. There was a lower proportion of obesity in higher income groups and higher educational groups. The proportion of obesity appeared to be similar in different categories of marital status, immigration status as well as occupation. The proportion of obesity events across availability of fast-food outlets and physical activity facilities was also similar. In all demographic and exposure variables, the cumulative incidence of obesity per 1000 individuals was consistently higher in more deprived neighborhoods.

Table 2 shows the association between neighborhood availability of fast-food outlets and incidence of obesity among women. There was a significant but weak association between fast-food outlets and incidence of obesity only in Model 3, after adjusting for neighborhood deprivation (HR: 0.95, 95% CI: 0.92, 0.98).

Table 3 shows the association between neighborhood availability of physical activity facilities and obesity among women. There was no significant association throughout all models even after adjusting for neighborhood deprivation (Model 3: HR: 0.98, 95% CI: 0.95, 1.01).

Table 4 shows the association between neighborhood availability of fast-food outlets and obesity among men. There was no significant association throughout all models (Model 3: HR: 0.98, 95% CI: 0.95, 1.01).

Table 5 shows the association between neighborhood availability of physical activity facilities and obesity among men. There was no significant association between physical activity facilities and incidence of obesity in all models (Model 3: HR: 0.99, 95% CI: 0.95, 1.02).

Table S1 shows the result of a sensitivity analysis when the availability of fast-food outlets and physical activity facilities were categorized into more than two categories. No dose-relationship seemed to exist neither in women nor in men. For women, however, a significantly decreased risk of obesity was observed for those living in a neighborhood with seven or more fast-food outlets compared with those living in neighborhoods without fast-food outlets (HR: 0.83, 95% CI: 0.73, 0.95). In addition, significantly decreased risk of obesity was observed for those living in neighborhoods with six and seven or more physical activity facilities

Table 1 Distribution of the study population, number of obesity events, and cumulative incidence (per 1000 individuals) by level of neighborhood deprivation.

	Population		Obesity events		Neighborhood deprivation		
	No.	%	No.	%	Low	Moderate	High
Total population	1,710,055				334,049 (19.5%)	1,138,652 (66.6%)	237,254 (13.9%)
Total cases of obesity			31,671		11.8	18.8	26.7
Birth year							
1950–59	429,266	25.1	6163	19.5	10.6	14.7	18.8
1960–69	616,733	36.1	12,537	39.6	12.5	20.9	31.0
1970–79	537,207	31.4	11,067	34.9	12.7	20.6	29.4
1980–85	126,849	7.4	1904	6.0	7.3	14.2	21.7
Gender							
Males	1,167,449	68.3	14,488	45.7	8.3	12.7	16.5
Females	542,606	31.7	17,183	54.3	18.3	32.5	48.2
Marrital status							
Married	708,621	41.4	12,731	40.2	11.2	18.9	29.1
Not married/divorced/widowed	1,001,434	58.6	18,940	59.8	12.5	18.7	25.8
Family income							
Low	426,911	25.0	9293	29.3	13.2	22.0	27.8
Middle low	426,975	25.0	8444	26.7	13.3	19.7	28.5
Middle high	426,776	25.0	7627	24.1	11.6	18.0	26.9
High	429,393	25.1	6307	19.9	10.0	15.4	22.0
Educational level							
≤9 years	196,460	11.5	5134	16.2	18.6	24.7	35.0
10–12 years	533,828	31.2	12,165	38.4	15.7	22.7	31.2
>12 year	979,767	57.3	14,372	45.4	9.7	15.2	21.3
Immigration status							
Born in Sweden	1,604,249	93.8	28,978	91.5	11.5	18.5	26.0
Born in other countries	105,806	6.2	2693	8.5	18.1	23.6	30.6
Occupation							
Farmers/self-employed/others	774,190	45.3	14,865	46.9	11.7	19.0	27.3
Professonals	72,395	4.2	638	2.0	6.5	10.0	11.9
White collar workers	271,924	15.9	3505	11.1	9.2	13.7	20.1
Blue collar workers	591,546	34.6	12,663	40.0	15.4	21.5	28.4
Neighborhood fast-food outlets							
Not accessible	1,006,925	58.9	18,844	59.5	12.1	19.4	27.6
Accessible	703,130	41.1	12,827	40.5	11.0	18.0	25.9
Neighborhood physical activity facilities							
Not accessible	1,031,015	60.3	19265	60.8	11.8	19.0	27.1
Accessible	679,040	39.7	12406	39.2	11.8	18.6	25.9

compared with those living in neighborhoods without physical activity facilities (HR: 0.73, 95% CI: 0.60, 0.89, and HR: 0.83, 95% CI: 0.72, 0.96, respectively).

No significant interactions were identified between fast-food outlets or physical activity facilities and neighborhood deprivation.

Discussion

In this nationwide longitudinal sample of adults, we did not find any significant positive associations between availability of fast-food outlets or physical activity facilities and incidence of obesity. While a slightly negative association

Table 2 Association between obesity and neighborhood availability to fast-food outlets, small area market unit in women.

	Model 1			Model 2			Model 3		
	HR	95% CI		HR	95% CI		HR	95% CI	
Fast food outlets (ref. non)	1.00	0.97	1.03	0.99	0.96	1.02	0.95	0.92	0.98
Birth year	1.05	1.05	1.05	1.04	1.04	1.05	1.04	1.04	1.04
Marital status (ref. married)				1.13	1.10	1.17	1.09	1.05	1.12
Family income (ref. high)									
Low				1.20	1.14	1.26	1.14	1.09	1.20
Middle low				1.08	1.03	1.13	1.06	1.02	1.11
Middle high				1.13	1.08	1.18	1.11	1.06	1.16
Education (ref. >12 years)									
≤9 years				1.83	1.74	1.91	1.68	1.60	1.76
10–12 years				1.53	1.47	1.58	1.46	1.41	1.51
Immigration status (ref. born in Sweden)				0.87	0.83	0.92	0.77	0.74	0.81
Occupation (ref. professionals)									
Farmers/self-employed/others				1.76	1.52	2.04	1.66	1.43	1.92
White collar workers				1.17	1.01	1.36	1.14	0.98	1.32
Blue collar workers				1.88	1.62	2.17	1.78	1.54	2.07
Neighborhood deprivation (ref. low)									
Moderate							1.56	1.48	1.63
High							2.09	1.98	2.21

Model 1: adjusted for birth year; Model 2: adjusted for birth year, marital status, family income, education, immigration status, and occupation; Model 3: full model.

Table 3 Association between obesity and neighborhood availability to physical activity facilities, small area market unit in women.

	Model 1			Model 2			Model 3		
	HR	95% CI		HR	95% CI		HR	95% CI	
Physical activity facilities (ref. non)	0.98	0.95	1.01	0.98	0.95	1.01	0.98	0.95	1.01
Birth year	1.05	1.05	1.05	1.04	1.04	1.05	1.04	1.04	1.04
Marital status (ref. married)				1.13	1.10	1.17	1.09	1.05	1.12
Family income (ref. high)									
Low				1.20	1.14	1.26	1.14	1.09	1.20
Middle low				1.08	1.03	1.13	1.06	1.02	1.12
Middle high				1.13	1.08	1.18	1.11	1.06	1.16
Education (ref. >12 years)									
≤9 years				1.83	1.74	1.91	1.68	1.60	1.76
10–12 years				1.53	1.47	1.58	1.46	1.41	1.51
Immigration status (ref. born in Sweden)				0.87	0.83	0.91	0.77	0.73	0.81
Occupation (ref. professionals									
Farmers/self-employed/others				1.76	1.52	2.04	1.66	1.43	1.92
White collar workers				1.17	1.01	1.36	1.14	0.98	1.32
Blue collar workers				1.88	1.62	2.17	1.79	1.54	2.07
Neighborhood deprivation (ref. low)									
Moderate							1.55	1.48	1.62
High							2.07	1.96	2.19

Model 1: adjusted for birth year; Model 2: adjusted for birth year, marital status, family income, education, immigration status, and occupation; Model 3: full model.

was observed between fast-food outlets and obesity in women, it was only in the final model after the effect of neighborhood deprivation had been taken into account. No evidence of a potential dose–response relationship was observed either.

In the US, it has been reported that fast-food outlets are more prevalent in deprived neighborhoods [29]. In Sweden, a higher density of fast-food outlets has also been observed in deprived neighborhoods [28]. Nevertheless, neighborhood availability of fast-food outlets was not associated with obesity in the current analysis. This might be because fast food is not one of the cheapest food options in Sweden as it is in the US. In the US, fast food would often be a choice for low SES populations as it is cheap and a food source rich on energy. The term "food desert" is often used in the US to describe deprived neighborhoods with limited healthy food options in both geographical and economical terms [30]. Several studies in the US have found significant associations between "food

Table 4 Association between obesity and neighborhood availability to fast-food outlets, small area market unit in men.

	Model 1			Model 2			Model 3		
	HR	95% CI		HR	95% CI		HR	95% CI	
Fast food outlets (ref. non)	1.00	0.97	1.03	1.01	0.98	1.04	0.98	0.95	1.01
Birth year	0.98	0.98	0.98	0.98	0.98	0.99	0.98	0.98	0.99
Marital status (ref. married)				1.28	1.24	1.33	1.23	1.19	1.28
Family income (ref. high)									
Low				1.29	1.23	1.36	1.26	1.20	1.32
Middle low				1.27	1.21	1.34	1.25	1.19	1.31
Middle high				1.08	1.03	1.14	1.07	1.02	1.13
Education (ref. >12 years)									
≤9 years				1.90	1.81	2.00	1.84	1.74	1.93
10–12 years				1.78	1.71	1.86	1.74	1.67	1.82
Immigration status (ref. born in Sweden)				1.15	1.06	1.26	1.10	1.01	1.20
Occupation (ref. professionals)									
Farmers/self-employed/others				1.23	1.11	1.37	1.17	1.05	1.29
White collar workers				1.07	0.96	1.19	1.05	0.95	1.17
Blue collar workers				1.28	1.16	1.42	1.22	1.11	1.36
Neighborhood deprivation (ref. low)									
Moderate							1.36	1.29	1.43
High							1.73	1.63	1.84

Model 1: adjusted for birth year; Model 2: adjusted for birth year, marital status, family income, education, immigration status, and occupation; Model 3: full model.

Table 5 Association between obesity and neighborhood availability to physical activity facilities, small area market unit in men.

	Model 1			Model 2			Model 3		
	HR	95% CI		HR	95% CI		HR	95% CI	
Physical activity facilities (ref. non)	0.99	0.96	1.02	0.99	0.95	1.02	0.99	0.95	1.02
Birth year	0.98	0.98	0.98	0.98	0.98	0.99	0.98	0.98	0.99
Marital status (ref. married)				1.28	1.24	1.33	1.23	1.19	1.28
Family income (ref. high)									
Low				1.29	1.23	1.36	1.26	1.20	1.32
Middle low				1.27	1.21	1.34	1.25	1.19	1.31
Middle high				1.08	1.03	1.14	1.07	1.02	1.13
Education (ref. >12 years)									
≤9 years				1.90	1.81	2.00	1.84	1.75	1.93
10–12 years				1.78	1.71	1.86	1.75	1.67	1.82
Immigration status (ref. born in Sweden)				1.15	1.06	1.26	1.10	1.01	1.20
Occupation (ref. professionals)									
Farmers/self-employed/others				1.23	1.11	1.37	1.17	1.05	1.29
White collar workers				1.07	0.96	1.19	1.05	0.95	1.17
Blue collar workers				1.28	1.16	1.42	1.23	1.11	1.36
Neighborhood deprivation (ref. low)									
Moderate							1.36	1.29	1.43
High							1.73	1.63	1.84

Model 1: adjusted for birth year; Model 2: adjusted for birth year, marital status, family income, education, immigration status, and occupation; Model 3: full model.

deserts" and chronic conditions such as obesity, chronic kidney disease, and hypertension [31, 32]. However, such neighborhoods are less common in Sweden [25]. There is also a possibility that insufficient information on fast-food outlets or healthy food outlets might have biased our results. Fast food outlets are often defined as health-damaging resources, yet they provide several healthy options (e.g., salads) as well. Unavailability of data on healthy food outlets, such as grocery stores which sell fruits and vegetables, made it difficult to measure independent effects of fast-food outlets [33, 34]. However, there was no crude association between fast-food outlets and incidence of obesity, and no dose–response relationship was observed either. These findings indicate that fast-food outlets might not affect obesity to a high extent in Sweden that also have healthier food options in deprived neighborhoods, where fast-food outlets are more common. The findings are informative in the sense that increasing the prices on fast food by taxing fast-food options might be effective to reduce obesity rates in countries where fast food is a cheap option. Although there is no sufficient evidence for this yet, several studies indicate the potential impact of taxing on fast food to reduce obesity rates in certain populations, such as those with low SES and those with particularly high obesity risks [35–37]. While many studies found associations between neighborhood availability of fast-food outlets and obesity in the US, inconsistent findings have been reported internationally. For example, a study in New Zealand found no association between neighborhood availability of fast-food outlets and diet-related health outcomes, i.e., overweight, and concluded that fast-food retailing might not factor into obesity [38].

As for physical activity facilities, our findings were inconsistent with the most recent findings in Scotland and the UK [17, 39], which may be related to other differences between countries. Similarly to the results from the food environment, lack of information for other components such as street connectivity or land use mix, which are known to be associated with physical activity, might have influenced our results [40]. Nonetheless, physical activity facilities were our main focus since they are amenable, compared with street or city designs, which requires significant investment of time and costs to change. Several previous studies show that there is no clear association between neighborhood deprivation and accessibility of neighborhood physical activity facilities [41, 42]. A study from Sweden also found that health promoting resources, such as physical activity facilities, are more available in deprived than affluent neighborhoods [28]. Our study's results may partly be explained by these previous findings.

This study has several limitations. First, we did not take into account individual diet and physical activity in our analysis. Unfortunately, we did not have access to such individual information in a nationwide population. Second, we used SAMS, i.e., administrative units to define neighborhoods. This might have under- or over-estimated the effect of fast-food outlets and physical activity facilities as individuals' daily activity space can be beyond administrative boundaries. Nevertheless, SAMS is defined by not only natural borders but also by types of buildings, and they have been used in a previous study of the association between fast-food outlets and childhood obesity [24]. Third, we did not account for clustering of obesity as well as obesity-related behavior from social network perspectives. As recent social network analyses have found that obesity and unhealthy behaviors such as smoking or excess eating may be transmitted from person to person, failing to control for these factors might have biased our results toward the null [43]. Fourth, the outcome of our study was based on a clinical diagnoses of obesity rather than actual weight and height measurements. Thus, it is possible that the outcome includes a relatively high number of morbid obesity cases, which may be the reason behind the observed gender differences. Previous Swedish studies have also reported a gender difference in morbid obesity [44]. It is also possible that a gender difference exists because women are in general more concerned about their weight status than men are [45]; thus, women may seek healthcare for obesity to a higher extent than men. Other studies have described the prevalence of obesity by gender based on nationwide surveys on randomly sampled participants in Sweden. These studies found that the prevalence of obesity (BMI ≥ 30) based on self-reported height and weight was higher among women compared with men [45–48].

Our study also has several strengths. First, we used longitudinal nationwide data to examine the incidence of obesity rather than cross-sectional associations which have been more commonly used in most previous studies. By linking multiple national data registers, such as migration and mortality data, we could censor some individuals that no longer should contribute to the person-years instead of keeping them in the study. Second, we conducted several sensitivity analyses that supported our main results. For both food and physical activity environments, we examined several categories (rather than dichotomizing in yes/no) in an attempt to assess dose–response relationships. Furthermore, for women, we used multiple measures for obesity based on clinical diagnosis as well as BMI to define incidence of obesity. Third, we included precise information of individual SES from national registries as well as a neighborhood deprivation index objectively measured by GIS.

Conclusions

Even though fast-food outlets and physical activity facilities have been found to be associated with obesity in some settings, they did not seem to be important predictors of obesity among Swedish adults. This could be due to differences in the social, economic, and demographic context between countries. The results of our nationwide study indicate that other modifiable factors are more likely to play a role in the increased rates of obesity in Sweden and that different obesogenic pathways may lie behind the increased obesity rates across the globe. This also highlights the importance of studies in different settings, as well as studies of other potentially modifiable physical environmental characteristics in order to reduce the global burden of obesity.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

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