Table S1 - PRISMA 2009 Checklist.

|  |  |  |  |
| --- | --- | --- | --- |
| **Section/topic** | **#** | **Checklist item** | **Reported on page #** |
| **TITLE** | | |  |
| Title | 1 | Identify the report as a systematic review, meta-analysis, or both. | 1 |
| **ABSTRACT** | | |  |
| Structured summary | 2 | Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number. | 1 |
| **INTRODUCTION** | | |  |
| Rationale | 3 | Describe the rationale for the review in the context of what is already known. | 2,3 |
| Objectives | 4 | Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS). | 3 |
| **METHODS** | | |  |
| Protocol and registration | 5 | Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number. | 3 |
| Eligibility criteria | 6 | Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale. | 3,4 |
| Information sources | 7 | Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched. | 4,5 |
| Search | 8 | Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated. | Table S3 |
| Study selection | 9 | State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis). | 5 |
| Data collection process | 10 | Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators. | 5,6 |
| Data items | 11 | List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made. | 6 |
| Risk of bias in individual studies | 12 | Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis. | 6, 7, Tables S4 and S5 |
| Summary measures | 13 | State the principal summary measures (e.g., risk ratio, difference in means). | 7,8 |
| Synthesis of results | 14 | Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I2) for each meta-analysis. | 8, 9 |
| Risk of bias across studies | 15 | Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies). | 6, 7, Tables S4 and S5 |
| Additional analyses | 16 | Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified. | 9 |
| **RESULTS** | | |  |
| Study selection | 17 | Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram. | 9 |
| Study characteristics | 18 | For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations. | 9, 10, 11, Table 1 |
| Risk of bias within studies | 19 | Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12). | 11, 12 |
| Results of individual studies | 20 | For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot. | 12, 13, Tables 2 and 3 |
| Synthesis of results | 21 | Present results of each meta-analysis done, including confidence intervals and measures of consistency. | 12, 13, 14, Tables 4 and 5 |
| Risk of bias across studies | 22 | Present results of any assessment of risk of bias across studies (see Item 15). | 11, 12 |
| Additional analysis | 23 | Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]). | Table S9 |
| **DISCUSSION** | | |  |
| Summary of evidence | 24 | Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers). | 14, 15 |
| Limitations | 25 | Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias). | 16, 17, 19, 20, 21 |
| Conclusions | 26 | Provide a general interpretation of the results in the context of other evidence, and implications for future research. | 21 |
| **FUNDING** | | |  |
| Funding | 27 | Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review. | Table S8 |

Table S2: PECOS criteria for inclusion and exclusion of studies.

|  |  |  |
| --- | --- | --- |
| **Criteria** | **Inclusion criteria** | **Exclusion criteria** |
| Participants | Adolescents aged ≥10 to ≤19 years | Children under 10 years of age, adults, seniors, and non-healthy adolescents (e.g., individuals with type 2 diabetes, hypertension, or eating disorders) |
| Exposure | Lifestyle patterns identified by data driven exploratory analysis (cluster analysis, principal components analysis, treelet transform, reduced rank regression, and latent class analysis) composed by diet domain in conjunction with at least one of the following behavioral domains: physical activity, sedentary behavior, and sleep | Do not use data driven exploratory analysis to determine lifestyle patterns and that did not include the diet domain |
| Comparasion | - | - |
| Outcome | Weight status (overweight/obesity) determined from age- and gender-specific body mass index (BMI) percentiles, BMI *z*-scores, BMI standard deviation scores, and BMI cutoff points proposed by the International Obesity Task Force (IOTF), the World Health Organization (WHO), the United States Centers for Disease Control and Prevention (CDC) or national references | Other outcomes |
| Study design | Observational (cross-sectional and prospective) | Other study designs |

Table S3: Search strategies used in the databases.

|  |  |
| --- | --- |
| Database | Search Strategy |
| LILACS | (tw:(adolescent OR adolescents OR adolescence OR adolescente OR adolescentes OR teen OR teenager OR youth OR jovem OR joven OR jovens OR schoolchildren OR escolares)) AND (tw:(clustering OR "clustering pattern" OR "clustering patterns" OR "behavior pattern" OR "behavior patterns" OR "lifestyle pattern" OR "lifestyle patterns" OR "health risk" OR "health behavior" OR "health behaviors" OR "health risk behaviors" OR "health risk behavior" OR "risky health behavior" OR "risky health behaviors" OR "life style" OR "life styles" OR "lifestyle" OR "lifestyles" OR "healthy lifestyle" OR "healthy lifestyle" OR "healthy lifestyles" OR "healthy life style" OR "healthy life styles" OR "risk factors" OR "risk factor" OR "behavior patterning" OR agrupamento OR agrupamentos OR "padrão de agrupamento" OR "padrões de agrupamentos" OR "padrão de comportamento" OR "padrões de comportamentos" OR "padrão de estilo de vida" OR "padrões de estilo de vida" OR "risk factor" OR "behavior patterning" OR "risco a saúde" OR "comportamento de saúde" OR "comportamentos de saúde" OR "comportamentos de risco a saúde" OR "comportamento de risco a saúde" OR "estilo de vida" OR "estilos de vida" OR "fatores de risco" OR "fator de risco" OR "food consumption" OR "food habit" OR "food habits" OR "feeding behavior" OR "feeding behaviors" OR "feeding behaviour" OR "feeding behaviours" OR "dietary behavior" OR "dietary behaviors" OR "dietary behaviour" OR "dietary behaviours" OR "eating behavior" OR "eating behaviors" OR "eating behaviour" OR "eating behaviours" OR "consumo alimentar" OR alimentação OR "padrões alimentares" OR "sedentary behavior" OR "sedentary behaviors" OR "sedentary lifestyle" OR "sedentary lifestyles" OR sedentarismo OR "comportamento sedentário" OR "sleep" OR "bedtime" OR "sleep duration" OR "sleep pattern" OR "sleep patterns" OR "sleep habits" OR "sleep habit" OR "sleep time" OR "sleep Hygiene" OR sono OR "duração do sono" OR "qualidade do sono" OR "padrão de sono" OR "padrões de sono" OR exercise OR "physical activity" OR "physical activities" OR "physical exercise" OR "physical exercises" OR exercício OR "atividade física" OR "atividades físicas")) AND (tw:(obesity OR overweight OR "body mass index" OR "abdominal obesity" OR "weight status" OR sobrepeso OR excesso de peso OR obesidade OR "obesidade abdominal" OR "índice de massa corporal"OR "obesidad abdominal" OR obesidad OR "índice de masa corporal")) AND (tw:("principal component analysis" OR "cluster analysis" OR "cluster analyses" OR cluster OR clusters OR "reduced rank regression" OR "statistical factor analysis" OR "factor analysis" OR "factor analyses" OR "treelet transform" OR "latent class analysis" OR "análise de componentes principais" OR "classe latente" OR "análise fatorial")) |
| Scopus | TITLE-ABS-KEY(adolescent OR adolescence OR teen OR teenager OR youth OR schoolchildren) AND TITLE-ABS-KEY("clustering" OR "clustering pattern" OR "clustering patterns" OR "behavior pattern" OR "behavior patterns" OR "lifestyle pattern" OR "lifestyle patterns" OR "health risk" OR "health behavior" OR "health behaviors" OR "health risk behaviors" OR "health risk behavior" OR "risky health behavior" OR "risky health behaviors" OR "life style" OR "life styles" OR "lifestyle" OR "lifestyles" OR "healthy lifestyle" OR "healthy lifestyles" OR "healthy life style" OR "healthy life styles" OR "risk factors" OR "risk factor" OR "behavior patterning" OR "food consumption" OR "food habit" OR "food habits" OR "feeding behavior" OR "feeding behaviors" OR "feeding behaviour" OR "feeding behaviours" OR "dietary behavior" OR "dietary behaviors" OR "dietary behaviour" OR "dietary behaviours" OR "eating behavior" OR "eating behaviors" OR "eating behaviour" OR "eating behaviours" OR "sedentary behavior" OR "sedentary behaviors" OR "sedentary lifestyle" OR "sedentary lifestyles" OR "sleep" OR "bedtime" OR "sleep duration" OR "sleep pattern" OR "sleep patterns" OR "sleep habits" OR "sleep habit" OR "sleep time" OR "sleep hygiene" OR exercise OR "physical activity" OR "physical activities" OR "physical exercise" OR "physical exercises") AND TITLE-ABS-KEY("obesity" OR "overweight" OR "abdominal obesity" OR "adolescent overweight" OR "adolescent obesity" OR "weight status" OR "body mass index") AND TITLE-ABS-KEY("principal component analysis" OR "principal component analysis" OR "cluster analysis" OR "cluster analyses" OR cluster OR "reduced rank regression" OR "factor analysis" OR "statistical factor analysis" OR "factor analyses" OR "treelet transform" OR "latent class analysis") |
| PubMed | ("adolescent"[Mesh] OR "adolescent"[Title/Abstract] OR "adolescents"[Title/Abstract] OR "adolescence"[Title/Abstract] OR "teen"[Title/Abstract] OR "teens"[Title/Abstract] OR "teenager"[Title/Abstract] OR "teenagers"[Title/Abstract] OR "youth"[Title/Abstract] OR "youths"[Title/Abstract] OR schoolchildren[Title/Abstract]) AND ("clustering"[Title/Abstract] OR "clustering pattern"[Title/Abstract] OR "clustering patterns"[Title/Abstract] OR "behavior pattern"[Title/Abstract] OR "behavior patterns"[Title/Abstract] OR "lifestyle pattern"[Title/Abstract] OR "lifestyle patterns"[Title/Abstract] OR "health risk"[Title/Abstract] OR "health behavior"[Title/Abstract] OR "health behaviors"[Title/Abstract] OR "Health Risk Behaviors"[Mesh] OR "Health Risk Behavior"[Title/Abstract] OR "Risky Health Behavior"[Title/Abstract] OR "Risky Health Behaviors"[Title/Abstract] OR "Life Style"[Mesh] OR "Life Styles"[Title/Abstract] OR "Lifestyle"[Title/Abstract] OR "Lifestyles"[Title/Abstract] OR "Healthy Lifestyle"[Mesh] OR "Healthy Lifestyle"[Title/Abstract] OR "Healthy Lifestyles"[Title/Abstract] OR "Healthy Life Style"[Title/Abstract] OR "Healthy Life Styles"[Title/Abstract] OR "Risk Factors"[Mesh] OR "Risk Factor"[Title/Abstract] OR "behavior patterning"[Title/Abstract] OR "food consumption"[Title/Abstract] OR "food habit"[Title/Abstract] OR "food habits"[Title/Abstract] OR "feeding behaviour"[Title/Abstract] OR "feeding behavior"[MeSH] OR "feeding behavior"[Title/Abstract] OR "feeding behaviors"[Title/Abstract] OR "feeding behaviour"[Title/Abstract] OR "feeding behaviours"[Title/Abstract] OR "dietary behavior"[Title/Abstract] OR "dietary behaviors"[Title/Abstract] OR "dietary behaviour"[Title/Abstract] OR "dietary behaviours"[Title/Abstract] OR "eating behavior"[Title/Abstract] OR "eating behaviors"[Title/Abstract] OR "eating behaviour"[Title/Abstract] OR "eating behaviours"[Title/Abstract] OR "exercise"[Mesh] OR "exercise"[Title/Abstract] OR "exercises"[Title/Abstract] OR "Physical Activity"[Title/Abstract] OR "Physical Activities"[Title/Abstract] OR "Physical Exercise"[Title/Abstract] OR "Physical Exercises"[Title/Abstract]) OR "Sedentary Behavior"[Mesh] OR "Sedentary Behavior"[Title/Abstract] OR "Sedentary behaviors"[Title/Abstract] OR "sedentary lifestyle"[Title/Abstract] OR "sedentary lifestyles"[Title/Abstract] OR "Sleep"[Mesh] OR "sleep"[Title/Abstract] OR "bedtime"[Title/Abstract] OR "sleep duration"[Title/Abstract] OR "sleep pattern"[Title/Abstract] OR "sleep patterns"[Title/Abstract] OR "sleep habits"[Title/Abstract] OR "sleep habit"[Title/Abstract] OR "sleep time"[Title/Abstract] OR "Sleep Hygiene"[Mesh]) AND ("Obesity"[Mesh] OR "Obesity"[title/abstract] OR "Overweight"[Mesh] OR "Overweight"[title/abstract] OR “Obesity, Abdominal”[Mesh] OR “Obesity, Abdominal”[Title/Abstract] OR "Adolescent Overweight"[Title/Abstract] OR "Adolescent Obesity"[Title/Abstract] OR "Weight Status"[Title/Abstract] OR "Body Mass Index"[Mesh] OR "Body Mass Index"[Title/Abstract]) AND ("Principal Component Analysis"[MeSH] OR "Principal Component Analysis"[Title/Abstract] OR "Cluster Analysis"[MeSH] OR "Cluster Analysis"[Title/Abstract] OR "Cluster Analyses"[Title/Abstract] OR "Cluster"[Title/Abstract] OR "Clusters"[Title/Abstract] OR "Reduced Rank Regression"[Title/Abstract] OR "Factor Analysis, Statistical"[MeSH] OR "Statistical Factor Analysis"[Title/Abstract] OR "Factor Analysis"[Title/Abstract] OR "Factor Analyses"[Title/Abstract] OR "Treelet Transform"[Title/Abstract] OR "Latent Class Analysis"[Title/Abstract]) |
| Web of Science | TS=(adolescent OR adolescence OR teen OR teenager OR youth OR schoolchildren) AND TS=("Overweight" OR "Obesity" OR "Abdominal Obesity" OR "Adolescent Overweight" OR "Adolescent Obesity" OR "weight status" OR "Body Mass Index") AND TS=("clustering" OR "clustering pattern" OR "clustering patterns" OR "behavior pattern" OR "behavior patterns" OR "lifestyle pattern" OR "lifestyle patterns" OR "health risk" OR "health behavior" OR "health behaviors" OR "Health Risk Behaviors" OR "Health Risk Behavior" OR "Risky Health Behavior" OR "Risky Health Behaviors" OR "Life Style" OR "Life Styles" OR "Lifestyle" OR "Lifestyles" OR "Healthy Lifestyle" OR "Healthy Lifestyle" OR "Healthy Lifestyles" OR "Healthy Life Style" OR "Healthy Life Styles" OR "Risk Factors" OR "Risk Factor" OR "behavior patterning" OR "food consumption" OR "food habit" OR "food habits" OR "feeding behaviour" OR "feeding behavior" OR "feeding behavior" OR "feeding behaviors" OR "feeding behaviour" OR "feeding behaviours" OR "dietary behavior" OR "dietary behaviors" OR "dietary behaviour" OR "dietary behaviours" OR "eating behavior" OR "eating behaviors" OR "eating behaviour" OR "eating behaviours" OR "Sedentary Behavior" OR "Sedentary Behavior" OR "Sedentary behaviors" OR "sedentary lifestyle" OR "sedentary lifestyles" OR "sleep" OR "bedtime" OR "sleep duration" OR "sleep pattern" OR "sleep patterns" OR "sleep habits" OR "sleep habit" OR "sleep time" OR "Sleep Hygiene" OR exercise OR "Physical Activity" OR "Physical Activities" OR "Physical Exercise" OR "Physical Exercises") AND TS=("principal component analysis" OR "principal component analysis" OR "cluster analysis" OR "cluster analyses" OR cluster OR "reduced rank regression" OR "factor analysis" OR "statistical factor analysis" OR "factor analyses" OR "treelet transform" OR "latent class analysis") |
| ProQuest | noft(adolescent OR adolescence OR teen OR teenager OR youth OR schoolchildren) AND noft("clustering" OR "clustering pattern" OR "clustering patterns" OR "behavior pattern" OR "behavior patterns" OR "lifestyle pattern" OR "lifestyle patterns" OR "health risk" OR "health behavior" OR "health behaviors" OR "health risk behaviors" OR "health risk behavior" OR "risky health behavior" OR "risky health behaviors" OR "life style" OR "life styles" OR "lifestyle" OR "lifestyles" OR "healthy lifestyle" OR "healthy lifestyles" OR "healthy life style" OR "healthy life styles" OR "risk factors" OR "risk factor" OR "behavior patterning" OR "food consumption" OR "food habit" OR "food habits" OR "feeding behavior" OR "feeding behaviors" OR "feeding behaviour" OR "feeding behaviours" OR "dietary behavior" OR "dietary behaviors" OR "dietary behaviour" OR "dietary behaviours" OR "eating behavior" OR "eating behaviors" OR "eating behaviour" OR "eating behaviours" OR "sedentary behavior" OR "sedentary behaviors" OR "sedentary lifestyle" OR "sedentary lifestyles" OR "sleep" OR "bedtime" OR "sleep duration" OR "sleep pattern" OR "sleep patterns" OR "sleep habits" OR "sleep habit" OR "sleep time" OR "sleep hygiene" OR exercise OR "physical activity" OR "physical activities" OR "physical exercise" OR "physical exercises") AND noft("obesity" OR "overweight" OR "abdominal obesity" OR "adolescent overweight" OR "adolescent obesity" OR "weight status" OR "body mass index") AND noft("principal component analysis" OR "principal component analysis" OR "cluster analysis" OR "cluster analyses" OR cluster OR "reduced rank regression" OR "factor analysis" OR "statistical factor analysis" OR "factor analyses" OR "treelet transform" OR "latent class analysis") |
| Google Scholar | adolescent AND (clustering OR lifestyle pattern OR behavior pattern OR food consumption OR sedentary behavior OR sleep OR physical activity) AND (obesity OR overweight) |

Table S4 - Checklist items by The Joanna Briggs Institute Critical Appraisal tools for use in JBI Systematic Reviews and criteria determined by authors of this review to evaluate the studies.

|  |  |  |
| --- | --- | --- |
| Items | | Criteria for scoring “YES” |
| Report in the study or reference citation |
| 1 | Were the criteria for inclusion in the sample clearly defined? | Report whether adolescents with physical or mental disabilities, illnesses, pregnancy, lactation, or restrictive diet were excluded from the sample |
| 2 | Were the study subjects and the setting described in detail? | Report about characteristics such as sex, age or school grade, socioeconomic status (SES), year of the research, location, sampling, and sample size estimation. |
| 3 | Was the exposure measured in a valid and reliable way? | Report whether the instruments used to measure all exposure variables were subjected to validity and reliability tests in the same population of interest, presenting the respective reference. |
| 4 | Were objective, standard criteria used for measurement of the condition? | Not applicable. |
| 5 | Were confounding factors identified? | Report whether typical confounders such baseline characteristics (age, sex, and SES) were identified. |
| 6 | Were strategies to deal with confounding factors stated? | Report whether multivariate analysis adjusted for confounders was used. |
| 7 | Were the outcomes measured in a valid and reliable way? | Report whether outcome variables were measured objectively and not self-reported. |
| 8 | Was appropriate statistical analysis used? | Report whether multivariate analysis adjusted (multivariate analysis of variance and regression analysis) for typical confounders was used. |

Table S5. Risk of bias assessed by The Joanna Briggs Institute Critical Appraisal tools for use in JBI Systematic Reviews.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Item in checklist | BOONE-HEINONEN; GORDON-LARSEN; ADAIR, 2008(47) | SABBE et al., 2008(49) | LANDSBERG et al., 2010(48) | VAN DER SLUIS et al., 2010(50) | SEGHERS; RUTTEN, 2010(51) | OTTEVAERE et al., 2011(52) | VELOSO et al., 2012(62) | SPENGLER et al., 2012(64) | IANNOTTI; WANG, 2013(53) | FERNANDEZ-ALVIRA et al., 2013(54) | PEREZ-RODRIGO et al., 2015(55) | LAXER, R.. E. et al., 2017(45) | NUUTINEN et al., 2017(56) | BERLIN et al., 2017(61) | LAXER, R. E. et al., 2018(46) | DANTAS et al., 2018(57) | MOREIRA et al., 2018(44) | WADOLOWSKA et al., 2018(58) | SEVIL-SERRANO et al., 2019(59) | MARTTILA‐TORNIO et al., 2019(63) | DOS SANTOS et al., 2020(60) |
| 1 | Y | N | N | N | N | U | N | N | N | U | Y | U | U | Y | U | Y | Y | Y | N | U | Y |
| 2 | Y | N | N | Y | U | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | U | Y | Y | N | U | Y |
| 3 | N | N | N | N | U | N | U | N | Y | Y | N | N | U | U | N | N | N | N | N | U | U |
| 4a | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 5 | Y | N | N | Y | N | N | N | N | N | N | Y | Y | Y | N | Y | Y | N | Y | N | N | Y |
| 6 | Y | Y | N | Y | Y | Y | N | N | Y | Y | Y | Y | Y | N | Y | Y | Y | Y | Y | Y | Y |
| 7 | Y | N | Y | N | N | Y | N | Y | N | Y | Y | N | N | Y | N | Y | Y | Y | N | N | N |
| 8 | U | N | N | Y | N | N | N | N | N | N | Y | Y | Y | N | Y | Y | Y | Y | N | N | Y |
| %YESb | 85.71c | 14.29 | 14.29 | 57.14c | 14.29 | 42.86 | 14.29 | 28.57 | 42.86 | 57.14 | 85.71c | 57.14c | 57.14c | 42.86 | 57.14c | 71.43c | 71.43c | 85.71c | 14.29c | 14.29 | 71.43c |
| Risk of biasd | L | H | H | M | H | H | H | H | H | M | L | M | M | H | M | L | L | L | H | H | L |

Note:

Y=Yes, N=No, U=Unclear, NA=Not applicable, L=low risk of bias, M=moderate risk of bias, H=high risk of bias

aItem 4 was not applicable to the nature of the selected studies and was not considered in the calculation.

bFormula: ()

c Articles used to synthesize the results

d Risk of bias was categorized as “high” when the study reaches up to 49% score “yes”, “moderate” when the study reached 50% to 69% score “yes”, and “low” when the study reached more than 70% score “yes”.

Table S6 - Determination of behaviors and classification of lifestyle patterns included in the systematic review.

|  |  |
| --- | --- |
| **Behaviors** | **Characteristics** |
| Healthy behavior | Presence or high levels of physical activity |
| Healthy diet |
| Adequate sleep habits |
| Low levels or absence of sedentary behavior |
| Low consumption of unhealthy foods |
| Unhealthy behavior | Presence or high levels of sedentary behavior |
| Unhealthy diet |
| Inadequate sleep habits |
| Low levels or absence of physical activity |
| Low consumption of healthy foods |
| Moderate behavior | Intermediate levels of diet quality, sleep quality, physical activity, and sedentary behavior |
| **Lifestyle Patterns** | **Characteristics** |
| Completely Healthy | Included only healthy behaviors |
| Completely Unhealthy | Included only unhealthy behaviors |
| Predominantly Healthy | Characterized by at least two healthy behaviors and one unhealthy or moderately unhealthy behavior |
| Predominantly Unhealthy | Characterized by at least two unhealthy behaviors and one healthy or moderately healthy behavior |
| Mixed | Characterized by an equal proportion of healthy and unhealthy behaviors |

Table S7: Studies excluded from the systematic review according to PECOS items.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Reference** | **Was the article accessible in full?** | **The study was conducted with adolescents aged ≥10 to ≤19 years?** | **The lifestyle patterns were composed by diet domain in conjunction with at least one of the following behavioral domains: physical activity, sedentary behavior, and sleep?** | **The lifestyle patterns were identified by data driven exploratory analysis?** | **Was overweight/obesity the study outcome?** |
| BOONE; GORDON-LARSEN; ADAIR, 2007(43) | Not | N/A | N/A | N/A | N/A |
| KONTOGIANNI et al., 2010(22) | Yes | Not | Yes | Yes | Yes |
| TURNER et al., 2011(39) | Not | N/A | N/A | N/A | N/A |
| CUENCA-GARCÍA et al., 2013(34) | Yes | Yes | Yes | Yes | Not |
| BUSCH et al., 2013(38) | Yes | Yes | Yes | Yes | Not |
| HÖPKER; LAMPERT; SPALLEK, 2014(37) | Yes | Yes | Yes | Yes | Not |
| MOSCHONIS et al., 2014(23) | Yes | Not | Yes | Yes | Yes |
| SPENGLER et al., 2014(27) | Yes | Not | Yes | Yes | Yes |
| FERRAR; GOLLEY, 2015(24) | Yes | Not | Yes | Yes | Yes |
| LEECH; MCNAUGHTON; TIMPERIO, 2015(28) | Yes | Not | Yes | Yes | Yes |
| MAIA, 2016(30) | Yes | Yes | Yes | Yes | Not |
| SCHMIEGE et al., 2016(25) | Yes | Not | Yes | Yes | Yes |
| FLEARY, 2017(36) | Yes | Yes | Yes | Yes | Not |
| SENA et al., 2017(35) | Yes | Yes | Yes | Yes | Not |
| MANDIC et al., 2017(42) | Not | N/A | N/A | N/A | N/A |
| SPENGLER; MESS; WOLL, 2017(41) | Not | N/A | N/A | N/A | N/A |
| MAIA et al., 2018(31) | Yes | Yes | Yes | Yes | Not |
| SANCHEZ-OLIVA et al., 2018(32) | Yes | Yes | Yes | Yes | Not |
| TABACCHI et al., 2018(33) | Yes | Yes | Yes | Yes | Not |
| CABANAS-SÁNCHEZ et al., 2018(26) | Yes | Not | Yes | Yes | Yes |
| ZHANG et al., 2018(40) | Not | N/A | N/A | N/A | N/A |
| WERNECK et al., 2018(29) | Yes | Yes | Yes | Not | Yes |

Note: N/A= not applicable

Table S8: Funding and competing interest information in the included studies and assessments of potential conflict of interest concerns.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Authors** | **Funding** | **Declaration** | **Contribution** | **Judgement** |
| BOONE-HEINONEN; GORDON-LARSEN; ADAIR, 2008(47) | The major funding of this project comes from the National Institutes of Health (R01-HD041375, R01-HD041375, K01-HD044263, and R01-HD39183-01). This research uses data from Add Health, a program project funded by a grant P01-HD31921 from the Eunice Kennedy Shriver National Institute of Child Health and Human Development, with cooperative funding from 17 other agencies. | There were no potential or real conflicts of financial or personal interest with the financial sponsors of the scientific project. | N/A | No notable concern about conflict of interest |
| SABBE et al., 2008(49) | This project was made possible thanks to the Ghent University. | None declared. | N/A | No notable concern about conflict of interest |
| LANDSBERG et al., 2010(48) | KOPS is supported by grants from Deutsche Forschungsgemeinschaft (DFG Mu 5-1, 5-2, 5-3, 5-5), Kompetenznetz Adipositas (Competence Network on Obesity) funded by the Federal Ministry of Education and Research (FKZ: 01GI0821), Wirtschaftliche Vereinigung Zucker, Precon and WCRF. The present study has been facilitated by the EU-funded HOPE project: Health Promotion through Obesity Prevention across Europe (the Commission of the European Communities, SP5A-CT-2006-044128). | The authors have no conflict of interest. | The study does not necessarily reflect the Commission’s views and in no way anticipates the Commission’s future policy in this area. | No notable concern about conflict of interest |
| VAN DER SLUIS et al., 2010(50) | The present study was supported by the Norwegian research Council and has been facilitated by the EU-funded HOPE project: Health-promotion through Obesity Prevention across Europe (the Commission of the European Communities, SP5A-CT-2006-044128). | The authors have no conflict of interest. | N/A | No notable concern about conflict of interest |
| SEGHERS; RUTTEN, 2010(51) | The present study received no specific grant from any funding agency in the public, commercial or not-for-profit sectors. | The authors have no conflict of interest to declare. | N/A | No notable concern about conflict of interest |
| OTTEVAERE et al., 2011(52) | The HELENA study took place with the financial support of the European Community Sixth RTD Framework Programme (Contract FOOD-CT: 2005-007034). This work was also partially supported by the European Union, in the framework of the Public Health Programme (ALPHA project, Ref:2006120), the Swedish Council for Working Life and Social Research (FAS), the Spanish Ministry of Education (EX-2007-1124, and EX-2008-0641), and the Spanish Ministry of Health, Maternal, Child Health and Development Network (number RD08/0072) (JPRL, LAM). | The authors declare that they have no competing interests. | N/A | No notable concern about conflict of interest |
| SPENGLER et al., 2012(64) | The MoMo Study was funded by the German Bundesministerium für Familie, Senioren, Frauen und Jugend (Federal Ministry for Families, Senior Citizens, Women and Youth) and by the German Bundesministerium für Bildung und Forschung (Federal Ministry of Education and Research). | The authors declare that they have no competing interests. | N/A | No notable concern about conflict of interest |
| VELOSO et al., 2012(62) | This research was supported by Centro de Malária e Outras  Doenças Tropicais (CMDT), Instituto de Higiene e Medicina  Tropical, Universidade Nova de Lisboa, Portugal. The  Portuguese Foundation for Science and Technology (FCT)  financed a doctoral grant to the first author during this  research. | Comment: no information. | N/A | No notable concern about conflict of interest |
| IANNOTTI; WANG, 2013(53) | This research was supported in part by the intramural research program of the Eunice Kennedy Shriver National Institute of Child Health and Human Development (Contract N01-HD-5-3401) and by the Maternal and Child Health Bureau of the Health Resources and Services Administration with the first author (Ronald J. Iannotti) as principal investigator. | None. | N/A | No notable concern about conflict of interest |
| FERNANDEZ-ALVIRA et al., 2013(54) | The ENERGY-project is funded by the Seventh Framework Programme (CORDIS FP7) of the European Commission, HEALTH (FP7-HEALTH-2007-B). | The authors declare that they have no competing interests. | The content of this article reflects only the authors’ views and the European Community is not liable for any use that may be made of the information contained therein. | No notable concern about conflict of interest |
| PÉREZ-RODRIGO et al., 2015(55) | The ANIBES study was financially supported by a grant from Coca-Cola Iberia through an agreement with the Spanish Nutrition Foundation (FEN). | The authors declare no conflict of interest. | The funding sponsor had no role in the design of the study, the collection, analysis, or interpretation of the data, writing of the manuscript, or in the decision to publish the results. | No notable concern about conflict of interest |
| LAXER et al., 2017(45) | The COMPASS study was supported by a bridge grant from the Canadian Institutes of Health Research (CIHR) Institute of Nutrition, Metabolism and Diabetes (INMD) through the “Obesity - Interventions to Prevent or Treat” priority funding awards (OOP-110788; grant awarded to S. Leatherdale) and an operating grant from the Canadian Institutes of Health Research (CIHR) Institute of Population and Public Health (IPPH) (MOP-114875; grant awarded to S. Leatherdale). S. Leatherdale is a CIHR-PHAC Chair in Applied Public Health Research. | The authors declare that they have no competing interests. | N/A | No notable concern about conflict of interest |
| NUUTINEN et al., 2017(56) | This study was funded by the Juho Vainio Foundation in line with Teija Nuutinen’s personal grant. | Authors declare that they have no conflict of interest. | N/A | No notable concern about conflict of interest |
| LAXER et al., 2018(46) | The COMPASS study was supported by a bridge grant from the Canadian Institutes of Health Research (CIHR) Institute of Nutrition, Metabolism and Diabetes (INMD) through the “Obesity - Interventions to Prevent or Treat” priority funding awards (OOP-110788; grant awarded to S. Leatherdale) and an operating grant from the Canadian Institutes of Health Research (CIHR) Institute of Population and Public Health (IPPH) (MOP-114875; grant awarded to S. Leatherdale). | The authors have declared that no competing interests exist. | N/A | No notable concern about conflict of interest |
| DANTAS et al., 2018(57) | This research received no external funding. | The authors declare no conflict of interest. | N/A | No notable concern about conflict of interest |
| MOREIRA et al., 2018(44) | The HELENA study was funded by the European Community Sixth RTD Framework Programmed (Contract FOOD-CT: 2005-007034), partially supported by the Spanish Ministry of Health, Maternal, Child Health and Development Network (number RD08/0072) (AMS-P, LAM). The ELANA study was funded by the National Council for Scientific and Technological Development (CNPq, grant 47667/2011-9), the Research Support Foundation of the State of Rio de Janeiro (FAPERJ, grants E26/110.847/2009, E-26/110.626/2011, and E-26/110.774/2013), and Coordination for the Improvement of Higher Education Personnel (CAPES, grant 23038.007702/2011-5). | The authors have declared that no competing interests exist. | The content of this paper reflects only the authors’ views and the remaining HELENA study members and the European Community are not liable for any use that may be made of the information contained therein. | No notable concern about conflict of interest |
| WADOLOWSKA et al., 2018(58) | The study was financially supported by Carrefour Foundation (Agreement ABC No.1/2014; Agreement ABC No. 2/2016) and each scientific centre from sources of the Polish Ministry of Sciences and Higher Education. | The authors declare no conflicts of interest. The funding sponsors had no role in the study design, data collection, analysis or interpretation of the data, the writing of the manuscript or the decision to publish the results. | N/A | No notable concern about conflict of interest |
| SEVIL-SERRANO et al., 2019(59) | This research was funded by the Spanish Ministry of Economy and Competitiveness (MINECO; EDU2013-42048-R), the Government of Aragon (Code: 24288) and the European Social Fund. | The authors declare no conflict of interest. | N/A | No notable concern about conflict of interest |
| MARTTILA‐TORNIO et al., 2019(63) | Financial support was received for this study from a Juho Vainio Foundation. | None | N/A | No notable concern about conflict of interest |
| DOS SANTOS et al., 2020(60) | There is no funding source. | The authors declare that they have no competing interests. | N/A | No notable concern about conflict of interest |
| BERLIN et al., 2017(61) | Comment: no information. | Comment: no information | N/A | No notable concern about conflict of interest |

Table S9. Direction of associations between lifestyle patterns and overweight and obesity in adolescents according to risk of bias.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Risk of bias** | **Study design** | **Lifestyle Patterns classification** | **Number of times the association was tested** | **Direction of association** | | |
| **Positive** | **Inverse** | **No association** |
| **Low Risk of Bias** | **Cross-sectional** | Completely Healthy | 2 | 0 | 1 | 1 |
| Completely Unhealthy | 4 | 0 | 0 | 4 |
| Predominantly Healthy | 10a | 2 | 0 | 8a |
| Predominantly Unhealthy | 12 | 4 | 0 | 8 |
| Mixed | 7b | 0 | 0 | 7b |
| **Moderate Risk of Bias** | **Cross-sectional** | Completely Healthy | 0 | 0 | 0 | 0 |
| Completely Unhealthy | 4 | 0 | 1 | 3 |
| Predominantly Healthy | 1 | 0 | 0 | 1 |
| Predominantly Unhealthy | 4b | 3b | 0 | 1 |
| Mixed | 1a | 1a | 0 | 0 |
| **Longitudinal** | Completely Healthy | 0 | 0 | 0 | 0 |
| Completely Unhealthy | 0 | 0 | 0 | 0 |
| Predominantly Healthy | 0 | 0 | 0 | 0 |
| Predominantly Unhealthy | 2b | 2b | 0 | 0 |
| Mixed | 1a | 1a | 0 | 0 |
| **High Risk of Bias** | **Cross-sectional** | Completely Healthy | 1 | 0 | 0 | 1 |
| Completely Unhealthy | 1 | 0 | 0 | 1 |
| Predominantly Healthy | 0 | 0 | 0 | 0 |
| Predominantly Unhealthy | 0 | 0 | 0 | 0 |
| Mixed | 4 | 0 | 0 | 4 |

a included 1 lifestyle pattern with risk behaviors

b included 2 lifestyle patterns with risk behaviors