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Systematic Review

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Obesity after Natural disasters and Associated Risk Factors: A Systematic Review

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Abstract

Background: Natural disasters occur unexpectedly, leading to long-term consequences like obesity. That contributes to various noncommunicable diseases such as cardiovascular disease, diabetes, and cancer. This review aimed to examine the link between natural disasters and obesity, along with related risk factors.
Objective: This systematic review aimed to examine the relationship between natural disasters and obesity, as well as the associated risk factors.
Methods: A thorough search was conducted using electronic databases such as PubMed, Scopus, Web of Science, HINARI, and Google Scholar. Additional articles were manually searched. Studies that reported weight gain and risk factors were included. The quality of the studies was assessed using the Joanna Briggs Institute (JBI) tools. Data were collected from eligible articles and synthesized.
Results: The participants in this research ranged from 3 months to 67 years old. Of the 17 articles, 11 focused on children, while the 5 focused on adults and 1 on adolescents. All studies followed a cohort design, with follow-up periods varying from 6 months to 15.5 years. Results indicated weight gain post-disaster, with risk factors including sedentary behavior, unhealthy eating habits, maternal high Body Mass Index (BMI), mixed feeding, stress, alcohol consumption, coastal residence, temporary housing, and timing from disaster onset.
Conclusions: This research emphasizes the significance of addressing post-disaster obesity as a pivotal aspect of public health, suggesting its integration with immediate priorities such as trauma management. Emphasizing its long-lasting effects across generations, the study offers policymakers valuable insights to develop effective approaches in tackling post-disaster obesity.

Disasters, whether natural or human-induced, present significant challenges and can lead to harmful outcomes for communities around the globe. According to United Nations Office for Disaster Risk Reduction (UNDRR), a disaster is defined as a serious disruption to the functioning of a community or a society at any scale due to hazardous events interacting with conditions of exposure, vulnerability, and capacity, leading to 1 or more of the following: human, material, economic, and environmental losses, and their impacts.[1] Disasters are also classified into natural (geophysical, hydrological, meteorological, climatological, biological, and extra-terrestrial hazards) and human-induced (technological and societal hazards).[2]

Recognizing disaster types and their potential impacts are crucial for developing effective responses and mitigation strategies. They can be natural disasters, such as earthquakes, tsunamis, floods, cyclones, and pandemics, or human induced such as industrial accidents, terrorism, war, and road traffic accidents. The most frequently occurring natural disasters are earthquakes, tsunamis, floods, cyclones, and pandemic.[3] The complexity of natural disasters significantly impacts the health of individuals, exacerbating existing health problems, damaging properties, and harming the environment.[4] Mostly, priority is given to handling the short-term effects of natural disasters rather than long-term consequences, which may be as serious as their short-term consequences. Many of these long-term consequences can be prevented through simple lifestyle changes and modifications to the environment. Obesity is one such long-term consequence.[5,6]

There is an increasing link between disaster aftermath and obesity, largely due to a lack of focus on the long-term effects of these events. According to World Health Organization (WHO), body mass index (BMI) is classified into normal (BMI between 18.5 and < 25 kg/m^2), overweight (BMI ≥ 25 kg/m^2 to < 30 kg/m^2), and obese (BMI ≥ 30 kg/m^2).[7] Regardless of the long-term effects of natural disasters, the number of people with obesity has almost tripled since 1975, with the indices shifting from wealthy countries to poorer ones.[8] In 2016, the WHO reported that 1.9 billion adults were overweight, with an additional 650 million classified as obese. Furthermore, in 2019, approximately 38.2 million children under the age of 5 were overweight or obese. In addition to that, in 2020, there were estimates that 39 million children and teenagers aged 5-19 years were affected by overweight or obesity.[8,9] In recent decades, natural disasters such as earthquakes, tsunamis, landslides, floods, and cyclones have affected over 2.6 billion individuals.[10]

The increasing prevalence of obesity significantly contributes to a range of short- and long-term health issues and imposing an economic burden on societies. Evidence has revealed that obesity is a major contributor to common noncommunicable diseases (NCDs),[5,6] and has serious consequences for both children and adults, causing physical and emotional problems, financial losses, and premature death.[11] In addition, there is a heavy economic burden that directly impacts the health of individuals. A study predicted the economic burden of obesity if not intervened; the cost of overweight and obesity is expected to reach 3 trillion USD annually by 2030, and could rise to 18 trillion USD by 2060.[12] This highlights the urgent need for effective interventions, especially in a disaster context. Several studies have also revealed that sudden lifestyle changes during disasters can lead to overweight and obesity.[11,13] Studies have shown that obesity is a complex issue during disasters, and sudden changes in lifestyle can lead to weight gain.[11,13]

A similar study identified a connection between natural disasters and the development of obesity and related issues.[14] Understanding the specific risk factors that exacerbate obesity during disasters is crucial for addressing this growing issue. The main risk factors contributing to obesity during natural disasters are summarized as relocation, lack of access to amenities like playgrounds, sleep disturbances resulting from post-traumatic stress disorder, and stress experienced during pregnancy, which can also contribute to obesity and overweight.[15–17] Similarly, studies also identified that the death of close family members or friends during or after disasters, as well as being pregnant, can increase the likelihood of a child becoming obese in childhood.[18] These factors highlight the immediate consequences of disasters and their long-lasting effects on community health.

Furthermore, disasters not only disrupt daily life but also hinder access to essential health care services, thus further intensifying the obesity crisis. This has been observed in instances such as floods in Ghana,[19] earthquakes in Japan,[20] earthquakes in Nepal,[21] and earthquakes in Haiti.[22] Such disruptions emphasize the need for effective public health strategies in disaster-prone areas. To prevent and manage obesity in normal circumstances, world bodies have developed different strategies to tackle overweight and obesity, such as the implementation of a school policy framework in 2008. This framework prioritizes diet-related issues, performing exercise, as well as health issues.[23–25] The WHO also created a global action plan for physical activity spanning from 2018 to 2030 with the purpose of promoting and increasing movement to contribute to healthier individuals.[26] A nonbinding agreement is the Sendai Framework for Disaster Risk Reduction 2015-2030 adopted by United Nations (UN) members advocating for disaster reduction. It focuses on 4 key priorities: understanding disaster risk, strengthening disaster risk governance, investing in disaster risk reduction for resilience, and enhancing disaster preparedness for effective response and recovery.[27] If the effect of natural disasters on obesity is not prevented early, it will be hard for global bodies to achieve sustainable development goal 3, target 3.4, which is zero growth in prevalence of obesity, and reduce premature mortality from NCDs by one-third by 2030.

Obesity, once mainly a concern in high-income countries, is now a growing health issue in low- and middle-income nations.[28] In addition to that, disasters exacerbate existing problems and significantly increase obesity, but planners and decision-makers have not adequately addressed the long-term consequences of disasters on obesity. It has serious implications for future generations because parental obesity has a positive impact on the degree of offspring obesity.[29]

Despite the importance of understanding the dynamics between natural disasters and obesity, there remains a significant knowledge gap regarding this relationship and its associated factors. Therefore, the current systematic review aimed to investigate all observational studies conducted on disasters and obesity, and synthesized them to provide comprehensive evidence to support policymakers and enable them to develop strategies to address overweight or obesity and associated factors in the aftermath of disasters.

Materials and Methods

This systematic review was conducted following the Preferred Systematic Review and Meta-analysis (PRISMA) guidelines.[30] Its protocol was registered as an international prospective register of systematic reviews with PROSPERO no: **CRD 42024506070** and it is available at https://www.crd.york.ac.uk/prospero/display_record.php?ID=CRD42024506070.

Searching Strategies

Electronic searches were conducted in PubMed/Medline, Web of Science, HINARI, Scopus, and Google Scholar to identify published articles that met the inclusion criteria for obesity or weight gain and their associated risk factors. Manual searches were also conducted to identify articles about prevalent forms of natural disasters, such as earthquakes, floods, tsunamis, cyclones, and hurricanes using the Boolean operators "AND/OR" to refine the search strategies. The search was guided by the PECO (Population, Exposure, Comparison, Outcome) framework to include articles involving individuals of all age groups whom reported being overweight or obese following natural disasters, risk factors for outcomes following disasters, individuals who developed overweight or obesity in comparison to those who did not after common natural disasters, and the presence of primary and secondary outcomes of overweight or obesity and their determinants following natural disasters.

Study Selection

The search terms were matched with relevant subject headings and searched as keywords in the title and abstract of the included databases. We used a predetermined and comprehensive search strategy that specifically examines the link between natural disasters and obesity or being overweight. This systematic review included all articles reporting either BMI and BMI z score and waist circumference, or both, without time restriction using these MeSH terms ((((''Natural Disasters''[MeSH Terms] OR(''Natural disaster''[MeSH Terms] OR "Earthquakes"[-MeSH Terms] OR "Floods"[MeSH Terms] OR "Tsunamis"[MeSH Terms] OR "Cyclonic Storms"[MeSH Terms]) OR "Hurricane"[-MeSH Terms]) AND (''Overweight''[MeSH Terms] OR "Paediatric Obesity"[MeSH Terms])) OR (''Obesity''[MeSH Terms] OR "obesity, abdominal"[MeSH Terms])) AND ((observational study[Filter]) AND (humans[Filter])). All articles that met the inclusion criteria were included in the current systematic review. They were extracted, summarized, and reported in the systematic review.

Inclusion and Exclusion Criteria

Inclusion: For this study, we examined articles that focused on observational study designs, including cohort, case-control, and cross-sectional studies. There were no restrictions on age or time.

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We also included articles that investigated the increase in body weight following natural disasters. This used BMI for adults and BMI z-score for children, in addition to waist circumference. According to the classification, body weight participants might be normal (BMI between 18.5 and < 25 kg/m^2), overweight (BMI ≥ 25 kg/m^2 to < 30 kg/m^2), and obese (BMI ≥ 30 kg/m^2).[31] Waist circumference is a basic test to assess if someone has too much body fat or potential health issues. If a woman's waist circumference is over 88 cm (35 inches) or a man's is over 102 cm (40 inches), it may indicate the need to pay attention to their belly fat and overall health. It is not a diagnostic tool, but rather a screening tool.[32]

Exclusion: The following criteria were used to exclude certain studies from our systematic review: human induced disasters, studies conducted on species other than humans, non-observational and qualitative study designs, editorial letters, articles written in languages other than English, articles that were inaccessible despite 2 attempts to contact the authors, and non-peer-reviewed articles.

Data Extraction

Two authors developed a Microsoft Excel template for data extraction and independently collected data after piloting and making subsequent changes. The essential characteristics that were included were the first author, year of publication, country, type of disaster, study design, study setting, total sample size, male proportion, study period, age, anthropometric measurements, prevalence of overweight or obesity, and all significant factors, as shown in Table 1.

Quality Assessments

Critical appraisal

The authors independently assessed the methodological quality of all 17 eligible studies using Joanna Briggs Institute (JBI) critical appraisal tools,[33] as shown in Table 1. The tools consist of 11 detailed questions with 4 possible answers: (1) Yes, (2) No, (3) Unclear, and (4) Not Applicable,[33] as shown in Appendix I. Conflicts were resolved through discussion and consensus among the authors. The findings of all eligible articles that scored above the average for all questions were synthesized and reported in narrative form.

Types of outcomes

The outcomes of interest in this review were obesity after natural disasters and its risk factors. We assessed weight increment based on weight indices and identified the risk factors associated with obesity in the aftermath of natural disasters.

Data analysis

Data analysis involved a narrative synthesis of the articles that passed the risk of bias assessment using the JBI critical appraisal tools mentioned above. The results were reported in a narrative format for both primary and secondary outcomes.

Results

Included Studies

A total of 2343 articles from databases and through searching through previously accessed references were gathered. Before we started reviewing, we excluded 81 articles that didn't meet our requirements. We exported all of the articles to EndNote software version X9.3.3 for easier management, which automatically excluded 1746 articles. We couldn't locate 7 articles, so we only had 509 left to access and review the full text according to our criteria. Finally, after going through all of that, we ended up with 17 articles that met our criteria and were included in the current systematic review. You can see the entire process in Figure 1.

Critical Appraisal

The quality of the 17 included articles was assessed using the JBI critical appraisal checklist. All the articles were above average according to the authors' agreement. Some of the articles did not answer 2 questions of (1) Whether the follow-up was completed and (2) The reason for the loss of follow-up was not clear.

Characteristics of Included Studies

Seventeen relevant studies were included, with a total sample size of 229 058 participants that met the inclusion criteria. The smallest sample size was 103 participants,[34] and the largest was 93 538.[35] Eleven of the included studies focused on children,[34–44] 5 were conducted on adults,[44–48] and only 1 on adolescents.[49] Geographically, most of the included studies (n = 12) were conducted in Japan,[35,36,39–42,44–48,50] followed by the USA,[34,38,49] and Canada.[37,43] The research covered various natural disasters, with 7 studies on earthquakes,[35,36,40–42,47,50] 4 on a combination of earthquakes and tsunamis,[39,44,46,48] 2 on floods,[34,38] 2 on storms,[37,43] and 1 on hurricanes.[49] Both prospective and retrospective cohort study designs were utilized, with follow-up times ranging from 6 months[36] to 15.5 years.[43] The minimum reported mean age of participants was 3 months,[36] and the maximum was 67 years.[47] The 17 included studies used various anthropometric measurements or indices, including only BMI,[34,35,37,40–42,44–46,48,50] BMI and waist circumference,[43,47] BMI z-score for children and adolescents,[38,42,49] and 2 studies that measured BMI standard deviation score (SDS).[39,40] A detailed summary of the included studies can be found in Table 1.

Change of Body Weight After Natural Disasters

Disaster management encompasses 4 essential phases: mitigation, preparedness, response, and recovery, each playing a crucial role at different stages.[51] Overweight or obesity which is the byproduct of natural disasters occur during the recovery phase following natural disasters.[52] Based on evidence, it can emerge with a timeframe of 7 months[48] to 6 years.[41] To effectively manage these byproducts, early planning during the mitigation phase is key. Based on current systematic review all 17 included studies reported an increase in body weight following natural disasters. Five studies[44–48] focused on adult populations, while only 1 specifically targeted adolescents.[49] Eleven studies examined the impact on children.[34–43,50] In adolescents, the prevalence of obesity increased by 5.79% in the aftermath of natural disasters.[49] The studies presented different prevalence rates for obesity or overweight conditions. The smallest reported increase was 5.3%,[42] while the highest documented was 42.1%[47] as shown in Table 1.

Determinant Factors

The systematic review identified risk factors that link natural disasters to overweight or obesity. These risk factors were classified as sociodemographic and socioeconomic (SES), limited access to healthy food, sedentary behavior, concerns related to maternal nutrition, child feeding practices, maternal psychological factors,

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Table 1. Characteristics of included studies in systematic review

Name of author, publication year and reference	Country	Study design	Sample size	Type of disasters	% of Male	Study groups	Average study follow-up duration	Age	Measurements	Prevalence	Risk factors	JBS
Ohira et al 2016[45]	Japan	Longitudinal study	27 486	Earthquake and nuclear accident	44.2	Adults	1.6 years	67 years	BMI	The percentages of overweight/obesity among evacuees were 31.8% and 39.4%, respectively. For non-evacuees, the percentages were 28.3% and 30.3% before and after the disaster, respectively.	Being evacuated Adjusted Hazard Ratio((AHR) =1.67, 95% CI=1.53, 1.83, *P* < 0.001), age of < 65 year and > =65 year (AHR = 1.67, 95% CI = 1.53, 1.83, *P* < 0.001) for men, being male (AHR 1.82, 95% CI = 1.60, 2.06, *P* < 0.05), Both, and (AHR = 1.53, 95% CI = 1.34, 1.74, *P* < 0.001)) for women.	Low risk of bias
Yokomichi et al 2018[36]	Japan	Prospective cohort	16 697	Earthquake	50.8	Children	6 months	3 months–42 months	BMI	Body weight increased significantly for both boys and girls.	Increased sedentary lifestyle (*P* value < 0.001), and age of 42 months were significant for both boys and girls (*P* < 0.001).	Low risk of bias
Takahashi et al 2021[46]	Japan	Longitudinal study	9909	Earthquake and tsunami	38.9	Adults	4 years	61.0 years	BMI	Body weight significantly increased for both temporary housing and NTH (non-temporary housing) men between 2011 and 2012.	Living conditions and survey year were significant for both sexes (F = 6.958; *P* < 0.001), while the time of survey was significant only for women (F = 19.127; *P* < 0.001).	Low risk of bias
Uemura et al 2022[47]	Japan	Cohort	19 673	Earthquake	43.9	Adults	1.4 years	40- > 75 years	Waist circumference and BMI	Evacuees' obesity increased from 37.0% to 42.1% and overweight increased from 31.9% to 39.6%. Non-evacuees' obesity changed from 32.8% to 43.0% and overweight changed from 27.9% to 30.3%. Overall, the average BMI remained relatively stable at 23.5 to 23.8 kg/m[2] before and after the disasters.	Smoking cessation (OR 4.08; 95% CI, 3.00–5.55), snacking after dinner (OR 1.33; 95% CI, 1.03–1.72), non-breakfast skipping (OR 1.48; 95% CI, 1.02–2.14), and alcohol drinking (OR 1.21; 95% CI, 1.02–1.44) significantly increased after the disaster.	Low risk of bias
Dancause et al 2015[37]	USA	Cohort	106	Flooding	55.6	Children	2.5–4 years	Age range 2.5 to 4 years	BMI z score	Both adiposity and BMI increase significantly from 2011 to 2015 after natural disaster.	High maternal BMI (*P* = 0.01), early exposure to floods (*P* = 0.03), both objective hardship and subjective maternal stress (*P* = 0.03 and *P* = 0.04), and maternal generalized depression (*P* = 0.04).	Low risk of bias

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Table 1. (*Continued*)

Name of author, publication year and reference	Country	Study design	Sample size	Type of disasters	% of Male	Study groups	Average study follow-up duration	Age	Measurements	Prevalence	Risk factors	JBS
Ono et al 2018[40]	Japan	Cohort	21 657	Earthquake	50.8	Children	2 years	18 months - to 4 years	BMI SDS	The prevalence of overweight or obesity significantly increased among children exposed to the earthquake.	Boys were more likely to develop overweight compared to girls. Living in a coastal region was more of a risk for overweight than living on an island.	Low risk of bias
Takahashi 2016[48]	Japan	Cohort	6601	Earthquake and tsunami	37.9	Adults	4 years	62.3 years	BMI	There is a significant increase in body weight between the temporary houses and non-temporary houses groups in both sexes after a natural disaster, with an increment of +0.53kg ($P < 0.001$) for males and 0.56kg ($P < 0.001$) for females.	Significant factors for males were living conditions ($P < 0.001$), age ($P = 0.021$), HbA1c (P value = 0.007), and quitting smoking ($P = 0.010$). For females, the significant factors for weight change were living conditions ($P < 0.001$), SBP ($P < 0.001$), HDLC ($P = 0.013$), and quitting smoking ($P = 0.035$).	Low risk of bias
Zheng et al 2017[41]	Japan	Cohort	8601	Earthquake	51.9	Children	6 years	4 to 5 years old	BMI	The prevalence of overweight for those who experienced a disaster was 30.0%, with an increment of 4.7% for exposed groups.	Those whose houses collapsed during the disaster and those who experienced a tsunami were significantly overweight or obese compared to their counterparts ($P < 0.05$ and $P < 0.05$, respectively).	Low risk of bias
Arlinghaus et al 2023[49]	USA	Cohort	175	Hurricane	49.0	Adolescents	15 weeks	14.6 years	BMI z score	The prevalence of overweight and obesity for overall impacted Hurricane were 44% and 53% respectively. While overall overweight or obesity were 55%.	The effects of hurricanes on interaction time were significant (F (1171) = 2.85, ($P < 0.05$)). At 8- and 15-weeks post-Hurricane, there was a significant decrease in BMI z score for students who were highly impacted by the Hurricane compared to those who were less impacted (95% CI 0.001 to 0.06, $P < 0.05$), (95% CI 0.02 to 0.25, $P < 0.05$) respectively.	Low risk of bias

(*Continued*)

Table 1. (*Continued*)

Name of author, publication year and reference	Country	Study design	Sample size	Type of disasters	% of Male	Study groups	Average study follow-up duration	Age	Measurements	Prevalence	Risk factors	JBS
Kuniyoshi et al 2019[50]	Japan	Retrospectives cohort	15 563	Earthquake	51.0	Children	3 years	3-years	BMI	The prevalence of overweight for those breastfeeding was 41.0% for the 18–24 month period, while for the 28–42 month period it was 40.0%, and for the 28–42 month period it was 30.0%.	Mixed feeding (breastfed and formula-fed) was found to have a statistically significant association with obesity/overweight (OR 1.6, CI: 1.20–2.22; $P < 0.047$).	Low risk of bias
Kikuya et al 2017[35]	Japan	Cohort	93 538	Earthquake	54.1	Children	1.5 year	3.5–5.5 years	BMI	The rate of overweight/ obesity was 1.25 times higher than before the disaster occurred.	Experiencing a severe disaster ($P = 0.013$), a collapsed house ($P = 0.001$), a tsunami ($P = 0.001$), and moving from a house ($P = 0.001$) were statistically significant factors contributing to obesity or overweight after a disaster.	Low risk of bias
Isojima et al 2017[39]	Japan	Cohort	4359	Earthquake and tsunami	54.1	Children	1.5 years	47–59 months	BMI SDS	There was a statistically significant increment in BMI SDS when comparing the historical group and exposure group. In the exposure group, there were differences of 0.092 (95% CI: 0.031–0.15, $P = 0.0032$) in M5, 0.088 (95% CI: 0.029–0.15, $P = 0.0033$) in M7 and 0.14 (95% CI: 0.074–0.20, $P < 0.0001$) in M8.	Being boy was significantly affected comparing to girls. Living near nuclear power plant was also more likely to develop obesity comparing those who are far from the NPP during disaster.	Low risk of bias
Moriyama et al 2018[42]	Japan	Cohort	526	Earthquake	47.9	Children	3 years	6–12 years	BMI z score	The prevalence of obesity in temporary and contemporary houses increased from 5.3% to 7.8% and from 7.6% to 7.8%, respectively, from 2010 to 2013.	Changing dietary habits ($P < 0.001$), frequent snacking ($P < 0.001$), walking to and from school ($P = 0.01$), amount of sleep on different days of the week/hour ($P = 0.01$), time spent watching TV ($P = 0.04$), and time spent reading comic books ($P = 0.001$) were statistically significant.	Low risk of bias

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Table 1. (*Continued*)

Name of author, publication year and reference	Country	Study design	Sample size	Type of disasters	% of Male	Study groups	Average study follow-up duration	Age	Measurements	Prevalence	Risk factors	JBS
Kroska et al 2018[34]	USA	Longitudinal	103	Flooding	54.4	Children	1 year	30 months	BMI	The mean weight increased 16.24+/-(1.32)	low social supported mother (*P* = 0.032), and maternal subjective stress (*P* = 0.024) were statistically significant to predict high BMI baby.	Low risk of bias
Hikichi et al 2019[44]	Japan	Prospective cohort	3567	Earthquake and Tsunami	43.5	Adults	2.5 years	65 years	BMI	Comparing displaced and non-displaced individuals, obesity increased sharply from 25.0% to 35.1%. For non-displaced individuals, obesity decreased slightly from 26.9% to 26.6% before and after the disaster, respectively.	A shorter distance to a food outlet or bar was found to be associated with an increased BMI from normal to overweight (≥ 25.0 kg/m2), with an OR of 1.43. Similarly, the presence of supermarkets was associated with a 1.46 times higher likelihood of developing obesity.	Low risk of bias
Liu et al 2016[43]	Canada	Longitudinal	386	Ice storm	52.8	Children	5.5–15.5 years	3 months to 18 years	BMI and waist circumference	During an ice storm, anthropometric measurements tend to show an increase in body weight among children of different age groups, including 5½ years, 8½ years, 13½ years, and 15½ years.	The interaction of the child's age, subjective hardship, objective hardship, and waist-to-height ratio was statistically significant (*P* = 0.048).	Low risk of bias
Dancause et al 2012[38]	Canada	Cohort	111	Storm	50.5	Children	At 5.5 year	5.5 years	BMI	The prevalence of obese children was 8.1% among participants.	Shorter maternal height was predictive of childhood obesity (*P* = 0.03, OR = 0.79). A greater number of maternal life events and increased obesity risk (*P* = 0.06, OR = 1.26). Higher maternal BMI predicted childhood obesity (*P* = 0.03, OR = 1.47). Higher SES and obesity risk (*P* = 0.07, OR = 0.81). Not breastfeeding children was (*P* = 0.07, OR = 0.02)	Low risk of bias

AHR, Adjusted Hazard Ratio; BMI, Body Mass Index; BMI SDS, Body Mass Index Standard Deviation Scores; CI, Confidence Interval; HDLC, high-density lipoprotein cholesterol; HbA1c, hemoglobin A1c or glycosylated hemoglobin; M5, Measurement 5; OR, Odd Ratio; PNMS, Postnatal Maternal Stress; SES, Socioeconomic Status; SBP, Systolic Blood Pressure.

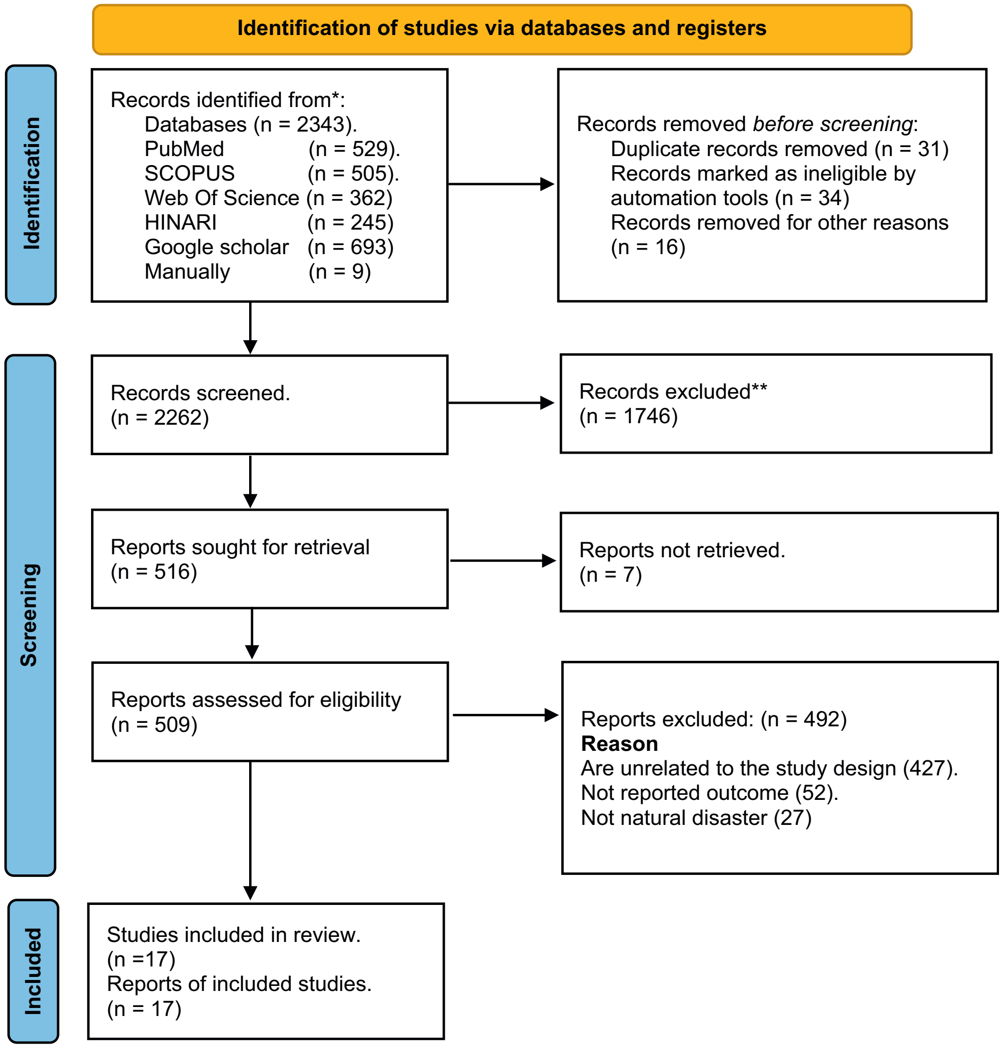

Figure 1. PRISMA flow diagram for the search result of included studies.

unhealthy lifestyle behaviors, and factors related to location and displacement. This approach thoroughly analyzed the impact of natural disasters on overweight and obesity in people of all age groups as shown in Table 1.

Sociodemographic and socioeconomic factors

It was found that age and sex were significant risk factors for development of overweight or obesity after natural disasters. One study evaluated that being male and being older increased the likelihood of developing obesity.[46] Similarly, 2 studies showed a significant relation between childhood age and obesity after occurrence of natural disasters.[36,43] Furthermore, 1 study evaluated that being a boy increased the probability of becoming obese.[44] However, 3 studies revealed that both sexes are at risk for obesity after natural disasters.[36,47,48] As a determinant of health, SES is one of the important risk factors for health. High SES households were more likely to develop overweight or obesity in the aftermath of natural disasters.[34]

Access to unhealthy food and sedentary behavior

This systematic review examined the relationship between obesity and post-natural disaster risk factors. It is commonly observed that significant changes in lifestyles and eating habits occur following natural disasters. A study conducted on children showed that physical inactivity is a potential risk factor for obesity.[36] Similarly, another study identified sedentary activities, such as prolonged comic book reading, altered walking habits to and from school, and excessive film watching as risk factors for obesity after disasters.[42] Additionally, frequent snacking was found to contribute to this phenomenon.[42] Consuming snacks after dinner and not skipping breakfast were significant risk factors for being overweight or obese after natural disasters.[47] Furthermore, living in close proximity to supermarkets, food establishments, or bars was associated with an increased likelihood of obesity.[48]

Maternal nutritional status and child feeding

The nutritional status of the mother and feeding practices for the child have a significant impact on the child's nutritional status and overall well-being. They can also enhance Intelligence Quotient (IQ), school performance, and even result in higher income in adulthood.[53] Three studies have found a significant association between high maternal BMI and increased risk of childhood obesity after natural disasters.[34,37,38] One of the studies specifically indicated that maternal height could potentially serve as a risk factor for overweight and obesity following natural disasters.[37] Another study found that the lack of breastfeeding was associated with an increased risk of obesity.[37] Additionally, a study reported that mixed feeding was also linked to obesity outcomes after natural disasters.[50]

Maternal psychological factors

Two studies were conducted to investigate the link between the objective hardship stress experienced by mothers and the increased risk of childhood overweight or obesity.[38,43] Additionally, 3 studies examined maternal subjective hardship stress.[34,38,43] Moreover, 1 study indicated that maternal generalized stress was a contributing factor to obesity.[38] Previous maternal exposure to natural disasters, specifically floods[36] and tsunamis,[41] was also identified as a general risk factor.[35,37] Furthermore, a study highlighted that insufficient social support during natural disasters could potentially contribute to childhood overweight and obesity.[34]

Unhealthy behavioral lifestyle

Healthy behaviors are actions taken to promote and maintain good health, while unhealthy behaviors are actions that harm health.[54] A recent systematic review identified a study that reported a significant association between alcohol consumption before and after natural disasters and obesity.[47] Similarly, 2 studies found that quitting smoking was statistically linked to increased obesity following natural disasters.[47,48]

Location and displacement related factors

Three studies found a link between individuals whose homes collapsed and a higher prevalence of obesity or being overweight.[35,37,41] Researchers identified that living near coastal areas and proximity to nuclear power plants were associated with an increased likelihood of being overweight or obese.[40] Evacuees or displaced people were more prone to developing obesity compared to non-evacuees, according to 3 studies.[35,45,47] Non-displacement was negatively associated with obesity, and obesity was decreased from 26.9% to 26.6%.[44] Regardless of whether individuals were living in temporary or permanent settlements, there was a risk of being overweight or obese, according to 3 studies.[46–48] A study with similar findings demonstrated that individuals living in temporary housing tended to gain weight, regardless of their sex or previous BMI.[48] Moreover, the duration of residing in temporary housing versus permanent housing had a significant impact on body weight gain for both sexes following natural disasters, according to 2 studies.[46,48]

Discussion

This is the first comprehensive review to examine the relationship between obesity and natural disasters. Its primary objective was to synthesize overweight or obesity and report it, while the secondary objective was to identify factors influencing this link, which is crucial for developing strategies to reduce obesity after natural disasters. In total, 17 studies involving 229 058 participants were included in the review. All eligible studies reported significant increases in overweight or obesity prevalence following natural disasters in both children and adults. The determinant factors were grouped into several categories, including sociodemographic and SES factors, access to unhealthy food, sedentary behavior, maternal nutrition-related issues, child feeding practices, maternal psychological factors, unhealthy lifestyle behaviors, and location- or displacement-related issues. These findings highlight the complex interplay between disaster-induced factors and their impact on health, like overweight or obesity.

Children are particularly vulnerable during and after natural disasters, which can increase the risk of developing overweight or obesity. Eleven studies have reported an increase in overweight or obesity among children following natural disasters.[34–44] In contrast, 2 studies have found that children experience undernutrition in the aftermath of such events.[55,56] Similarly, research conducted in Haiti and China has observed cases of undernutrition across various childhood age groups.[57,58] The possible reasons for this discrepancy may be studies in Haiti and other low-income countries have reported that limited access to nutritious foods, clean water, and sanitation contributes to undernutrition.[59–61] Additionally, increased episodes of diarrhea due to bottle feeding contribute to decreased BMI.[62] A disrupted food supply chain caused by damaged transportation routes is another cause of undernutrition.[63] Conversely, overweight and obesity are due to natural disasters disrupting normal lifestyles[16,19,34–41,43–48,64] and physical inactivity.[65] Moreover, a study explained that one of the main reasons for the increase in obesity among children following natural disasters is that parents restrict outdoor play due to fear of environmental hazards.[66]

The current systematic review identified age and sex as risk factors for overweight or obesity. Two studies highlighted age and sex,[36,43] whereas, 1 study focused on male sex alone.[36] Across age groups, overweight or obesity are not evenly distributed. BMI of children aged 42 months or above is higher than that of children younger than 42 months.[36,43] The possible reasons may be parents restricting outdoor activities and reducing the opportunity to exercise because of possible hazards.[66,67] At this age, children who were more active may experience higher levels of stress due to parents' restrictions, leading to sleeplessness and preventing them from engaging in outdoor activities and exercise, resulting in an increased risk of overweight and obesity after natural disasters. Additionally, the fear of environmental hazards and the possibility of future disasters can further exacerbate these issues, as parents may continue to restrict their children's outdoor activities.

Another important determinant was sedentary behavior that increases the risk of all causes of morbidity and mortality, including overweight or obesity. A sedentary behavior refers to sitting, reclining, or lying down with an energy expenditure of less than 1.5 metabolic equivalents (METs).[68] Sedentary behavior can occur in educational settings, at home, and during travel.[69] Two studies found that increased access to technology leads to prolonged sitting time,[70,71] which, along with extended TV watching, contributes to excessive weight gain.[70,72] Disruption of infrastructure due to natural disasters also is a risk factor for weight gain.[73] Adopting a healthy lifestyle, including a balanced diet, regular exercise, and minimising risk factors, remains the most commonly effective strategy for preventing obesity.[74] Notably, physical exercise accounts for 20-30% of daily energy expenditure.[70,72] This indicates that sedentary behavior is a key risk factor for obesity, especially when combined with reduced physical activity opportunities and parental restrictions on outdoor activities, which significantly diminish exercise opportunities.[67,69,75]

SES is another significant risk factor for overweight and obesity in the aftermath of natural disasters. A previous study found that high SES is associated with weight gain.[34] Conversely, 2 studies reported that low SES also contributes to weight gain.[76,77] The possible reasons for an increase in weight gain among low-income individuals including the tendency to choose cheaper, unhealthy foods, increased stress leading to poor dietary habits, and stress-related eating behaviors, or emotional eating disorders during natural disasters.[76,77]

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Maternal factors, such as anthropometric indices, play a role in childhood obesity caused by natural disasters. High maternal BMI before[34,37,38] and during pregnancy,[70,78] maternal smoking during pregnancy,[79] caesarean section,[70,80] gestational diabetes,[78] and short maternal stature are associated with an increased risk of childhood obesity.[37] The possible reasons for childhood obesity may be intergenerational in nature, and hormonal imbalance, such as adrenocorticotropic hormone, corticosterone, and catecholamines triggered by disasters, affects appetite and contributes to offspring overweight or obesity.[29]

Breastfeeding is one of the most effective ways of ensuring health and survival. Breastfeeding provides several benefits for children, such as providing energy and nutrients, improving intelligence, and being less prone to diabetes, overweight or obesity. Available evidence suggests that exclusive breastfeeding enhances infant and child health and reduces morbidity and mortality.[81,82] Another similar study identified that exclusive breastfeeding promotes optimal weight gain and protects against overweight or obesity.[83] Conversely, not breastfeeding[37] or shorter periods of breastfeeding with mixed feeding,[50] can lead to overweight or obesity. A previous systematic review and meta-analysis found that breastfeeding decreases the risk of becoming overweight.[84] Furthermore, a comparative study revealed that infants who receive expressed breast milk have a higher risk of obesity than those who are directly breastfed, emphasizing the importance of direct breastfeeding.[85] Despite the presence of microbiota in human milk either expressed or direct breastfed, and other factors that help maintain a healthy immune balance, exerting an obesity prevention effect found in the digestive tract of breastmilkfed children.[86,87] A possible reason for expressed breast milk being linked to obesity may be due to potential overfeeding of a child when caregivers may encourage excessive bottle feeding when the mother is unavailable, which can lead to mixed feeding. Furthermore, the nutritional degradation that occurs during storage might reduce some of the health benefits, potentially influencing infants' overweight or obesity after natural dissters.

Moreover, maternal psychological issues during or following a natural disaster also significantly influence childhood obesity. Factors such as subjective hardship stress,[34,38,43] stress resulting from both subjective and objective hardship stress,[38,43] general stress,[38] negative experiences during flood events,[36] negative tsunami experiences,[41] severe experiences of natural disasters,[35] exposure to multiple stressful events,[37] and lack of social support[34] contribute to overweight and obesity following natural disasters. Our findings are consistent with a previous study which revealed that prenatal maternal stress contributed to childhood overweight or obesity.[88] In addition, increased activity of serotonergic neurons and levels of tryptophan for adults contribute to excessive consumption of carbohydrate-rich, low-protein meals, resulting in weight gain.[89] It's very important to focus on preventing childhood obesity by improving maternal health, early healthy eating behaviors, physical activity according to WHO recommendations, adequate sleep, and decreasing screen time for all children under 5.

Interestingly, adolescents and adults are also not immune to the effects of overweight or obesity following the occurrence of natural disasters. Six of the included studies reported that they developed overweight or obesity due to sedentary behavior, and sociodemographic, socioeconomic, psychological, and behavioral factors.[44–49]

As age increases, the probability of becoming obese also increases. Two of the included studies found that male sex and age > 57 years were key determinants of overweight or obesity.[43,46] There are several possible explanations for this trend. As people age, hormonal changes, such as the decline of growth and leptin hormones, lead to metabolic slowdown.[90,91] Additionally, sensory perception of taste and smell can decline and lead to loss of appetite and choosing inadequate nutritious foods.[92,93] Increased physical inactivity is also related to age,[65] and reduced social activities can lead to increased depressive symptoms and affect appetite.[94] In addition, both subjective and objective causes of stress can lead to emotional eating of unhealthy foods.[95] Furthermore, natural disasters can limit access and affordability of fresh foods, resulting in a diet high in sugar and calories, ultimately exacerbating the risk of obesity.[63,96–98]

The study also underscores SES as a risk factor for overweight and obesity following natural disasters. Specifically, individuals with high SES are more likely to experience weight gain during disasters.[34] However, current evidence has identified that the burden of SES is shifting from high to low-income individuals, and rural residents instead of urban residents.[99,100] Another study stated that the prevalence of obesity is higher among individuals with the lowest SES compared with their higher SES counterparts.[101] Similarly, 2 studies found that individuals with low SES are at greater risk of overweight or obesity.[102,103] During disaster, households with low SES often choose cheaper, unhealthy foods over expensive and nutritious alternatives.[76] The possible reason for developing low SES-based obesity may be the financial constraint on access to health facilities, contributing to the obesity epidemic among vulnerable populations.[104] The reliance of unhealthy foods such as high-energy processed and saturated fats may contribute to overweight and obesity during disasters. Although both the high and low SES groups are at risk of developing overweight or obesity, individuals with low SES face a greater risk because of limited access to healthy foods.

Additionally, physical activity plays a crucial role in maintaining a healthy weight and lifestyle. The WHO defines physical activity as any movement driven by skeletal muscles that requires energy expenditure. Activities performed for recreation, transportation, or work can range from light to intense exercise, all of which contribute to better health.[105] Natural disasters are inversely correlated with normal lifestyles, and enhance sedentary lifestyle, ease of access to unhealthy food, and development of unhealthy behaviors. Evidence has shown that access to technology leads to prolonged sitting time and enhances excessive weight gain.[70,71] Improving healthy lifestyle habits, such as consuming a nutritious diet and engaging in regular exercise which accounts for 20-30% of daily energy expenditure, plays a significant role in reducing overweight and obesity, both under normal conditions and during natural disasters.[70,72,74]

While breakfast consumption can support weight management, poor food choices or excessive calorie intake can contribute to weight gain. Moreover, abstaining from skipping breakfast has been identified as a risk factor for weight gain.[47] In contrast, 2 separate studies conducted on preschoolers and adolescents have indicated that skipping breakfast is associated with increased abdominal adiposity.[106,107] The plausible mechanism underlying this finding could be attributed to energy depletion, which prompts the utilization of stored fat and subsequently results in weight loss. However, the possible explanations for weight gain may include unhealthy breakfast choices, increased overall caloric intake, false sense of nutritional balance, and disrupted hunger cues.

Maternal psychology during and after natural disasters as mentioned above[34–38,41,43] is associated unhealthy maternal weight gain.

This finding is consistent with previous research, which revealed that maternal stress contributes to increased abdominal adiposity.[108] The possible explanation is that stress can lead to emotional eating, characterized by consumption of high-energy foods, as well as prolonged sedentary behavior after natural disaster. Hormonal imbalance during stress increases activity of serotonergic neurons and elevated tryptophan levels, which may contribute to excessive consumption of carbohydrate-rich, low-protein meals, resulting in weight gain.[89]

According to the WHO, quitting smoking has immediate and long-term benefits, including increasing life expectancy and preventing various health issues, such as impotence, premature birth, low birth weight (LBW) babies, asthma, and ear infections, active smokers and second-hand or passive smokers.[109] One study found a link between disasters, smoking cessation, and abdominal obesity.[47] A similar study identified quitting smoking as a risk factor for obesity.[110] Another study reported weight gain after quitting smoking.[111] Conversely, 3 studies have shown that quitting smoking before or after a disaster reduced weight.[112–114] Similarly, 1 study aligns with this, as nonsmokers were less likely to be obese compared to with smokers.[115] The possible reason for increasing weight after quitting smoking post-disaster include nicotine withdrawal, which contributes to increased food consumption and decreased energy expenditure, potentially increasing the risk of obesity.[116] Other reasons for quitting smoking include concerns about family members' health, lack of designated smoking areas, and overall health concerns. Overall, smoking poses significant risks to respiratory health, decreases lung function, intensifies asthma, causes chronic obstructive pulmonary disease, and contributes to cardiovascular problems. Quitting smoking can help prevent all these issues, including financial-related issues.

According to the WHO, alcohol is a toxic and psychoactive substance that causes dependency and contributes to 3 million deaths globally each year, as well as disabilities and poor health for millions of people. It is also a leading risk factor of premature mortality.[117] This study found that alcohol consumption was a risk factor for overweight and obesity during and after natural disasters.[47] A previous study found that alcohol consumption is associated with increased total energy intake and excessive weight gain.[118] Similarly, a systematic review and meta-analysis showed that alcohol consumption causes abdominal obesity in men.[119] It is reasonable to assume that alcohol consumption exceeds the daily required energy, and the body converts it into fat, resulting in overweight and obesity, which worsen during and after disasters when people are inactive in that setting and/or physically inactive after consuming alcohol.

Obesity is the result of a mix of biological, environmental, and behavioral influences, including excessive energy intake and insufficient energy expenditure.[120,121] Notably, individuals displaced by natural disasters are at a higher risk for developing obesity, particularly in temporary housing situations where access to healthy food is often limited.[35,45] Likewise, 2 additional studies showed that residing in temporary housing is associated with a higher likelihood of being overweight or obese.[47,48] After natural disasters, most public and private facilities were either completely or partially destroyed, leading to a sedentary lifestyle for the entire community.[122] Additionally, there is an increase in the consumption of high-energy foods, resulting in an excess energy consumption. Another significant risk factor for obesity was living in coastal areas.[40] One possible reason is that people have easy access to seafood, as well as food distribution during disasters. Coastal residents have numerous options to obtain unhealthy foods which are processed foods because of fear of contaminated seafood after disasters, as disasters are less likely to disrupt the transportation compared to other areas. Similarly, the other possible reasons for overweight and obesity after natural disasters may be limited access to healthy foods and physical inactivates.[75] Moreover, low SES leads to limited access to health facilities.[77]

Conclusion

The conclusion of this paper highlights that natural disasters significantly contribute to increased rates of overweight or obesity in both children and adults. The review synthesizes evidence from 17 studies, showing that disaster-related factors such as socioeconomic conditions, limited access to healthy food, increased sedentary behavior, maternal health, psychological stress, and lifestyle changes play key roles in exacerbating obesity risk. Vulnerable populations, including children, low-income individuals, and those displaced by disasters, are particularly affected.

To mitigate the impact of natural disasters on obesity, a comprehensive approach is needed, focusing on promoting healthy lifestyles, improving access to nutritious food, encouraging physical activity, and addressing stress-related behaviors. Special attention should be given to high-risk groups such as children and those of lower SES. Ultimately, targeted strategies are crucial to reducing the long-term health consequences of natural disasters and preventing the growing epidemic of obesity in disaster affected populations. Promoting community gathering initiatives to empower informed food choices and stress management are important to prevent overweight or obesity.

Strengths and Limitations

This study is the first review ever done on the topic of overweight and obesity after natural disasters and their related risk factors. With climate change, more natural disasters are happening around the world, and this issue is a big problem globally. This research gives us valuable insights about disasters' effect on obesity and their risk factors in the aftermath of disasters. Despite its strengths, the paper has several limitations. Firstly, the quality of the included studies varies, which may affect the reliability of the findings. Secondly, the lack of standardized definitions for obesity and related factors across studies complicates data comparisons. Thirdly, the geographical context of the studies may limit the generalizability of the findings, as many focus on specific regions. Most of the studies we looked at are from a few specific countries. Fourthly, this systematic review did not include all types of disasters, like biological disasters. Finally, we only considered papers written in English for this study, which is more likely to have a risk of publication bias.

Study Implications

To our knowledge, this systematic review is the first to examine the link between post-natural disasters and obesity. The findings of the study suggest that there is a limited understanding of obesity following natural disasters. Obesity is a complex issue that contributes to chronic diseases, highlighting the need to address the factors that contribute to obesity after natural disasters to implement effective prevention and control strategies.

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Data availability statement. The data for this systematic review is available in this research paper and the authors' records.

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Author contribution. The authors have been involved in every stage of the study. TY and KHA were responsible for planning, conducting literature searches, performing critical appraisal and quality assessments, and data extraction. TY drafted the manuscript, KHA reviewed and revised it, and finally proofread it. Then, both authors approved the final version for publication.

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References

1. Definition: Disaster. *UNDRR*. Accessed September 2024. https://www.undrr.org/terminology/disaster
2. Health Emergency and Disaster Risk Management Framework. *World Health Organization.* Published 2019. Accessed September 8, 2024. https://iris.who.int/bitstream/handle/10665/326106/9789241516181-eng.pdf?sequence=1
3. **Martin ML**. Child participation in disaster risk reduction: The case of flood-affected children in Bangladesh. *Third World Q*. 2010;**31**(8): 1357–1375. doi:10.1080/01436597.2010.541086
4. **Kreimer A.** Social and economic impacts of natural disasters. *Int Geol Rev*. 2001;**43**(5):401–405. doi:10.1080/00206810109465021
5. **Qasim A**, **Turcotte M**, **De Souza R**, et al. On the origin of obesity: identifying the biological, environmental and cultural drivers of genetic risk among human populations. *Obes Rev*. 2018;**19**(2):121–149. doi: 10.1111/obr.12625
6. **Jia P**, **Cheng X**, **Xue H**, et al. Applications of geographic information systems (GIS) data and methods in obesity-related research. *Obes Rev*. 2017;**18**(4):400–411. doi:10.1111/obr.12495
7. Obesity and overweight. In: Fact sheet no 311 January 2015. *World Health Organization*. Published 2015. Accessed September 13, 2024. https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight
8. Obesity and overweight. *World Health Organization.* Published 2021. Accessed October 14, 2024. https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight
9. **Llewellyn A**, **Simmonds M**, **Owen CG**, et al. Childhood obesity as a predictor of morbidity in adulthood: a systematic review and meta-analysis. *Obes Rev*. 2016;**17**(1):56–67. doi:10.1111/obr.12316
10. Disasters and emergencies. *World Health Organization.* Published 2023. Accessed September 15, 2024. https://www.who.int/teams/integrated-health-services/clinical-services-and-systems/surgical-care/disasters-and-emergencies
11. **Reilly JJ**, **Kelly J.** Long-term impact of overweight and obesity in childhood and adolescence on morbidity and premature mortality in adulthood: systematic review. *Int J Obes.* 2011;**35**(7):891–898. doi:10.1038/ijo.2010.222
12. **Okunogbe A**, **Nugent R**, **Spencer G**, et al. Economic impacts of overweight and obesity: current and future estimates for 161 countries. *BMJ Glob Health*. 2022;**7**(9):e009773. doi:10.1136/bmjgh-2022-009773
13. **Moynihan AB**, **Tilburg WAv**, **Igou ER**, et al. Eaten up by boredom: consuming food to escape awareness of the bored self. *Front Psychol.* 2015;**6**:369. doi:10.3389/fpsyg.2015.00369
14. Global health risks: mortality and burden of disease attributable to selected major risks. *World Health Organization.* Published 2009. Accessed September 16, 2024. https://iris.who.int/bitstream/handle/10665/44203/9789241563871_eng.pdf?sequence=1
15. **Powell T**, **Wegmann KM**, **Backode E.** Coping and post-traumatic stress in children and adolescents after an acute onset disaster: a systematic review. *Int J Environ Res Public Health.* 2021;**18**(9). doi:10.3390/ijerph18094865
16. **Lai BS**, **La Greca AM**, **Colgan CA**, et al. Sleep problems and posttraumatic stress: children exposed to a natural disaster. *J Pediatr Psychol.* 2020;**45**(9): 1016–1026. doi:10.1093/jpepsy/jsaa061
17. **Schulz LC**. The Dutch Hunger Winter and the developmental origins of health and disease. *.Proc Natl Acad Sci U S A* 2010;**107**(39):16757–16758. doi:10.1073/pnas.1012911107
18. **Hohwü L**, **Li J**, **Olsen J**, et al. Severe maternal stress exposure due to bereavement before, during and after pregnancy and risk of overweight and obesity in young adult men: a Danish national cohort study. *PLoS One.* 2014;**9**(5):e97490. doi:10.1371/journal.pone.0097490
19. **Codjoe SN**, **Gough KV**, **Wilby RL**, et al. Impact of extreme weather conditions on healthcare provision in urban Ghana. *Soc Sci Med.* 2020; **258**:113072. doi:10.1016/j.socscimed.2020.113072
20. **Hasegawa M**, **Murakami M**, **Nomura S**, et al. Worsening Health status among evacuees: analysis of medical expenditures after the 2011 great East Japan earthquake and nuclear disaster in Fukushima. *Tohoku J Exp Med.* 2019;**248**(2):115–123. doi:10.1620/tjem.248.115
21. **Giri S**, **Risnes K**, **Uleberg O**, et al. Impact of 2015 earthquakes on a local hospital in Nepal: a prospective hospital-based study. *PloS One.* 2018; **13**(2):e0192076. doi:10.1371/journal.pone.0192076
22. **McIntyre T**, **Hughes CD**, **Pauyo T**, et al. Emergency surgical care delivery in post-earthquake Haiti: Partners in health and Zanmi Lasante experience. *World J Surg.* 2011;**35**:745–750. doi:10.1007/s00268-011-0961-6
23. School Policy Framework Implementation of the WHO Global Strategy on Diet, Physical Activity and Health. *World Health Organization.* Published 2008. Accessed 16, 2024. https://www.who.int/publications/i/item/9789241596862
24. Global Strategy on Diet, Physical Activity and Health. *World Health Organization.* Published 2004. Accessed September 9, 2024. https://iris.who.int/bitstream/handle/10665/43035/9241592222_eng.pdf?sequence=1
25. A Guide for Population-Based Approaches to increasing Levels Of Physical Activity: Implementation of the WHO Global Strategy on diet, Physical Activity and Health. *World Health Organization.* Published 2007. Accessed September 13, 2024. https://iris.who.int/bitstream/handle/10665/43612/9789241595179_eng.pdf?sequence=1
26. Global Action Plan on Physical Activity 2018-2030: More Active People for a Healthier World. *World Health Organization.* Published 2019. Accessed September 9, 2024. https://www.who.int/publications/i/item/9789241514187
27. Sendai Framework for Disaster Risk Reduction 2015 - 2030. *UNDRR.* Published 2015. Accessed October 12, 2024. https://www.undrr.org/media/16176/download?startDownload=20241005
28. **Prentice AM**, **Jebb SA**. Obesity in Britain: gluttony or sloth? *BMJ.* 1995; **311**(7002):437–439. doi:10.1136/bmj.311.7002.437
29. **Dong Z**, **Wu L**, **Chen Y**, et al. Intergenerational transmission of obesity: role of education and income. *Int J Environ Res Public Health.* 2022;**19**(23). doi:10.3390/ijerph192315931
30. **Moher D**, **Liberati A**, **Tetzlaff J**, et al. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *PLoS Med.* 2009;**6**(7):e1000097. doi:10.1371/journal.pmed.1000097
31. Obesity and overweight. In: Fact sheet no 311 January 2015. *World Health Organization.* https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight
32. **Mason C**, **Katzmarzyk PT**. Variability in waist circumference measurements according to anatomic measurement site. *Obesity.* 2009;**17**(9): 1789–1795. doi:10.1038/oby.2009.87
33. **Moola S**, **Munn Z**, **Tufanaru C**, et al. Chapter 7: Systematic reviews of etiology and risk. *Joanna Briggs Institute reviewer's manual The Joanna Briggs Institute*. 2017;**5**:217–269.

34. **Kroska EB**, **O'Hara MW**, **Elgbeili G**, et al. The impact of maternal flood-related stress and social support on offspring weight in early childhood. *Arch Womens Ment Health.* 2018;**21**:225–233. doi:10.1007/s00737-017-0786-x
35. **Kikuya M**, **Matsubara H**, **Ishikuro M**, et al. Alterations in physique among young children after the great East Japan earthquake: Results from a nationwide survey. *J Epidemiol.* 2017;**27**(10):462–468. doi:10.1016/j.je.2016.09.012
36. **Yokomichi H**, **Matsubara H**, **Ishikuro M**, et al. Impact of the great East Japan earthquake on body mass index, weight, and height of infants and toddlers: an infant survey. *J Epidemiol.* 2018;**28**(5):237–244. doi:10.2188/jea.JE20170006
37. **Dancause KN**, **Laplante DP**, **Fraser S**, et al. Prenatal exposure to a natural disaster increases risk for obesity in 5½-year-old children. *Pediatr Res.* 2012;**71**(1):126–131. doi:10.1038/pr.2011.18
38. **Dancause KN**, **Laplante DP**, **Hart KJ**, et al. Prenatal stress due to a natural disaster predicts adiposity in childhood: the Iowa flood Study. *J Obes.* 2015; 2015:570541. doi:10.1155/2015/570541
39. **Isojima T**, **Yokoya S**, **Ono A**, et al. Prolonged elevated body mass index in preschool children after the great East Japan earthquake. *Pediatr Int.* 2017; **59**(9):1002–1009. doi:10.1111/ped.13340
40. **Ono A**, **Isojima T**, **Yokoya S**, et al. Effect of the Fukushima earthquake on weight in early childhood: a retrospective analysis. *BMJ Paediatr Open.* 2018;**2**(1). doi:10.1136/bmjpo-2017-000229
41. **Zheng W**, **Yokomichi H**, **Matsubara H**, et al. Longitudinal changes in body mass index of children affected by the great East Japan earthquake. *Int J Obes.* 2017;**41**(4):606–612. doi:10.1038/ijo.2017.6
42. **Moriyama H**, **Fuchimukai T**, **Kondo N**, et al. Obesity in elementary school children after the great East Japan earthquake. *Pediatr Int.* 2018; **60**(3):282–286. doi:10.1111/ped.13468
43. **Liu GT**, **Dancause KN**, **Elgbeili G**, et al. Disaster-related prenatal maternal stress explains increasing amounts of variance in body composition through childhood and adolescence: Project ice storm. *Environ Res.* 2016; **150**:1–7. doi:10.1016/j.envres.2016.04.039
44. **Hikichi H**, **Aida J**, **Kondo K**, et al. Residential relocation and obesity after a natural disaster: A natural experiment from the 2011 Japan earthquake and tsunami. *Sci Rep.* 2019;**9**(1):374. doi:10.1038/s41598-018-36906-y
45. **Ohira T**, **Hosoya M**, **Yasumura S**, et al. Effect of evacuation on body weight after the great East Japan earthquake. *Am J Prev Med.* 2016;**50**(5): 553–560. doi:10.1016/j.amepre.2015.10.008
46. **Takahashi S**, **Yonekura Y**, **Tanno K**, et al. Increase in body weight following residential displacement: 5-year follow-up after the 2011 great East Japan earthquake and tsunami. *J Epidemiol.* 2021;**31**(5):328–334. doi:10.2188/jea.JE20190333
47. **Uemura MY**, **Ohira T**, **Yasumura S**, et al. Association between lifestyle habits and the prevalence of abdominal obesity after the great East Japan earthquake: the Fukushima health management survey. *J Epidemiol.* 2022; **32**(11):496–501. doi:10.2188/jea.JE20200597
48. **Takahashi S**, **Yonekura Y**, **Sasaki R**, et al. Weight gain in survivors living in temporary housing in the tsunami-stricken area during the recovery phase following the great East Japan earthquake and tsunami. *PLoS One.* 2016;**11**(12):e0166817. doi:10.1371/journal.pone.0166817
49. **Arlinghaus KR**, **Gorniak SL**, **Hernandez DC**, et al. Impact of Hurricane Harvey on the growth of low income, ethnic minority adolescents. *Disaster Med Public Health Prep.* 2023;**17**:e9. doi:10.1017/dmp.2020.308
50. **Kuniyoshi Y**, **Kikuya M**, **Matsubara H**, et al. Association of feeding practice with childhood overweight and/or obesity in affected areas before and after the great East Japan earthquake. *Breastfeeding Med.* 2019;**14**(6): 382–389. doi:10.1089/bfm.2018.0254
51. Health Emergency and Disaster Risk Management Fact Sheets. *World Health Organization.* Published 2017. Accessed October 6, 2024. https://cdn.who.int/media/docs/default-source/disaster-mngmt/who-factsheet-overview-december2017.pdf?sfvrsn=de44c73a_1&download=true
52. Sendai framework for disaster risk reduction 2015–2030. *UNDRR.* Published 2015. Accessed September 9, 2024. https://www.undrr.org/media/16176/download?startDownload=20240909
53. **Victora CG**, **Bahl R**, **Barros AJ**, et al. Breastfeeding in the 21st century: epidemiology, mechanisms, and lifelong effect. *Lancet.* 2016;**387**(10017): 475–490. doi:10.1016/S0140-6736(15)01024-7
54. **Mokdad AH**, **Marks JS**, **Stroup DF**, et al. Actual causes of death in the United States, 2000. *JAMA.* 2004;**291**(10):1238–1245. doi:10.1001/jama.291.10.1238
55. **Zhao L**, **Yu D**, **Huang J**, et al. The nutrition status of special population living in the areas affected by Wenchuan earthquake after 3 months. *Zhonghua yu Fang yi xue za zhi* [Chinese Journal of Preventive Medicine]. 2010;**44**(8):701–705.
56. **Zhao X**, **Yin S**, **Zhao L**, et al. The nutritional status among children under 60 months year-old after one year of the earthquake in Wenchuan. *Zhonghua yu fang yi xue za zhi* [Chinese Journal of preventive medicine]. 2010;**44**(8):691–695.
57. **Ayoya MA**, **Heidkamp R**, **Ngnie–Teta I**, et al. Child malnutrition in Haiti: progress despite disasters. *Glob Health Sci Pract.* 2013;**1**(3):389–396. doi:10.9745/GHSP-D-13-00069
58. **Dong C**, **Ge P**, **Zhao X**, et al. Growth and anaemia among infants and young children for two years after the Wenchuan earthquake. *Asia Pac J Clin Nutr.* 2014;**23**(3):445–451.
59. **Gaire S**, **Delbiso TD**, **Pandey S**, et al. Impact of disasters on child stunting in Nepal. *Risk Manag and Healthc Policy*. 2016:113–127. doi:10.2147/RMHP.S101124
60. **Bustelo M**, **Arends-Kuenning M**, **Lucchetti L.** Persistent impact of natural disasters on child nutrition and schooling: Evidence from the 1999 Colombian earthquake. *Econstor*. Published 2012. Accessed 2024. https://www.econstor.eu/bitstream/10419/58554/1/715403001.pdf
61. **Del Ninno C**, **Dorosh PA**, **Smith LC**. Public policy, markets and household coping strategies in Bangladesh: Avoiding a food security crisis following the 1998 floods. *World Dev.* 2003;**31**(7):1221–1238. doi:10.1016/S0305-750X(03)00071-8
62. **Yokomichi H**, **Matsubara H**, **Ishikuro M**, et al. Impact of the great East Japan earthquake on body mass index, weight, and height of infants and toddlers: an infant survey. *J Epidemiol.* 2018;**28**(5):237–244. doi:10.2188/jea.JE20170006
63. **Shozugawa K**, **Nogawa N**, **Matsuo M.** Deposition of fission and activation products after the Fukushima Dai-ichi nuclear power plant accident. *Environ Pollut.* 2012;**163**:243–247. doi:10.1016/j.envpol.2012.01.001
64. **Arcaya M**, **James P**, **Rhodes JE**, et al. Urban sprawl and body mass index among displaced Hurricane Katrina survivors. *Prev Med.* 2014;**65**:40–46. doi:10.1016/j.ypmed.2014.04.006
65. **O'Brien M**, **Nader PR**, **Houts RM**, et al. The ecology of childhood overweight: a 12-year longitudinal analysis. *Int J Obes.* 2007;**31**(9): 1469–1478. doi:10.1038/sj.ijo.0803611
66. **McCurry J.** Fukushima residents still struggling 2 years after disaster. *Lancet.* 2013;**381**(9869):791–792. doi:10.1016/S0140-6736(13)60611-X
67. **Tremblay MS**, **LeBlanc AG**, **Carson V**, et al. Canadian physical activity guidelines for the early years (aged 0–4 years). *Appl Physiol Nutr Metab.* 2012;**37**(2):345–356. doi:10.1139/h2012-018
68. **Clemes SA**, **O'Connell SE**, **Edwardson CL**. Office workers' objectively measured sedentary behavior and physical activity during and outside working hours. *J Occup Environ Med.* 2014;**56**(3):298–303. doi:10.1097/jom.0000000000000101
69. WHO guidelines on physical activity and sedentary behaviour. *World Health Organization.* Published 2020. Accessed February 12, 2024. https://www.who.int/publications/i/item/9789240015128
70. **Kadouh HC**, **Acosta A.** Current paradigms in the etiology of obesity. *Tech Gastrointest Endosc.* 2017;**19**(1):2–11. doi:10.1016/j.tgie.2016.12.001
71. **Jakicic JM**, **Davis KK**. Obesity and physical activity. *Psychiatr Clin North Am.* 2011;**34**(4):829–840. doi:10.1016/j.psc.2011.08.009
72. **Segal KR**, **Lacayanga I**, **Dunaif A**, et al. Impact of body fat mass and percent fat on metabolic rate and thermogenesis in men. *Am J Physiol Endocrinol Metab.* 1989;**256**(5):E573–E579. doi:10.1152/ajpendo.1989.256.5.E573

73. **Tsuboyama-Kasaoka N**, **Hoshi Y**, **Onodera K**, et al. What factors were important for dietary improvement in emergency shelters after the great East Japan earthquake? *Asia Pac J Clin Nutr.* 2014;**23**(1):159–166. doi:10.6133/apjcn.2014.23.1.17
74. **Malekzadeh R**, **Mohamadnejad M**, **Merat S**, et al. Obesity pandemic: an Iranian perspective. *Arch Iran Med.* 2005;**8**(1):1–7.
75. **Scharadin B**, **Zanocco C**, **Chistolini J.** Food retail environments, extreme weather, and their overlap: Exploratory analysis and recommendations for US food policy. *PLoS One.* 2023;**18**(11):e0289282. doi:10.1371/journal.pone.0289282
76. **Ng DM**, **Jeffery RW**. Relationships between perceived stress and health behaviors in a sample of working adults. *Health Psychol.* 2003;**22**(6):638. doi:10.1037/0278-6133.22.6.638
77. **Gray L.** Social determinants of health, disaster vulnerability, severe and morbid obesity in adults: Triple jeopardy? *Int J Environ Res Public Health.* 2017;**14**(12):1452. doi:10.3390/ijerph14121452
78. **Baptiste-Roberts K**, **Nicholson WK**, **Wang N-Y**, et al. Gestational diabetes and subsequent growth patterns of offspring: the National Collaborative Perinatal Project. *Matern Child Health J.* 2012;**16**:125–132. doi:10.1007/s10995-011-0756-2
79. **Oken E**, **Levitan E**, **Gillman M.** Maternal smoking during pregnancy and child overweight: systematic review and meta-analysis. *Int J Obes.* 2008;**32**(2):201–210. doi:10.1038/sj.ijo.0803760
80. **Lifschitz C.** Early life factors influencing the risk of obesity. *Pediatr Gastroenterol Hepatol Nutr.* 2015;**18**(4):217–223. doi:10.5223/pghn.2015.18.4.217
81. **Lopez-Alarcon M**, **Villalpando S**, **Fajardo A.** Breast-feeding lowers the frequency and duration of acute respiratory infection and diarrhea in infants under six months of age. *J Nutr.* 1997;**127**(3):436–443. doi:10.1093/jn/127.3.436
82. **Perera B**, **Ganesan S**, **Jayarasa J**, et al. The impact of breastfeeding practices on respiratory and diarrhoeal disease in infancy: a study from Sri Lanka. *J Trop Pediatr.* 1999;**45**(2):115–118. doi:10.1093/tropej/45.2.115
83. **Owen CG**, **Martin RM**, **Whincup PH**, et al. Effect of infant feeding on the risk of obesity across the life course: a quantitative review of published evidence. *Pediatrics.* 2005;**115**(5):1367–1377. doi:10.1542/peds.2004-1176
84. **Horta BL**, **Rollins N**, **Dias MS**, et al. Systematic review and meta-analysis of breastfeeding and later overweight or obesity expands on previous study for World Health Organization. *Acta Paediatr.* 2023;**112**(1):34–41. doi:10.1111/apa.16460
85. **McCarthy C.** The real link between breastfeeding and preventing obesity. *Harvard Health Blog.* Published 2018. Accessed 2024. https://www.health.harvard.edu/blog/the-real-link-between-breastfeeding-and-preventing-obesity-2018101614998
86. **Enaud R**, **Prevel R**, **Ciarlo E**, et al. The gut-lung axis in health and respiratory diseases: a place for inter-organ and inter-kingdom crosstalks. *Front Cell Infect Microbiol.* 2020;**10**:9. doi:10.3389/fcimb.2020.00009
87. **Hufnagl K**, **Pali-Schöll I**, **Roth-Walter F**, et al. Dysbiosis of the gut and lung microbiome has a role in asthma. Semin Immunopathol. *Feb* 2020;**42**(1):75–93. doi:10.1007/s00281-019-00775-y
88. **Whitaker RC**, **Pepe MS**, **Wright JA**, et al. Early adiposity rebound and the risk of adult obesity. *Pediatrics.* 1998;**101**(3):e5–e5.
89. **Cooke DJ**, **Hole DJ**. The aetiological importance of stressful life events. *Br J Psychiatry.* 1983;**143**(4):397–400. doi:10.1192/bjp.143.4.397
90. **Pataky MW**, **Young WF**, **Nair KS**. Hormonal and metabolic changes of aging and the influence of lifestyle modifications. *Mayo Clin Proc.* 2021;**96**(3):788–814. doi:10.1016/j.mayocp.2020.07.033
91. **Rolls ET**. Taste, olfactory, and food texture processing in the brain, and the control of food intake. *Physiol Behav.* 2005;**85**(1):45–56. doi:10.1016/j.physbeh.2005.04.012
92. **de Jong N**, **Mulder I**, **de Graaf C**, et al. Impaired sensory functioning in elders: the relation with its potential determinants and nutritional intake. *J Gerontol A Biol Sci Med Sci.* 1999;**54**(8):B324–B331. doi:10.1093/gerona/54.8.b324
93. **Duffy VB**, **Backstrand JR**, **Ferris AM**. Olfactory dysfunction and related nutritional risk in free-living, elderly women. *J Am Diet Assoc.* 1995;**95**(8):879–884. doi:10.1016/S0002-8223(95)00244-8
94. **Kawaharada R**, **Sugimoto T**, **Uchida K**, et al. Indirect effects of social activity on appetite via depressive symptoms in community-dwelling older adults: A cross-sectional study. *Appetite.* 2022;**168**:105705. doi:10.1016/j.appet.2021.105705
95. **Calderón-Asenjo RE**, **Jalk-Muñoz MC**, **Calizaya-Milla YE**, et al. Association between emotional eating, sociodemographic characteristics, physical activity, sleep duration, and mental and physical health in young adults. *J Multidiscip Healthc.* 2022:2845–2859.
96. **Tsuchida N**, **Isobe S**, **Watanabe S**, et al. Changes in access to food and the frequency of food consumption before and after the Niigata Chuetsu earthquake: comparison between households in temporary housing and disaster-stricken housing. *J Jpn Diet Assoc.* 2010;**53**(4):340–348.
97. **Han J**, **Lawlor D.a**, & **Kimm, SYS** (2010). Childhood obesity. *Lancet.* **375**(9727):1737–1748.
98. **Mendez R**, **Grissom M.** Disorders of childhood growth and development: childhood obesity. *FP Essent.* 2013;**410**:20–24.
99. **Mendez MA**, **Monteiro CA**, **Popkin BM**. Overweight exceeds underweight among women in most developing countries. *Am J Clin Nutr.* 2005;**81**(3):714–721. doi:10.1093/ajcn/81.3.714
100. **Monteiro CA**, **Moura EC**, **Conde WL**, et al. Socioeconomic status and obesity in adult populations of developing countries: a review. *Bull World Health Organ.* 2004;**82**(12):940–946.
101. **Park E**, **Ko Y.** Socioeconomic vulnerability index and obesity among Korean adults. *Int J Environ Res Public Health*. 2021;**18**(24)doi:10.3390/ijerph182413370
102. **Drewnowski A**, **Moudon AV**, **Jiao J**, et al. Food environment and socioeconomic status influence obesity rates in Seattle and in Paris. *Int J Obes.* 2014;**38**(2):306–314. doi:10.1038/ijo.2013.97
103. **Wang Y**, **Beydoun MA**. The obesity epidemic in the United States—gender, age, socioeconomic, racial/ethnic, and geographic characteristics: a systematic review and meta-regression analysis. *Epidemiol Rev.* 2007;**29**(1):6–28. doi:10.1093/epirev/mxm007
104. **Tan Z**, **Min J**, **Xue H**, et al. Parenting practices and overweight status of junior high school students in China: A nationally representative study of 19,487 students from 112 schools. *Prev Med.* 2018/02/01/ 2018;**107**:1–7. doi:10.1016/j.ypmed.2017.09.014
105. WHO highlights high cost of physical inactivity in first-ever global report. *World Health Organization.* 2022. Accessed January 23, 2023. https://www.who.int/news/item/19-10-2022-who-highlights-high-cost-of-physical-inactivity-in-first-ever-global-report
106. **Kesztyüs D**, **Traub M**, **Lauer R**, et al. Correlates of longitudinal changes in the waist-to-height ratio of primary school children: Implications for prevention. *Prev Med Rep.* 2016;**3**:1–6. doi:10.1016/j.pmedr.2015.11.005
107. **Alexander KE**, **Ventura EE**, **Spruijt-Metz D**, et al. Association of breakfast skipping with visceral fat and insulin indices in overweight Latino youth. *Obesity.* 2009;**17**(8):1528–1533. doi:10.1038/oby.2009.127
108. **Liu GT**, **Dancause KN**, **Elgbeili G**, et al. Disaster-related prenatal maternal stress explains increasing amounts of variance in body composition through childhood and adolescence: Project Ice Storm. *Environ Res.* 2016;**150**:1–7. doi:10.1016/j.envres.2016.04.039
109. Tobacco: Health benefits of smoking cessation. *World Health Organization.* 2020. https://www.who.int/news-room/questions-and-answers/item/tobacco-health-benefits-of-smoking-cessation
110. **Pisinger C**, **Jorgensen T.** Waist circumference and weight following smoking cessation in a general population: The Inter99 study. *Prev Med.* 2007;**44**(4):290–295. doi:10.1016/j.ypmed.2006.11.015
111. **Williamson DF**, **Madans J**, **Anda RF**, et al. Smoking cessation and severity of weight gain in a national cohort. *N Engl J Med.* 1991;**324**(11):739–745. doi:10.1056/NEJM199103143241106
112. Ministry of Health L, Welfare. The national health and nutrition survey in Japan. 2015.
113. **Komiyama M**, **Wada H**, **Yamakage H**, et al. Analysis of changes on adiponectin levels and abdominal obesity after smoking cessation. *PloS One.* 2018;**13**(8):e0201244. doi:10.1371/journal.pone.0201244
114. **Clair C**, **Chiolero A**, **Faeh D**, et al. Dose-dependent positive association between cigarette smoking, abdominal obesity and body fat: cross-

sectional data from a population-based survey. *BMC Public Health*. 2011; **11**:1–10. doi:10.1186/1471-2458-11-23.

115. **Audrain-McGovern J**, **Benowitz N.** Cigarette smoking, nicotine, and body weight. *Clin Pharmacol Ther*. 2011;**90**(1):164–168. doi:10.1038/clpt.2011.105
116. **Filozof C**, **Fernandez Pinilla M**, **Fernández-Cruz A.** Smoking cessation and weight gain. *Obes Rev*. 2004;**5**(2):95–103. doi:10.1111/j.1467-789X.2004.00131.x
117. Alcohol. https://www.who.int/health-topics/alcohol#tab=tab_1. *World Health Organization.* Published 2023. Accessed October 7, **2024**.
118. **Schröder H**, **Morales-Molina JA**, **Bermejo S**, et al. Relationship of abdominal obesity with alcohol consumption at population scale. *Eur J Nutr*. 2007;**46**:369–376. doi:10.1007/s00394-007-0674-7
119. **Bendsen NT**, **Christensen R**, **Bartels EM**, et al. Is beer consumption related to measures of abdominal and general obesity? A systematic review and meta-analysis. *Nutr Rev*. 2013;**71**(2):67–87. doi:10.1111/j.1753-4887.2012.00548.x
120. **Hill JO**, **Commerford R.** Physical activity, fat balance, and energy balance. *Int J Sport Nutr Exerc Metab* 1996;**6**(2):80–92. doi:10.1123/ijsn.6.2.80
121. **Walley AJ**, **Blakemore AI**, **Froguel P.** Genetics of obesity and the prediction of risk for health. *Hum Mol Genet*. 2006;**15**(suppl_2):R124–R130. doi:10.1093/hmg/ddl215
122. **Davison KK**, **Lawson CT**. Do attributes in the physical environment influence children's physical activity? A review of the literature. *Int J Behav Nutr Phys Act*. 2006;**3**(1):1–17. doi:10.1186/1479-5868-3-19