Impacts of the 2008 Great Recession on dietary intake: a systematic review

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Abstract

Background: The 2008 Great Recession significantly impacted economies and individuals globally, with potential impacts on food systems and dietary intake. We systematically reviewed evidence on the impact of the Great Recession on children's and adults' dietary intake globally and whether disadvantaged individuals were disproportionately affected.

Methods: We searched seven databases and relevant grey literature through June 2020. Longitudinal quantitative studies with the 2008 recession as the exposure and any measure of dietary intake (energy intake, dietary quality and food/macronutrient consumption) as outcomes were eligible for inclusion. Eligibility was independently assessed by two reviewers. The Newcastle Ottawa Scale was used for quality assessment. We undertook a random effects meta-analysis for changes in energy intake. Harvest plots were used to display and summarise study results for other outcomes. The study was registered with PROSPERO (CRD42019135864).

Results: Forty-one studies including 2.6 million people met our inclusion criteria and were heterogenous in both methods and results. Ten studies reported energy intake, 11 dietary quality, 34 food intake, and 15 macronutrient consumption. The Great Recession was associated with a mean reduction of 39.9 calories per adult equivalent per day (95% Confidence Interval: -119.9, 40.2) in the meta-analysis of seven studies. We found reductions in dietary quality and small decreases in fruit and vegetable intake. We also found reductions in intake of meat and fish, fast food, sugary products, and soft drinks alongside an increase in the consumption of eggs and legumes. Impacts on macronutrients were inconclusive. Of 17 studies examining inequalities, 14 found that the Great Recession was associated with greater reductions in dietary intake and quality among more disadvantaged individuals. Only 4 studies investigated children's intakes.

Conclusions: The 2008 recession was associated with poorer dietary quality and decreased fruit and vegetable consumption, especially for more disadvantaged individuals. Implementing effective policies to mitigate adverse nutritional changes during the COVID pandemic and other major economic shocks should be prioritised.

Background

The 2008 Great Recession had a severe impact on the global economy. Gross Domestic Products (GDP) decreased and unemployment increased in many countries, impacting industries, communities, and individuals globally (1). The Great Recession had wide-ranging impacts on health including poorer self-rated health and increased cardiovascular and respiratory disease (2-4). A review of the impacts of the Great Recession on children also suggested increases in infant and child mortality in some countries and in perceived health and health-related quality of life (5). The recession may have greater impacted people of lower socio-economic position (SEP), widening inequalities (4, 5).

There are various ways in which the Great Recession may have affected the food environment. Food prices generally increased over the recession due to inflation and food companies changing their market strategies to increase price per quantity of foods and package content (6, 7). Price-off promotions on products – particularly on processed foods - also increased during the recession (8, 9). These changes happened alongside households experiencing a reduction in resources (10). This may have decreased food expenditure and the affordability of healthy food items, especially in low SEP groups (11-13). For example, a study in Chicago compared low income areas to more affluent areas and found that access to healthy food worsened in low income areas (14). There is conflicting evidence regarding impacts on overweight and obesity but available data is suggestive of a potential increase, particularly for low SEP individuals (15, 16).

Evidence from previous recessions suggests that economic shocks may impact dietary intake. The 1997 Asian economic crisis likely impacted dietary intake, with decreased energy intake and changes in food consumption although findings appear inconsistent (17, 18). The 1994 Mexican crisis appears to have negatively affected dietary intakes, although changes in food consumption varied between rural and urban areas (19). Compared to these previous recessions, the Great Recession is notable for its duration and international reach, and severe impacts on unemployment, GDP, and public budgets (1). It was also characterised by a slow recovery and, in Europe, a sovereign debt crisis leading to austerity measures for many countries. This occurred against a backdrop of increasing ubiquity of ultra-processed food, which means that impacts on dietary intakes may have been larger compared to previous recessions due to their lower cost (20). Therefore, we hypothesise that the Great Recession had a substantive impact on dietary intake which justifies a focused and systematic examination. We aimed to systematically review the evidence on impacts of the Great Recession on children's and adults' dietary intake and whether impacts were greater among low SEP groups. As the Great Recession represents one of the largest economic shocks prior to the emergence of COVID-19, our study provides valuable data to inform policy action to protect population health during the current pandemic.

Methods

Search Strategy and Selection Criteria

We undertook a systematic review following a protocol registered on the International Prospective Register of Systematic Reviews ([CRD42019135864](#)). The population for this review was individuals affected by the Great Recession, with the comparison as the population before the recession, or unaffected populations. The exposure of interest was the 2008 Great Recession, including macroeconomic indicators of recession such as the unemployment rate. Outcomes were any measure of dietary intake and included energy intake, nutritional quality of diet (we included all indexes retrieved in the literature such as the Healthy Eating Index and Dietary Diversity score), individual food item intake and macronutrient intake. Only longitudinal primary quantitative research studies in English were included. Alcohol intake was excluded from this review. We had no restrictions regarding the setting of studies. Search terms included “economic recession”, “Great Recession”, and “economic downturn” and

“food intake”, “nutrition”, “food expenditure” and “macronutrient” (full details can be found in Additional File 2).

Sources included:

1. Electronic databases: MEDLINE; Embase; PsycINFO; Health Management Information Consortium (HMIC); Business Source Ultimate; CINAHL; and Web of Science.
2. Grey Literature databases: WHOLit, OpenGrey Europe and a manual search of sources including relevant third sector bodies.
3. Hand searching citation lists to identify additional relevant papers.

We undertook the search on the 23rd June 2020. References were imported into Endnote and screened in accordance with PRISMA guidelines (21). Two authors (RJ & AL) independently screened the title and abstract of studies identified. Full texts of studies potentially eligible for inclusion were retrieved by the two reviewers and screened independently, with disagreements resolved by discussion.

Data Analysis

Data were extracted into a data extraction form by RJ including study author, year, and title; funding and ethics; study design; setting; exposure assessment; data collection time points; participants' age, gender, and other characteristics, for example being parents or in a specific age group; sample size; data collection method; outcome assessment methods; statistical methods; covariates; and key findings including differing impacts for low SEP individuals.

Study quality was assessed for each study by RJ according to the Newcastle Ottawa Scale: selection (representativeness of the sample, sample size, and exposure measurement), comparability (controlling for relevant confounders – one star if they stratified or adjusted for socio-economic measures and one star if they adjusted for other potential confounders such as age and sex), and outcome (outcome measurement and statistical test) (22, 23). While the Newcastle Ottawa Scale has no established thresholds, in line with previous studies we considered a score of less than five to indicate poor quality, five or six medium quality and seven or eight high quality (24). AL independently conducted a quality assessment for a 10% subset of studies and resolved differences via discussion.

We assessed outcome measures, exposures, and populations, and structured our review by outcome. We conducted a meta-analysis although this was only possible for studies reporting change in daily energy intake due to the heterogeneity of other outcomes. We contacted authors where data were not available, and for studies which reported stratified results (e.g. by sex), we combined these into an overall weighted estimate which we used in our meta-analysis. We converted measures to calories per adult per day and used a random effects model to calculate mean change in calories per adult per day. We used a Forest Plot to present the findings of this analysis. Each study is represented on the y axis, and number of calories intake increased or decreased by on the x axis. Study weights and I^2 estimates of heterogeneity

are also presented in the Forest Plot. We explored country income group (high vs. middle) as a potential source of heterogeneity and present stratified analyses.

For each of the other outcomes, we used harvest plots to display and summarise study results (25). Each study is reported as a single bar in each Harvest plot, with the height of the bar indicating low, medium, or high quality according to the Newcastle Ottawa Scale. The effect direction in terms of increase, decrease, no change or mixed results, was indicated via the x axis. To assess overall direction for individual studies reporting different results within the same food group, we aggregated effects into the overall direction as we only reported each study once in each Harvest Plot. If subcategories (e.g. bread and pasta for sources of carbohydrates for one study) reported both increases and decreases, we reported the category as having mixed effects. If the subcategories reported no change for one or more subcategories, alongside either an increase or decrease in another subcategory, we reported that as an overall increase or decrease respectively. We also examined separately whether findings differed for low SEP individuals using socio-economic indicators from each study, such as education, income, or social class. Analysis was conducted using Stata 15.

Results

We identified 8126 studies, of which 2305 were duplicates, and screened all non-duplicate studies by title and abstract (see Figure 1). We screened the full text of 164 studies. Of these, we excluded three conference abstracts, 12 cross-sectional studies, 40 studies not concerning the Great Recession, six studies not in English, 24 studies not reporting primary empirical data, 31 studies where the outcome was related to nutrition, and 18 studies with partial measures of dietary intakes ie. general expenditure on food at home. 30 studies were included after full text screening, plus two from grey literature and nine from reference lists to include 41 studies overall (Figure 1) (26-66). Table 1 presents characteristics of the 41 included studies.

Figure 1: Study Selection

Studies with a total of 2.6 million people from 25 countries were included: 12 high income, nine middle income, and four low income(67). Studies were heterogeneous regarding exposures, methods, and locations. Outcomes were also heterogeneous, but broadly fell into four categories:

1. energy intake (10 studies),
2. dietary quality (11 studies),
3. food intake and foods high in sugar, salt and fat (34 studies),
4. macronutrients (15 studies).

Study Quality and Characteristics

The majority of studies were of high or medium quality: eighteen studies (44%) were high quality, fifteen (37%) medium quality, and eight (19%) low quality. Only four studies investigated the impact of the Great

Recession on children's dietary intakes (32, 35, 46, 47). Most studies used individual-level data from pre-existing, nationally representative surveys, except for one study which used ecological data on calorie and protein intake per capita and currency movements (36). Thirty-one studies were serial cross-sectional (26-28, 30-35, 37-39, 42-45, 48-52, 54-56, 58-61, 64-66) and eight were cohort studies (29, 40, 41, 46, 47, 57, 62, 63). Thirteen studies (29%) used macroeconomic measures as the exposure such as unemployment rates, Consumer Confidence Index and neighbourhood characteristics (29, 31, 36, 41-44, 55-59, 64). Twenty-nine studies (71%) used commencement of the Great Recession as the exposure – this was the most common exposure measure for all four outcome categories. Most used regression methods with dummy time variables (27, 28, 30, 32-35, 37, 40, 41, 46, 51, 52, 54, 60-63, 65, 66). Others included using Difference-in Difference, t-tests, ANOVAs, and time-varying Almost Ideal Demand System and Bai Perron tests (26, 38, 39, 45, 47-49, 53, 54). Most studies adjusted for covariates including age, sex, education and socio-economic status – this was taken into account through the study quality assessment and we analysed adjusted results where possible. An additional file shows gives more detail on the studies [see Additional file 2]. Key findings are summarised in Table 2.

Energy Intake

Ten studies assessed changes in energy intake, generally located in high and middle income countries (27-29, 35, 36, 39, 44, 45, 48, 60). Seven used daily calorie intake as the outcome (28, 35, 39, 44, 45, 47, 60), while one used monthly intake in kJ (29) and one examined changes in growth rates using non-individual data (36). For one study based in seven different countries in Latin America, only data from Guatemala was available from the authors (44). We were unable to obtain standard deviations for a UK study so this was omitted from the meta-analysis, as was a Danish study assessing how Consumer Confidence Index affects energy intake (29, 48). Seven studies were included in our random effects meta-analysis (28, 35, 39, 44, 45, 60). We found that overall, energy intake decreased by 39.9 calories per adult equivalent per day (95% Confidence Interval: -119.9, 40.2) over the Great Recession (see Figure 2). The I^2 statistic for heterogeneity was 95.9%, suggesting considerable heterogeneity. When only high-income countries (USA and Italy) (27, 28, 35, 39, 60) were included in the meta-analysis, energy intake decreased by 103.0 calories per adult equivalent per day (95% Confidence Interval: -132.1, -73.9) with a lower I^2 statistic of 50.6%. When the meta-analysis was run for middle-income countries (Guatemala and Pakistan (44, 45)), energy intake increased by 105.5 calories per adult per day (95% confidence Interval: 72.8, 138.2), with an I^2 statistic of 0.0%, indicating very low heterogeneity.

The decrease in energy intake in high-income countries was supported by studies not included in the meta-analysis. A Danish study also reported that decreasing Consumer Confidence Index as a proxy for the recession was associated with lower monthly energy intake (29). Similarly, a UK study reported a decrease of 26 calories per day (48). The only study investigating children's daily energy intake suggested that children experienced larger decreases than adults (210 calories per capita per day) (35). Two studies observed a decrease in food expenditure alongside the decrease in calories (29, 47). Decreases in calories were also accompanied by decreases in consumption of several different food groups and

macronutrients, although the types of foods decreasing were not consistent (see below for further details) (29, 39, 47, 60).

Figure 2: Forest Plot for change in total energy intake per adult per day in calories.

Dietary Quality

Eleven studies examined the impact of the recession on dietary quality using indices of dietary quality and diversity (28, 34, 38, 40, 45-47, 49, 56, 59, 60). These studies were generally located in high and low income countries. Outcomes were heterogeneous, including Dietary Diversity Score (38, 45), Food Consumption Score (45, 59), and Healthy Eating Index (HEI) (46, 47). Eight studies (two of which were of high quality) reported negative impacts (28, 34, 38, 46, 49, 56, 59, 60) and three (all high quality) reported positive impacts (40, 45, 47) on dietary indices (Figure 3). Overall findings suggest a decrease in dietary quality over the Great Recession. There was little consistency across measures, for example Food Consumption Score decreased in Haiti but did not significantly change in Bangladesh (45, 59). There was also little consistency within countries. For example, in the UK, one study found that HEI improved by 1.5% over the recession, however, this increase masked a shift away from vegetables, grains, milk, and meat which was offset by a lower calorie share of saturated fat and lower salt consumption (47). An earlier paper using a different dataset over the same time period found a similar decrease in saturated fat intake and fruit and vegetable consumption, but a 1% decrease in HEI (46). Antioxidant consumption score decreased alongside a decrease in Mediterranean Diet score between 2005-2006 and 2007-2010 in Italy, suggesting a decrease in dietary quality (60).

Figure 3: Harvest plot for studies assessing dietary quality. Each bar represents a single study, with the height of the bar representing study quality via the Newcastle Ottawa Scale. The x axis indicates effect direction.

Food Intake

Thirty-four studies reported on food intake, generally located in high and middle income countries (26-33, 35, 37, 38, 41-43, 45-48, 50-58, 60-66). The most common outcome was consumption of a food group or an amount of food as a binary outcome per day/week (33, 37, 51, 52, 54, 55, 61, 65, 66). Other commonly used outcome measures included expenditure or frequency of consumption in a specified time period (29, 32, 41, 43, 48, 50, 56, 57, 62-64) or share of calories or calorie intake from food groups (27, 28, 35, 45, 47, 48). Overall, consumption of fruits and vegetables, meat and fish, fast food, sugary products, and soft drinks decreased during the recession, with egg and legume consumption increasing and sources of carbohydrate consumption unchanged. We found mixed results regarding intake of dairy, oils and fats, and snacks. Results were generally consistent by study quality. Harvest Plots for all outcomes can be found in Additional File 3.

Eight studies examined fruit and vegetable consumption combined, four of which found decreases in fruit and vegetable consumption (46, 48, 51, 55) and two found no significant impact (33, 52). Two

studies found increases in fruit and vegetable consumption, although both were of low quality (31, 58). Fourteen of the eighteen studies on fruit intake alone found that this decreased over the Great Recession (Figure 4) (29, 30, 38, 41-43, 54, 56, 61-63, 65, 66). One reported little impact (53) and three reported increases in fruit intake (45, 47, 50). All studies examining whether individuals consumed fruit daily reported decreases in fruit consumption (38, 43, 54, 61-63, 65, 66). Fifteen studies investigated the impact of the Great Recession on vegetable intake (Figure 5). Nine reported decreases in vegetable intake (41, 42, 47, 54, 56, 61, 63-65) and three reported no significant impacts (29, 37, 38). A Spanish study observed a decrease in daily vegetable consumption that was only significant in women without an educational qualification (61). One UK study found a 7.8% decrease in share of calories from vegetables (47) while another UK study found a small and weakly significant increase in portions of vegetables eaten per day in the UK (43). A study in Spain found that the odds of eating vegetables daily increased between 2006 and 2012 (66). In Pakistan, expenditure on vegetables increased slightly, but less than wheat and rice expenditure (30).

Figure 4: Harvest plot for studies assessing fruit intake. Each bar represents a single study, with the height of the bar representing study quality via the Newcastle Ottawa Scale. The x axis indicates effect direction.

Figure 5: harvest plot for studies assessing vegetable intake. Each bar represents a single study, with the height of the bar representing study quality via the Newcastle Ottawa Scale. The x axis indicates effect direction.

Five of eleven studies on sources of carbohydrates reported no change (29, 38, 41, 53, 65) and four reported differing directions of associations suggestive of within-category substitutions (45, 47, 48, 50) (Additional File 3 A1). An overall decrease (64) and increase (30) in expenditure on sources of carbohydrates was seen in one study each. Eleven studies examined dairy consumption (Additional File 3 A2) with mixed results. Five studies reported decreases (29, 38, 41, 53, 64) and two reported increases (30, 50), while one reported no change (37) and two reported increases in cheese but decreases in milk products (47, 48). Patterns were inconsistent across income groups in the US (26). Nine studies examined consumption of fats and oils (Additional File 3 A3) (29, 30, 38, 47, 48, 50, 53, 60, 64). Only one study found that oil consumption decreased (47); monthly purchases of fats decreased in Denmark, but not oils (29). Expenditure on fats and oils increased in Pakistan and Poland (30, 50). The remaining five studies found mixed or null results (38, 48, 53, 60, 64).

Sixteen studies investigated intake of sources of proteins (26, 29, 30, 37, 38, 41, 45, 47, 48, 50, 53, 54, 60, 61, 64, 65). While most studies examined consumption of protein sources separately, share of calories from poultry and fish increased while calories from red meat and nuts decreased in the UK (47). Expenditure on meat, poultry, and fish increased in Pakistan (30) but decreased in Russia (41). Animal proteins per day increased but vegetarian proteins decreased in Italy (60). Twelve studies examined meat consumption (Additional File 3 A4). Seven reported decreases (with consistent results in Spain and the UK) (38, 41, 47, 48, 54, 61, 64), one reported an increase (50), two reported no change (37, 65) and two

reported mixed results (26, 29). Eleven studies reported on fish consumption (Additional File 3 A5). Six reported decreases over the recession (29, 38, 48, 54, 64, 65), one reported an increase (26), two reported no association (37, 61) and two reported differential effects including a decrease in fish but an increase in seafood in Poland (45, 50). Potential substitution of high cost fish for low cost fish was reported in Bangladesh (45). Three of five studies reporting on egg consumption reported increases (Additional File 3 A6) (26, 29, 38, 48, 50). Consumption of beans, legumes, and pulses significantly increased in five of the six studies it was investigated in (30, 38, 45, 61, 65), with one US study reporting no change (26).

Eight studies examined the impact of the recession on fast food (Additional File 3 A7) - seven reported a decrease in consumption (27, 28, 32, 48, 57, 62, 63) and one reported no change (56). Food at restaurants, cafes, bars, bistros, fast food outlets, and takeaways decreased in the UK, but share of calories from prepared savoury foods and ready meals increased (48). There was an increase in calories from Consumer Packaged Goods (especially for households with children) in the USA (35). Consumer Confidence Index was not associated with processed food consumption in Denmark (29). Six studies reported on snack consumption (Additional File 3 A8). Three found increases in snack consumption (29, 55, 56), two found mixed results suggestive of decreases (27, 28) and one found no significant change (57). Higher area-level unemployment rate was associated with increase in snack consumption in the USA and Italy (55, 56). There was no significant change in total snacks consumed but a significant decrease in snacks eaten away from home in the USA (27, 28).

Eleven studies examined the Great Recession's impact on consumption of sugary products such as desserts and confectionary (Additional File 3 A9); seven reported decreases (29, 48, 54, 62-64, 66), two reported increases (47, 65) and two reported no significant change (56, 61). Calories from confectionary, soft drinks, sugary products, and preserves consumed in and out of the home decreased in one UK study (48). However, a UK study by the same authors found that share of calories from prepared sweets increased (47). Eight studies examined the impact of the Great Recession on non-alcoholic beverage consumption (Additional File 3 A10), primarily concerning soft drinks and fruit juice (29, 35, 47, 56, 57, 62, 63, 66). All reported decreases in consumption of beverages, although for two this decrease was not significant.

Macronutrients

Fifteen studies – from high, middle, and low income countries – assessed consumption of macronutrients with generally mixed results (27-30, 36, 38, 39, 45-47, 50, 58, 60, 62, 63). Macronutrient outcomes included calories (and share of calories) from macronutrient (27, 28, 45, 47), grams per day/month or grams per 100g (27-29, 39, 46), and price elasticity (36). For sugar consumption, measures also included percentage change in sugar consumption, budget share, and expenditure on sugar (29, 30, 38, 39, 46, 47, 50, 58).

Four studies reported on carbohydrate consumption (Additional File 3 A11) - two reported decreases ranging from 3.3g to 16g per day (39, 60), one reported a slight increase (47), and one reported no significant change (29). Eight studies examined sugar intake (Additional File 3 A12), although for many

of these it was unclear whether they were examining added sugar or general dietary sugar intake (29, 30, 38, 39, 46, 47, 50, 58). Four found that sugar intake increased (30, 46, 48, 58) while three studies identified decreases (38, 39, 50). For example, UK households increased their overall sugar intake by 0.20g per 100g, but for households with children this increase was by 0.44g per 100g increase (an increase of ~6g per day) (46).

Seven studies examined protein intakes (Figure A13) and four reported decreases (29, 36, 39, 47), two reported small increases (46, 60) and one reported no change (45). In one US study, protein intakes significantly decreased (by ~ 4g) only in men (39). Four studies reported on total fat consumption and saturated fat consumption (Additional File 3 A14 and A15) (27, 29, 39, 60). Directions of patterns were consistent within studies but different between studies, with increases (60), decreases (29), and no significant changes reported (27, 28). In the UK, the share of calories from unsaturated fats increased slightly alongside a decrease in share of calories from saturated fats in one study, although in a separate study there was a small increase in saturated fat consumption, particularly in pensioners (46, 47). Total daily fat intakes decreased by ~3g in women only in the USA (39). Additionally, there was no significant change in cholesterol consumption in the USA (27, 28). Three of five studies reported decreases in dietary fibre over the Great Recession (27, 28, 60); one reported no significant change (29) and one UK study observing an increase (47) (Additional File 3 A16).

Inequalities

Seventeen studies examined inequalities including high, middle, and low income nations (26-33, 35, 37, 38, 41-43, 45-48, 50-58, 60-65). Two studies assessed calorie intakes, four dietary quality, twelve food intake, and one macronutrients. Inequalities were operationalised in terms of education, income/wealth, social class, or job type. Fourteen studies found that the recession led to greater changes in dietary intakes for low SEP individuals (26, 30, 34, 42, 44, 45, 50, 51, 53, 54, 56, 60, 61, 65, 66). Results were consistent for fruit and vegetable intake (42, 50, 51, 54, 56, 61, 66) while patterns of meat and fish consumption were less clear but generally suggestive of inequalities (26, 54, 61, 65). Results were more mixed for fast food consumption (32, 56). The Great Recession also seems to have increased already existing inequalities in dietary quality (34, 45, 60), except for one UK study which found that lower income households improved their HEI score the most (47). Only four studies investigated the impact on children's dietary intakes so we were unable to make meaningful conclusions regarding this subgroup (32, 35, 46, 47).

Discussion

Our systematic review suggests that the Great Recession impacted dietary intake in diverse ways. Our meta-analysis found a decrease of 40 calories per adult equivalent per day. We report decreases in dietary quality and fruit and vegetable intake which may have large population health impacts. We also observed decreases in meat and fish, fast food, sugary products, and soft drink consumption and increases in the consumption of eggs and legumes. Impacts were larger among low SEP people.

Findings from our meta-analysis indicate decreases in calorie intake in high income countries (103 calories per adult per day) but increases in middle income countries (106 calories per adult per day). Although only based on five studies this is consistent with other evidence suggesting reduced food expenditure during the recession in high income settings, reflecting a tightening of household budgets (11, 13, 29, 47). These results in high income countries should be treated with caution although they may reflect a shift in foods consumed. Fast food, sugary products, and soft drinks consumption decreased in most high-income countries observed, which may have contributed to the decrease in calorie intake we describe. These decreases may confer benefits for health in high income countries (68, 69).

However, another response to the recession may be purchasing different groceries or altering the nutritional characteristics of foods, which may result in changes to calorie intakes and differential impacts on nutrition (47). The changes we have described in relation to food intakes and dietary quality support this. We report decreases in fruits, vegetables, and meat and fish which may be more expensive, suggesting that individuals may have switched to cheaper proteins eggs and legumes to save money (70). Small changes in fruit and vegetable consumption can significantly affect risk of coronary heart disease and overall mortality (71) and thus, reductions in intake of these foods may have large impacts on population health (72). Consistent with previous studies, we found that the Great Recession may have widened already existing inequalities, especially in relation to fruit and vegetable consumption (73). This further supports a role for dietary costs as a mechanism for the recession's impacts, as low SEP groups tend to select cheaper, nutrient-poor diets (74). Our review supports previous evidence regarding the impact of the recession on widening health inequalities within countries (4, 5). An increase in calorie consumption in middle-income countries may represent a concern for public health, although more research is needed.

Our review has several strengths. We focused on longitudinal studies, used a variety of dietary measures as outcomes, and employed meta-analysis where this was feasible. We applied numerous search terms to seven databases and a range of grey literature sources to ensure that our search of the literature was comprehensive and examined impacts globally. However, our systematic review has some limitations which should be considered when interpreting findings. First, studies were heterogeneous in terms of exposures, methods, outcomes, and results. Second, only studies in English were included in this review, which may have led to some research being excluded. Third, many of the included studies used the year when the Great Recession commenced as their exposure rather than macroeconomic measures, which may bias findings towards the null. However, both groups of studies had broadly similar findings suggesting that use of different exposure measures did not have a substantive impact.

More robust research is needed to overcome the issues relating to the heterogeneity of the literature that we have encountered and establish causal links between recessions and dietary intake. A large range of measures of dietary intake were identified in our study. The field of public health nutrition could benefit from initiatives to agree on core outcomes for measurement in future studies. Additionally, more research on the impact of recessions on food intakes and dietary quality is especially needed as we had insufficient study data to quantify impacts on these outcomes. We also recommend further research into

the pathways through which recessions impact dietary intakes, particularly the role of unemployment, changes in income, and food price increases. Furthermore, only four studies investigated the impact of the recession on children's diets which remains an important avenue for future work (32, 35, 46, 47).

Conclusions

Our systematic review suggests that the Great Recession had a negative impact on dietary intake, with reductions in daily energy intake, dietary quality, and fruit and vegetable consumption. These reductions are likely to have substantial impacts on population health. Furthermore, it seems that the Great Recession disproportionately affected dietary intake among low SEP individuals, and thus may contribute to widening health inequalities. Policymakers should consider interventions to ensure healthfulness of diets during recessions, particularly for low SEP individuals. With the coronavirus pandemic initiating a new global recession, we would urge international and national policy makers to consider strategies to mitigate potential impacts of recessions on dietary intakes, nutrition, and health for the whole population but particularly those of low SEP.

Abbreviations

GDP: Gross Domestic Product; SEP: socio-economic position; NOS: Newcastle-Ottawa Scale; HEI: Healthy Eating Index;

Declarations

Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable

Availability of data and materials

The dataset of energy intakes analysed during the current study are available from the corresponding author on reasonable request. All papers included in our review are cited.

Completing interests

The authors declare that they have no completing interests.

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Authors' contributions

RJ, AL and EV conceptualised and designed the study. RJ and AL did the literature search, study selection and quality assessment. RJ undertook data extraction. All authors contributed to the interpretation of the findings. RJ and AL wrote the first draft of the manuscript. All authors contributed to manuscript writing and revisions and approved the final version.

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Tables

Table 1: Characteristics of studies included in review

Author & Year	Location	N	Exposure	Years	Outcome Category	Quality [1]
Alves, 2019 (65)	Portugal	43,273	Commencement of GR ^[2]	2005-2006, 2014	Food intake	Medium
Antelo, 2017 (64)	Spain	28,695	Unemployment rates	2006, 2013	Food intake	High
Asgeirsdottir, 2014 (63)	Iceland	9,807	Commencement of GR	2007, 2009	Food intake	High
Asgeirsdottir, 2016 (62)	Iceland	3,238	Commencement of GR	2007, 2009, 2012	Food intake	High
Bartoll, 2015 (61)	Spain	47,156	Commencement of GR	2001, 2003-2004, 2006-2007, 2011-2012	Food intake	High
Bonaccio, 2014 (60)	Italy	21,001	Commencement of GR	2005-2006, 2007-2010	Energy intake, dietary quality, Food intake, macro- and micronutrients	High
Brinkman, 2010 (59)	Haiti, Nepal, Niger	5,493	Changes in food prices	2006, 2007	Dietary quality	Low
Colman, 2018 (57)	USA	7,100	Unemployment.	2008, 2010, 2012, 2014	Food intake	High
Çıraklı 2019 (58)	Turkey	Not stated	Commencement of GR	1994, 2001, 2008	Food intake	Medium
Dave, 2012 (56)	USA	1,353,612	Unemployment rates	1990-2009	Dietary quality and Food intake	High
Di Pietro, 2018 (55)	Italy	189,631	Unemployment rates	2005-2012	Food intake	High
Díaz-Méndez 2019 (54)	Spain	50,485	Commencement of GR	2005, 2011	Food intake	Medium
Duquenne, 2014 (53)	Greece	932	Change over time	Not stated	Food intake	Medium
Filippidis, 2014 (51)	Greece	3,503	Commencement of GR	2006, 2008, 2011	Food intake	Medium
Filippidis, 2017 (52)	Greece	5,504	Commencement of GR	2006, 2008, 2010, 2011, 2015	Food intake	Medium
Florkowski, 2012 (50)	Poland	Not stated	Commencement of GR	2004, 2005, 2006, 2007, 2008	Food intake and macro- and micronutrients	Low
Foscolou, 2017 (49)	20 Mediterranean islands	2749	Commencement of GR	2005-2008, 2009-2015	Dietary quality	Low
García-Mayor, 2020 (66)	Spain	51,370	Commencement of GR	2006, 2012, 2017	Food intake	High
Griffith,	UK	14,694	Commencement	2005-	Energy intake,	High

2016a (47)			of GR	2007, 2010-12	dietary quality, Food intake	
Griffith, 2016b (48)	UK	Not stated	Commencement of GR	1980-2007, 2007-2013	Energy intake, dietary quality, Food intake	High
Griffith, 2013 (46)	UK	15,850	Commencement of GR	2005-2007, 2008-2009, 2010-2012.	Energy intake, dietary quality, Food intake, macro- and micronutrients	High
Hasan, 2019 (45)	Bangladesh	11,722	Commencement of GR	2005, 2010	Energy intake, dietary quality, Food intake	High
Iannotti, 2011 (44)	Guatemala, Honduras, Nicaragua, Panama, Haiti, Ecuador, Peru	71,198	Actual vs. expected price changes	2006 – 2008	Energy intake	Low
Jofre-Bonet, 2016 (43)	UK	91,045	Unemployment rates, commencement of GR	2001-2013	Food intake	High
Kim, 2019 (42)	USA	1,359	Neighbourhood indicators	2000-2013	Food intake	High
Kotelnikova, 2017 (41)	Russia	17,645	Commencement of GR	1995, 1998, 2009, 2014	Food intake	Medium
Kuhns, 2014 (40)	USA	100,000	Commencement of GR	2004-2010	Dietary quality	High
Marcotte-Chenard, 2019 (39)	USA	38,541	Commencement of GR	1999-2006, 2007-2008.	Energy intake, macro- and micronutrients	Low
Martin-Prevel, 2012 (38)	Burkina Faso	6019	Commencement of GR	2007, 2008	Food intake	High
Mattei, 2017 (37)	Italy	Not stated	Commencement of GR	2000-2007, 2008-2015	Food intake	Low
Mohseni-Cheraglou, 2016 (36)	Global (ecological)	Not stated	Currency devaluation or banking distress	1981-2007.	Energy intake, macro- and micronutrients	Low
Ng, 2014 (35)	USA	81,509	Commencement of GR	2003-2004, 2005-2006, 2007-2008, 2009-2010	Energy intake, Food intake	High
Norte, 2019 (34)	Spain	49,216	Commencement of GR	2006-2007, 2011-2012	Dietary quality	Medium
Nour, 2019 (33)	Canada	281,421	Commencement of GR	2007-2008, 2008-2009, 2009-2011,	Food intake	High

				2011-2013		
Rajmil, 2013 (32)	Spain	3,982	Commencement of GR	2006, 2010-2012	Food intake	High
Regidor, 2019 (31)	Spain	Not stated	GDP	2004-2007, 2008-2010, 2011-2013, 2014-2016	Food intake	Low
Shabnam, 2016 (30)	Pakistan	30,054	Commencement of GR	2005-2006, 2010-2011	Energy intake, Food intake, macronutrients and micronutrients	High
Smed, 2017 (29)	Denmark	3,440	Consumer Confidence Index	2008-2012	Energy intake, dietary quality, Food intake, macro- and micronutrients	High
Todd, 2014 (28)	USA	9,839	Commencement of GR	2005-2006, 2007-2008, 2009-2010	Dietary quality, Food intake, macro- and micronutrients	Medium
Todd, 2017 (27)	USA	17,326	Commencement of GR	2005-2006, 2007-2008, 2009-2010, 2013-2014	Dietary quality, Food intake, macronutrients and micronutrients	High
Yang, 2019 (26)	USA	Not stated	Commencement of GR	1998-2016	Food intake	High

Table 2: Summary of Study Findings by Outcome

Author & Year	Exposure	Main results (only statistically significant findings described; see Additional File 2 for full details)
Alves, 2019 (65)	Commencement of GR	Food intake: Soup, fish, fruits and vegetables significantly decreased; legumes significantly increased.
Antelo, 2017 (64)	Unemployment rates	Food intake: Unemployment was associated with a decrease in expenditure on bread, cereals, rice and pasta; meat; fish; milk, cheese and eggs; fruits; vegetables, pulses, potatoes and other root crops; sugar, jam, honey, chocolate, sweets and ice cream.
Asgeirsdottir, 2014 (63)	Commencement of GR	Food intake: Daily sugared soft drink, daily sweets, weekly fast food, daily fruit and daily vegetables decreased
Asgeirsdottir, 2016 (62)	Commencement of GR	Food intake: Daily sugared soft drink, daily sweets, weekly fast food, daily fruit and decreased
Bartoll, 2015 (61)	Commencement of GR	Food intake: Reduction in fruits, meats, and cold meats; vegetable consumption decreased only in women without a qualification; increase in legumes.
Bonaccio, 2014 (60)	Commencement of GR	Energy intake: Calorie intake decreased. Dietary quality: Adherence to Mediterranean Diet and antioxidant score decreased. Food intakes: animal proteins and fats increased, vegetarian proteins and fats decreased. Macronutrients: Carbohydrate intake and fibre intake decreased. Protein, fats and saturated fats increased.
Brinkman, 2010 (59)	Changes in food prices	Dietary quality: Diet quality and diversity decreased in all three countries.
Colman, 2018 (57)	Unemployment	Food intake: Becoming nonemployed and unemployed was associated with decreased consumption of fast food.
Çıraklı 2019 (58)	Commencement of GR	Food intake: Annual per capita vegetable and fruit consumption increased. Macronutrients: sugar consumption increased.
Dave, 2012 (56)	Unemployment rates	Dietary quality: Higher state unemployment was associated with decreased dietary quality. Food intake: higher state unemployment was associated with decreased consumption of fruits, fruit juice, carrots and green salad and vegetables, as well as significantly increased snacks.
Di Pietro, 2018 (55)	Unemployment rates	Food intake: Higher unemployment rate was associated with decreased probability of consuming at least 5 portions of fruit and vegetables per day and increased probability of eating snacks high in salt every day.
Díaz-Méndez 2019 (54)	Commencement of GR	Food intake: Fruit, vegetables, meat, fish, and sweets consumption decreased.
Duquenne, 2014 (53)	Change over time	Food intake: Recession had limited impact on consumption of pasta, potatoes, olive oil, rice, bread, vegetables, milk, and fruits (component 1). There was a bigger impact on beef, sheep and goat, pork, cold cuts, chicken, fish, sweets, cheese and feta consumption, with more than 60% of households changing their behaviour (component 2).
Filippidis, 2014 (51)	Commencement of GR	Food intake: Significant decrease in consuming five portions of fruits and vegetables per day.
Filippidis, 2017 (52)	Commencement of GR	Food intake: No significant change in low fruit and vegetable consumption (two or less portions).
Florkowski, 2012 (50)	Commencement of GR	Food intake: Expenditure share from pasta, bread, seafood, offal, barley, pork, chicken, milk, farmers' cheese, hard cheese, eggs, margarine, vegetable oil, animal fats, citrus and apples increased. Expenditure share from freshwater fish, potatoes and sugar decreased.
Foscolou, 2017 (49)	Commencement of GR	Dietary quality: Adherence to Mediterranean Diet decreased after 2009.
García-Mayor, 2020 (66)	Commencement of GR	Food intake: Daily fruit, vegetables, pastries and sweets, and sugar-sweetened beverages decreased, with greater decreases in people of low socio-economic position.
Griffith, 2016a (47)	Commencement of GR	Energy intake: Calories purchased and energy density decreased. Dietary quality: Healthy Eating (HEI) score increased. Food intake: Share of calories from fruit, grains, poultry and fish, prepared sweets and desserts and confectionary increased; vegetables, red meat and nuts, fats and oils, eating out and fast food and drinks decreased. Macronutrients: Carbohydrates, sugar, fibre and saturated fats increased and protein and salt decreased.
Griffith, 2016b (48)	Commencement of GR	Food intake: Fruit and vegetables, dairy, meat, fish, eating out and fast food, soft drink and confectionary consumption decreased.

Griffith, 2013 (46)	Commencement of GR	Energy intake: Calorie density increased. Dietary quality: dietary quality decreased over the recession. Food intake: Decrease in calorie share from fruit and vegetables. Macronutrients: saturated fat, sugar and protein consumption increased.
Hasan, 2019 (45)	Commencement of GR	Energy intake: Calorie intake per day increased over the recession. Food intake: Consumed rice and calories from non-rice grain, pulses, high value and low value pulses, fruits, proteins, low value fish and other items increased, while calorie intake from high value fish decreased. Dietary quality: Household Dietary Diversity Score and number of food groups consumed increased while Food Consumption Score decreased.
Iannotti, 2011 (44)	Actual vs. expected price changes	Energy intake: Calories decreased in general. The decrease was greater for lowest income groups.
Jofre-Bonet, 2016 (43)	Unemployment rates, commencement of GR	Food intake: Vegetable consumption increased and fruit consumption decreased.
Kim, 2019 (42)	Local indicators	Food intake: Decrease in median household income was associated with decreased fruit and vegetable availability in the home.
Kotelnikova, 2017 (41)	Commencement of GR	Food intake: Food expenditure in the previous week on bread, cereals, and canned food; fresh vegetables; fresh meat and fish; Milk and dairy products; and berries and other fresh fruits decreased.
Kuhns, 2014 (40)	Commencement of GR	Dietary quality: USDA score for diet quality increased
Marcotte-Chenard, 2019 (39)	Commencement of GR	Energy intake: Calories decreased for men and women. Macronutrients: Protein, carbohydrate, sodium and sugar intake decreased in men and women. Fats significantly decreased in women only.
Martin-Prevel, 2012 (38)	Commencement of GR	Food intake: Tubers/roots, green leafy vegetables, eggs and vitamin A rich oil (red palm oil) increased. Vitamin A (VA)-rich vegetables and tubers, other vegetables, VA-rich fruits, other fruits, offal, meat, fish, legumes/ nuts/ seeds, milk/ dairy products and oils/fats decreased. Macronutrients: Sugar consumption decreased.
Mattei, 2017 (37)	Commencement of GR	Food intake: No significant impact on foods assessed.
Mohseni-Cheraglou, 2016 (36)	Currency devaluation or banking distress	Energy intake: Growth rates for calorie intake per day decrease during economic crises with or without recessions. Macronutrients: Growth rates for protein intake per day decrease during economic crises with or without recessions.
Ng, 2014 (35)	Commencement of GR	Energy intake: Mean calories consumed per day decreased in adults and children. Food intake: increase in unemployment rate associated with increased calories from CPGs and beverages.
Norte, 2019 (34)	Commencement of GR	Dietary quality: Odds of poor diet increased for the less affluent.
Nour, 2019 (33)	Commencement of GR	Food intake: Recession not significantly associated with fruit and vegetable consumption
Rajmil, 2013 (32)	Commencement of GR	Food intake: Junk food consumption decreased for families with maternal primary education level.
Regidor, 2019 (31)	GDP	Food intake: Fruit and vegetable consumption increased.
Shabnam, 2016 (30)	Commencement of GR	Food intake: Vegetable, wheat and wheat flour, rice, milk and milk products, legumes, fats and oils and sugar increased. Fruit consumption decreased. Macronutrients: Price elasticity for carbohydrates, fats and proteins decreased.
Smed, 2017 (29)	Consumer Confidence Index	Food intake: Canned and processed fish, fresh fish, fresh fruit, poultry, processed meat, slice meat, fats, cheese, dairy and sugar products significantly increase with increased CCI (so decreased during recession). Pork and snacks significant decrease with increased CCI (so increased during recession). Macronutrients: Total fat, saturated fats and protein increase with increased CCI. Added sugar and carbohydrates decreased with increased CCI.
Todd, 2014 (28)	Commencement of GR	Dietary intake: More likely to rate dietary quality as excellent or very good in 2009-2010 compared to 2007-2008. Food intake: No significant change in total snacks consumed but did find a significant decrease in snacks eaten

		away from home. Decrease in calories from fast food. Macronutrients: Percentage calories from fat and saturated fat, fibre intake and cholesterol intake decreased.
Todd, 2017 (27)	Commencement of GR	Food intake: No significant change in total snacks consumed but did find a significant decrease in snacks eaten away from home. Decrease in calories from fast food. Macronutrients: Saturated fat, fibre and cholesterol intake decreased.
Yang, 2019 (26)	Commencement of GR	Food intake: Decreases in beef and pork expenditure, with income differences. Increase in eggs and no change in dried beans

[1] Assessed using the Newcastle Ottawa Scale

[2] 'GR' denotes Great Recession

Figures

Figure 1

Study Selection

Figure 2

Forest Plot for change in total energy intake per adult per day in calories.

Figure 3

Harvest plot for studies assessing dietary quality. Each bar represents a single study, with the height of the bar representing study quality via the Newcastle Ottawa Scale. The x axis indicates effect direction.

Figure 4

Harvest plot for studies assessing fruit intake. Each bar represents a single study, with the height of the bar representing study quality via the Newcastle Ottawa Scale. The x axis indicates effect direction.

Figure 5

Harvest plot for studies assessing vegetable intake. Each bar represents a single study, with the height of the bar representing study quality via the Newcastle Ottawa Scale. The x axis indicates effect direction.

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