Correlates of children’s dietary intake, physical activity and sedentary behavior in home-based childcare: A systematic review

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ABSTRACT

This systematic review assessed the correlates of children’s dietary intake, physical activity and sedentary behavior in home-based childcare. A systematic search of five databases with articles published between January 2000 and July 2021 was conducted. Articles were included if they contained data from a home-based childcare (birth-5 years) setting; were a quantitative study that reported children’s dietary intake, physical activity or sedentary behavior; included variables associated with children’s dietary intake, physical activity or sedentary behavior; and were published in English. Correlates were categorized using McPheron’s ecological framework. Risk of bias was assessed using the Office of Health Assessment and Translation (OHAT) Risk of Bias Rating Tool. Fifteen studies met the inclusion criteria; six assessed children’s dietary intake, and nine assessed physical activity and/or sedentary behaviors. Studies were conducted in the USA (n = 12) and Canada (n = 3). Seventy-three correlates were identified, for children’s dietary intake (n = 11), physical activity (n = 35) and sedentary behavior (n = 27). Ethnicity and the food provided to children were associated with children’s dietary intake in two studies; both from the same study sample. Indoor play space was positively associated with physical activity in two separate studies. No consistent associations for children’s dietary intake, physical activity, or sedentary behavior outcomes were found between studies, however few studies assessed the same correlates. High-quality studies conducted in different countries that assess the nutrition and physical activity environments in home-based childcare using reliable and consistent methods are needed. This review was registered with PROSPERO, no. CRD42019103429.

1. Introduction

Healthy eating and physical activity in early childhood are essential for optimal development and the prevention of lifestyle diseases, such as cardiovascular disease and type 2 diabetes (Dalwood 2020, Morze 2020, Carson 2017). The World Health Organization recognizes early childhood education and care (ECEC) as a key setting to develop healthy nutrition and physical activity behaviors (WHO, 2017). In high-income countries, approximately 87% of children aged 3–5 years attend an ECEC setting for an average of 30 h each week (OECD, 2021).

Home-based childcare is a formal type of ECEC service where educators provide education and care to children in the educators’ homes. Home-based childcare is also known as family child care homes in the United States, family day care in Australia and child-minding in the United Kingdom. Home-based childcare is an important type of ECEC for many families, especially those from lower socioeconomic and ethnically diverse backgrounds, often offering lower fees and more flexible hours (Layzer and Burstein, 2007; Tonyan et al., 2017; Williamson et al., 2011). Over three million children attend home-based childcare in the United States (National Center on Early Childhood Quality Assurance, 2011).
2016), 228,975 in Canada (Statistics Canada, 2020) and 107,670 children in Australia (Australian Government, 2020). The conditions in which home-based childcare operates can, such as the regulations, qualification requirements, and child-to-educator ratios, vary across countries. The primary food provider also differs between countries. For example, educators typically provide food in the United States (Francis et al., 2018), whereas both educators and families may provide food to children in Australia (Wallace and Mills, 2019).

Research in the ECEC sector has predominately focused on center-based services (Tonge et al., 2016; Wolfenden et al., 2020), with less research conducted in home-based child care settings (Francis et al., 2018; Yoong et al., 2020). Home-based childcare services have distinctive challenges compared to center-based services, with one educator often providing education and care for multiple children of different ages and abilities (Stitou et al., 2018). Additional structural barriers in home-based childcare, such as equipment availability, challenges participating in professional development, and limited budget, space and resources, also mean findings from research in center-based services may not be generalizable to home-based childcare services (Fees et al., 2009; O’Connor and Temple, 2005).

Understanding the factors that influence children’s healthy eating and physical activity behaviors in home-based childcare is critical to informing educator professional development and home-based childcare interventions. Systematic reviews in center-based ECEC services have identified multiple correlates of children’s physical activity and sedentary behavior, including provision of active opportunities, features of outdoor environments, total area, provision of portable play equipment every day and educator's involvement in, and promotion of, physical activity (Tonge et al., 2016; Ward et al., 2015). In addition, mealtimne practices, such as family-style meals, has been positively associated with children’s consumption of nutritious foods (Ward et al., 2015). A review assessing the obesogenic characteristics of home-based childcare services in the US found that the physical, sociocultural, and policy environments were not conducive to supporting children’s healthy behaviors (Francis et al., 2018). However, no systematic reviews have synthesized the factors associated with children’s healthy eating and physical activity in home-based childcare services. In light of this, the aim of this systematic review was to assess the factors associated with children’s dietary intake, physical activity and sedentary behavior in home-based childcare.

2. Methods

2.1. Protocol and registration

This systematic review was reported in accordance with the Preferred Reporting Items for Systematic review and meta-Analysis (PRISMA) statement (Page et al., 2021) and prospectively registered with PROSPERO, the international prospective register of systematic reviews (registration no. CRD42019103429).

2.2. Eligibility criteria

Papers were included if they: (1) were peer reviewed, written in English and available in full text, (2) included data from a home-based childcare service (birth-5 years) setting, (3) were a quantitative study that reported children’s dietary intake, physical activity or sedentary behavior, (4) assessed variables associated with children’s dietary intake, physical activity or sedentary behaviour. Studies that did not test the statistical significance of associations were excluded.

Home-based childcare was defined as a child care service where children are provided education and care in a home by an educator (also known as a childcare provider). Studies that only involved center-based childcare services (for example, pre-schools, long day care services and kindergartens) or informal types of childcare provided in the child’s own home (for example, care given by grandparents, nannies, au pairs or babysitters) were excluded. Studies involving both home-based child care and center-based child care services were included if the correlates of home-based childcare related practices were reported separately to center-based. Studies only comparing home-based childcare combined with other types of ECEC services were not included. The primary outcome variables included measures of children’s dietary intake, physical activity or sedentary behavior. Outcome measures included weighed food records, diet recalls, accelerometers and direct observation of children’s dietary intake or physical activity. Examples of exposure variables (i.e. correlates) included child characteristics, educator characteristics, physical environment, policies and training.

2.3. Data sources and search strategy

A computerized literature search was conducted in March 2020 and updated in July 2021 using MEDLINE, Education Research Complete, Scopus, PsychINFO and Web of Science. The databases were searched from January 2000 to July 2021. The search was conducted using the search terms for home-based childcare AND diet OR physical activity OR sedentary behavior (Table 1). The complete search strategy is outlined in supplementary file 1. The reference lists of eligible articles were also screened to identify additional articles to be included in the review.

2.4. Study selection

Duplicates were removed (EK) in Microsoft Excel, and the remaining articles were uploaded into the software Rayyan (Ouzzani et al., 2016). Titles and abstracts were independently reviewed twice by two authors (EK, LH). All potentially relevant full-text articles were independently assessed by two authors (among EK, SR, LH, JN, ML). Any differences were discussed and then resolved between reviewers.

2.5. Data extraction

The following information was independently extracted from each eligible article by two authors (among EK, SR, LH, JN): author, date, location, study design, study population, assessment tool and outcome, correlates assessed, and the correlates identified. An association was classified as significant if p < 0.05.

2.6. Data analysis and synthesis

Meta-analyses were not possible as few studies assessed the same correlates. A narrative summary of the findings was described instead. Only findings from the most advanced, fully adjusted models were extracted if multiple analytic models were used. The correlates were categorized according to McLe roy’s social ecological framework domains (interpersonal, intrapersonal, organizational and policy) (McLe roy et al., 1988).

All exposure variables that had a reported significant association with children’s physical activity or sedentary behavior were entered into
a spreadsheet and coded as having either positive, negative or no association. The direction of the association (i.e. positive or negative) was determined based on whether the correlate increased or decreased the behavior. An overall summary code was calculated based on the percent of correlates that reported the same direction of association for children’s physical activity and sedentary behavior articles (Table 2), consistent with the method used in other studies (Hinkley et al., 2010; Tonge et al., 2016). For example, an association was coded as indeterminate if only 34–59 % of findings supported a positive or negative association. A summary code was not calculated for the nutrition articles due to the reporting of data from the same sample in multiple studies and a large number of different outcome variables. In studies where moderate-intensity physical activity, vigorous-intensity physical activity and moderate- to- vigorous-intensity physical activity (MVPA) were reported separately, only MVPA was included to avoid double reporting results.

### 2.7. Risk of bias assessment

The Office of Health Assessment and Translation (OHAT) Risk of Bias Rating Tool for Human and Animal Studies was used to assess the risk of bias in the articles extracted from the literature search.
Table 3
Correlates of children’s dietary intake, physical activity and sedentary behavior.

| Author, date, location | Study population (educators, children) | Outcome assessment method | Correlates assessed | Correlates identified | Social Ecological Framework Domain Association |
|------------------------|----------------------------------------|--------------------------|---------------------|-----------------------|-----------------------------------------------|
| **Nutrition – Dietary intake** |                                        |                          |                     |                       |                                               |
| Cuadrado-Soto et al. 2019 Rhode Island, US | 118 HBCC educators 366 children age 2–5 years | Food intake assessed using the DOCC over 2 days in HBCC | Age 2–3 years vs 4–5 years | Vitamin B12 higher in younger than older children (3.3 ± 1.6 µg/1000 kcal vs 3.0 ± 1.8 µg/1000 kcal, p < 0.05) | Intrapersonal |
| | | Mean critical nutrient density per 1000 kcal calculated for 12 vitamins and 10 minerals | | Potassium higher in younger than older children (1670.2 ± 490.4 mg/1000 kcal vs 1572.8 ± 443.6 mg/1000 kcal, p < 0.05) | |
| | | | | Zinc densities higher in younger than older children (6.2 ± 2.1 mg/1000 kcal vs 5.3 ± 1.5 mg/1000 kcal, p < 0.05) | |
| | | | | Sodium:potassium ratio higher in the older children (1.12 ± 0.5 vs 1.05 ± 0.6, p < 0.05) | |
| Ramirez et al. 2020 Rhode Island, US | 120 HBCC educators 374 children age 2–5 years | Food intake assessed using the DOCC over 2 days in HBCC | Ethnicity Latino vs non-Latino | Mean servings intake of legumes higher for children cared for by Latino educators compared to non-Latino educators (0.06 (0.07) vs 0.0 (0.00), p < 0.00) | Interpersonal |
| | | Food items in major food groups identified, mean food group intake per HBCC calculated and proportion of food item to its respective major food group was calculated | | Higher total grain foods intake associated with children cared for by non-Latino educators compared to non-Latino educators (0.60 ± 0.27 vs 0.70 ± 0.32, p < 0.00) | |
| | | | | Mean servings intake of oils higher for children cared for by Latino educators compared to non-Latino educators (0.12 (0.11) vs 0.05 (0.11); p < 0.00) | |
| | | | | Mean servings intake of vegetable oils higher for children cared for by Latino educators compared to non-Latino educators compared to non-Latino educators (0.16 ±0.27 vs 0.12 ±0.19; p < 0.00) | |
| Tovar et al. 2018b North Carolina US | 133 HBCC educators Final model included 125 HBCCs Number of children not specified | Food intake assessed using the DOCC over 2 days in HBCC | Educator feeding practices assessed using a modified version of the EPAO | Higher child HEI scores positively associated with autonomy-support practices (Estimate 9.4; 95% CI 3.9, 15.0, p = 0.00) | Interpersonal |
| | | Diet quality calculated using the HEI | | Higher child HEI-2015 scores positively associated with: | |
| | | Food intake assessed using the DOCC over 2 days in HBCCDiet quality calculated using the HEI-2015 (higher scores indicate closer adherence to guidelines) | Educators socio-demographics reported via survey | Latinx educators (beta = 6.5, SE = 2.4, p = 0.01) (adjusted for income, ethnicity and CACFP) | |
| | | | | High total vegetables score associated with: | |
| | | | | Latinx educators (2.2 (1.4) vs 1.5 (1.3), p = 0.02) | |
| | | | | Higher greens/beans score associated with: | |
| | | | | Latinx educators (2.7 (2.0) vs 0.5 (1.1), p = 0.00) | |
| | | | | Lower income educators (2.5 (2.1) and 2.3 (2.1) vs 0.6 (1.0), p = 0.00) | |
| | | | | Higher total protein foods score associated with: | |
| | | | | Latinx educators (3.7 (1.5) vs | |
| (continued on next page)
Table 3 (continued)

| Author, date, location | Study population (educators, children) | Outcome assessment method | Correlates assessed | Correlates identified | Social Ecological Framework Domain Association |
|------------------------|----------------------------------------|---------------------------|---------------------|-----------------------|-----------------------------------------------|
| Benjamin-Neelon et al. 2018 North Carolina, US | 166 HBCC educators 496 children aged 1.5–4 years | Food intake assessed using the DOCC over 2 days in HBCC Diet quality calculated using the HEI | Nutrition best practices assessed via the EPAO | 2.8 (1.7), p = 0.01) Lower income educators (3.9 (1.4) and 3.6 (1.5) vs 2.6 (1.9), p = 0.02) Higher seafood and plant protein foods score associated with: Latinx educators (2.8 (2.0) vs 1.1 (1.7), p < 0.00) Lower income educators (3.1 (2.2) and 2.4 (2.1) vs 0.9, p = 0.00) Higher refined grain foods associated score with: Latinx educators (5.4 (3.3) vs 3.8 (3.0), p = 0.01) Higher child HEI score associated with: Higher EPAO total nutrition score (1.16; 95 % CI: 0.34, 1.98; p = 0.01), Foods provided (8.98; 95 % CI: 3.94, 14.01; p = 0.00), Nutrition education (5.37; 95 % CI: 0.80, 9.94; p = 0.02), Nutrition policy (2.36; 95 % CI: 0.23, 4.49; p = 0.03) | Organizational |
| Tovar et al. 2018a North Carolina, US | 166 HBCC educators 495 children aged 1.5–4 years Mean 7.2 (3.6) children | Food intake assessed using the DOCC over 2 days in HBCC Diet quality calculated using the HEI-2010 | Food served and consumed assessed using the DOCC over 2 days in HBCC Diet quality calculated using the HEI | Higher child HEI-2010 score of foods consumed associated with: Higher HEI-2010 score of foods served (Estimate 0.96, 95 % CI 0.91, 1.02; p < 0.00) | Organizational |
| Chai, Rice-McNeil and Trost 2020 Oregan, US | 41 HBCC educators 127 children aged 2–5 years | ActiGraph GT1M accelerometer worn over a week in HBCC 15 s epochs Pate cut points Sedentary bout ≥ 4 consecutive 15 s epochs with <25 counts each epoch. Short bouts: 1.0–4.9 min Medium bouts: 0–9.9 min Long bouts: 10.0–14.9 min (long) Extended bouts ≥ 15 min | Gender NAPSACCP practices categorized as promoting physical activity (PPA) or not promoting physical activity (non-PPA) | Total number of sedentary bouts and short sedentary bouts higher with girls (41.6 vs 36.6; p = 0.002); (36.0 vs 30.8; p = 0.00) Short bouts: 5 min higher with girls (36.0 vs 30.8; p < 0.00) No significant differences in medium, long or extended bouts Fewer sedentary bouts associated with PPA HBCC’s compared to non-PPA for the following categories: Daily outdoor active play (38.3 ± 1.2 vs 43.9 ± 1.7; p = 0.00) Children not seated for more than 30 min at a time (38.6 ± 1.4 vs 43.2 ± 1.8; p = 0.01) Computer use limited to only a few times a week (37.5 ± 0.9 vs 44.0 ± 1.7, p = 0.00) Fixed play equipment available (39.0 ± 1.4 vs 43.3 ± 2.0, p = 0.02) Active play using portable play equipment provided daily (38.2 ± 1.3 vs 42.4 ± 1.7; p = 0.01) Educator routinely played with children during active free play time (37.4 ± 1.3 vs 42.7 ± 1.5; p < 0.00) | Intrapersonal Organizational |

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Table 3 (continued)

| Author, date, location | Study population (educators, children) | Outcome assessment method | Correlates assessed | Correlates identified | Social Ecological Framework Domain Association |
|------------------------|----------------------------------------|---------------------------|---------------------|-----------------------|-----------------------------------------------|
|                        |                                        |                           |                     |                       |                                               |
|                        |                                        |                           |                     |                       |                                               |
| - 0.00|Educator read books or played games with physical activity (39.6 ± 1.5 vs 44.0 ± 2.3; p = 0.02) Education about PA was offered to parents (35.5 ± 1.6 vs 40.4 ± 1.1; p = 0.01) 4 ≥ significant PPA characteristics (37.5 ± 0.8 vs 49.6 ± 2.1; p < 0.00) Less sedentary time in short bouts associated with PPA HBCC compared to non-PPA for the following categories: Daily outdoor active play (60.0 ± 1.6 vs 68.7 ± 3.1; p = 0.02) Children not seated for more than 30 min at a time (59.9 ± 2.1 vs 67.2 ± 2.4; p = 0.02) Computer use limited to only a few times a week (59.2 ± 1.6 vs 71.6 ± 3.0; p < 0.00) Active play using portable play equipment provided daily (59.4 ± 1.8 vs 66.2 ± 2.4; p = 0.02) Educators routinely played with children during active free play time (57.8 ± 1.8 vs 67.7 ± 2.2; p = 0.00) Educators read books or played games with physical activity (62.0 ± 2.6 vs 71.4 ± 4.0; p = 0.01) Education about PA was offered to parents (56.4 ± 2.8 vs 63.7 ± 1.7; p = 0.03) 4 ≥ significant PPA characteristics (59.3 ± 1.4 vs 80.3 ± 3.9; p < 0.00) Less sedentary time in medium bouts associated with HBCC classified as promoting physical activity for the following categories compared to non-PPA: Children not seated for more than 30 min at a time (24.2 ± 2.1 vs 31.2 ± 2.7; p = 0.00) Active play using portable play equipment provided daily (24.3 ± 2.1 vs 28.7 ± 2.6; p = 0.04) Indoor play space available for all activities (19.7 ± 2.8 vs 26.0 ± 1.9; p = 0.02) Educator routinely played with children during active free play time (23.4 ± 2.2 vs 26.0 ± 1.7; p = 0.01) Education about PA was offered to parents (21.6 ± 2.7 vs 26.7 ± 2.1; p = 0.04) 4 ≥ significant PPA characteristics (21.1 ± 1.1 vs 33.5 ± 3.0; p < 0.00) |                                               |                                               |

(continued on next page)
| Author, date, location | Study population (educators, children) | Outcome assessment method | Correlates assessed | Correlates identified | Social Ecological Framework Domain |
|------------------------|---------------------------------------|---------------------------|---------------------|-----------------------|----------------------------------|
| Kang et al. 2021 Rhode Island and Massachusetts, US | 118 HBCC educators 342 aged 2–5 years | Triaxial GT3X™ ActiGraph accelerometers worn for 2 days 5 sec epochs Freedson et al. cut points *naptime included in analysis | Survey assessed age, sex and ethnicity (Hispanic vs non-Hispanic) | % time sedentary positively associated with: Younger children aged 2-years compared to 4–5 year olds (66.3 % vs 62.6 %, p = 0.033) % time in moderate physical activity positively associated with: Older children- 2-year olds vs 3-year olds vs 4–5 yr olds (5.3 % vs 6.0 % vs 6.7 %, p < 0.001)Males vs females (6.3 ± 2.1 vs 5.5 ± 2.0, p = 0.01) % time in MVPA positively associated with: Older children- 2-year olds vs 2-year olds vs 4–5 yr olds (7.4 % vs 9.1 % vs 10.6 %, p < 0.001)Males vs females (9.7 ± 3.4 vs 8.1 ± 3.3, p = 0.00) | Intrapersonal |
| Rice et al. 2014 Oregon, US | 47 HBCC educators 114 children aged 2-5 years | ActiGraph GT1M accelerometer worn for 2-5 days.Van Cauwenberghe et al. cut points | Gender, body mass index and age group (2–3 year olds and 4–5 year olds) | Higher MVPA associated with: Gender - boys compared to girls Age- healthy weight 4–5 year olds compared to healthy weight 2–3 years old BMI- Healthy weight children aged 4–5 years compared to overweight and obese children aged 4-5 year age category Higher total physical activity associated with: Gender- boys compared to girls Age- healthy weight 4-5 years old compared to healthy weight 2–3 years old BMI- Healthy weight children aged 4-5 years compared to overweight and obese children aged 4-5 year age category (exact values not reported) | Intrapersonal |
| Temple et al. 2009 British Columbia, Canada | 23 HBCC educators 65 children aged 3–5 years | Actical™ accelerometers worn for 1–4 days 15 sec epochs Pfeiffer et al. cut points | Gender | No gender-related differences were detected sedentary behavior and light, moderate-vigorous and vigorous physical activity Higher total activity associated with HBCC classified as promoting physical activity for the following categories compared to non-PPA: Daily outdoor active play (32.2 (1.0) vs 28.6 (1.3) min/hr, p = 0.00) Variety of fixed play equipment (32.2 (1.0) vs 28.9 (1.3)) | Intrapersonal |
| Gunter et al. 2012 Oregan, US | 45 HBCC educators 136 children aged 2-5 years | ActiGraph GT1M accelerometers worn 2 or more days. Pate et al. cut points. Epochs not reported | NAP SACC Categories condensed to promoting physical activity or not promoting physical activity | (continued on next page) | Interpersonal Organizational |
bias (Office of Health Assessment and Translation, 2019). The OHAT tool was selected because it assesses the study designs of articles that meet the inclusion criteria and provides an assessment rating for each criterion rather than a summary assessment score or quality rating. The risk of bias was assessed by two authors (EK, SR, LH and JN), and any differences were resolved by discussion with other authors (AO, BK and MH). The criteria assessed selection bias, confounding bias, attrition/exclusion bias, detection bias (for correlate and outcome variables), selective reporting bias, conflict of interest and other potential sources of bias. Each criterion was rated: ‘definitely low risk of bias’, ‘probably low risk of bias’, ‘probably high risk of bias’ or ‘definitely high risk of bias’.

3. Results

3.1. Summarising the articles

A total of 2316 articles were screened, and 15 studies met the inclusion criteria (Fig. 1). All studies were cross-sectional; six assessed associations with children’s dietary intake, and nine assessed physical activity and sedentary behaviors (Table 3). Most studies (n = 12) were conducted in the United States and the remainder (n = 3) in Canada. The age of children ranged from 1.5 years to 5 years.

3.2. Summarising the outcome findings related to children’s dietary intake

3.2.1. Dietary intake

All studies that measured children’s dietary intake used the Diet Observation at Child Care methodology (Table 3). Two studies used baseline data from the Keys to Healthy Family Child Care Homes (Keys) intervention (Benjamin-Neelon et al., 2018; Tovar et al., 2018a), one study used follow-up data from the Keys intervention (Tovar et al., 2018b) and three studies used baseline data from the Healthy Start/Comienzos Sanos (Healthy Start) intervention (Cuadrado-Soto et al., 2019; Ramirez et al., 2020; Tovar et al., 2020). Educators provided food...
Table 4

Summary of reported correlates for children’s dietary intake in home-based childcare services.

| Correlate                          | Significant association between sub-groups | Association (+) | No association |
|-----------------------------------|--------------------------------------------|-----------------|---------------|
| **Intrapersonal**                 |                                            |                 |               |
| Educator ethnicity                | Latino compared to non-Latino             | + Legumes, + Oils, + Vegetable oils, + Total grain serves | (Ramirez et al., 2020) * |
|                                   | (Ramirez et al., 2020) *                  |                 |               |
|                                  | (Tovar et al., 2020) *                    |                 |               |
|                                  | + Diet quality                            | (Tovar et al., 2020) * |
|                                  | + Total vegetables                        |                 |               |
|                                  | + Greens/beans                            |                 |               |
|                                  | + Total protein foods                     |                 |               |
|                                  | + Seafood and plant proteins              |                 |               |
|                                  | + Lower refined grains                    |                 |               |
| Educator income                  | Lower income compared to higher income    | + Greens/beans, + Total protein foods, + Seafood and plant proteins | (Tovar et al., 2020) * |
|                                  | (Tovar et al., 2020) *                    |                 |               |
|                                  | + Diet quality                            | (Tovar et al., 2020) * |
| Educator feeding practices       | Higher autonomy support scores            |                 |               |
|                                  | (Tovar et al., 2018b)                     |                 |               |
| Organizational variables         | Overall nutrition environment             | + Diet quality  |               |
|                                  | EPAO total nutrition score                |                 |               |
|                                  | (Benjamin-Neelon et al., 2018)            |                 |               |
|                                  | Nutritional quality of food provided      | + Diet quality  |               |
|                                  | Higher nutrition quality (Benjamin-Neelon et al., 2018; Tovar et al., 2018b) | | |
|                                  | (Benjamin-Neelon et al., 2018; Tovar et al., 2018b) | | |
|                                  | Nutrition education and professional development | + Diet quality |               |
|                                  | Higher nutrition education scores (Benjamin-Neelon et al., 2018) | | |
|                                  | (Benjamin-Neelon et al., 2018) | | |
|                                  | Nutrition policy scores (Benjamin-Neelon et al., 2018) | | |
| Beverages provided               | (Benjamin-Neelon et al., 2018) *          | No associations with beverage scores and overall diet quality score | |
| Feeding environment              | (Benjamin-Neelon et al., 2018) *          | No associations with feeding environment scores and overall diet quality score | |
| Menus and variety                | (Benjamin-Neelon et al., 2018) *          | No associations with menus and variety scores and overall diet quality score | |

EPAO- Environment and Policy Assessment and Observation; HEI-Healthy Eating Index.

* Data from the Healthy Start/Comienzos Sanos intervention.
* Data from the Keys to Healthy Family Child Care Homes intervention.
* Food provided were assessed using the EPAO (Benjamin-Neelon et al., 2018) and Diet Observation at Child Care (Tovar et al., 2018a).

for children in all the studies. Eleven correlates of children’s dietary intake were identified (Table 4), one at an intrapersonal level, three at an interpersonal level and seven at an organizational level.

3.2.2. Intrapersonal variables

Age was the only intrapersonal correlate assessed. Younger children consumed higher nutrient densities for three vitamins and minerals (vitamin B12, potassium, and zinc) out of 19 micronutrients assessed compared to older children (Cuadrado-Soto et al., 2019).

3.2.3. Interpersonal variables

Three interpersonal variables were assessed. Two studies assessed educator ethnicity (Ramirez et al., 2020; Tovar et al., 2020) and educators’ feeding practices (Benjamin-Neelon et al., 2018; Tovar et al., 2018b) and one study assessed educators’ household income (Tovar et al., 2020). Ethnicity was positively associated with several food groups and food items (Ramirez et al., 2020; Tovar et al., 2020) and overall diet quality (Tovar et al., 2020). One study found that lower-income educators were positively associated with children’s intake of green beans, total protein foods and seafood/plant proteins (Tovar et al., 2020). However, there was no difference in overall diet quality between lower- and higher-income educators after adjusting for educators’ participation in the Child and Adult Food Program (Tovar et al., 2020). Out of the two studies that assessed educators’ feeding practices, one study found that autonomy support practices (whereby educators encouraged children to eat according to their satiety) were positively associated with children’s diet quality (Tovar et al., 2018b), and the other study found no association with educators’ feeding practice scores and children’s diets (Benjamin-Neelon et al., 2018).

3.2.4. Organizational variables

Seven organizational variables were assessed using baseline data from the Keys intervention (Benjamin-Neelon et al., 2018; Tovar et al., 2018b). Children’s diet quality was positively associated with the home-based childcare nutrition environment (Benjamin-Neelon et al., 2018), foods provided (Benjamin-Neelon et al., 2018; Tovar et al., 2018a), nutrition education and professional development (Benjamin-Neelon et al., 2018) and home-based childcare nutrition policy (Benjamin-Neelon et al., 2018) scores. Children’s diet quality was not associated with beverages provided, feeding environment, menus or variety scores (Benjamin-Neelon et al., 2018).

3.3. Summarizing the outcome findings related to children’s physical activity and sedentary behavior

3.3.1. Physical activity and sedentary behavior

All studies that measured children’s physical activity or sedentary behavior used accelerometers; six used ActiGraphs, and three used Acticals. The number of days that children wore an accelerometer ranged from one to five days. The epochs and cut points used to analyze the accelerometry data varied (Table 3). Thirty-seven correlates for children’s physical activity were identified (Table 5), four at an intrapersonal level and 33 at an organizational level. Twenty-nine correlates for children’s sedentary behavior were identified (Table 6), three at an intrapersonal level and 26 at an organizational level. Two tools assessed the organizational environment: a self-assessment survey, the Nutrition and Physical Activity Self-Assessment for Child Care Instrument (NAP-SACC) (Chai et al., 2020; Gunter et al., 2012) and a direct observation tool, the Environment and Policy Assessment and Observation (EPAO).
Table 5
Summary of reported correlates for children’s physical activity in home-based childcare services.

| Correlate                        | Found association with children’s physical activity in ECEC service (reference) | Found no association with children’s physical activity in ECEC service (reference) | Summary coding for row (n/N for row; %) | Summary code for association (+/-) |
|----------------------------------|--------------------------------------------------------------------------------|---------------------------------------------------------------------------------|---------------------------------------|-------------------------------------|
| **Intrapersonal**                |                                                                                  |                                                                                 |                                       |                                     |
| Age                              | Older children compared to younger children (Kang et al., 2021)                  | (Kang et al., 2021)                                                            | 3/6                                   | ?                                   |
|                                  | (Rice and Trost, 2014)                                                           | (Rice and Trost, 2014)                                                         |                                       |                                     |
|                                  | Boys compared to girls (Kang et al., 2021)                                       | (Kang et al., 2021)                                                            | 3/6 50 %                             | ?                                   |
|                                  | (Rice and Trost, 2014)                                                           | (Temple et al., 2009)                                                          |                                       |                                     |
|                                  | Healthy weight compared to overweight/obese children aged 4–5 years (Rice and Trost, 2014) | (Rice and Trost, 2014)                                                         | 2/4 (50 %)                            | ?                                   |
|                                  | (Rice and Trost, 2014)                                                           | (Temple et al., 2009)                                                          |                                       |                                     |
| Ethnicity                        | Hispanic compared to non-Hispanic (Kang et al., 2021)                            | (Kang et al., 2021)                                                            | 0/2                                   | 0                                   |
|                                  | (Rice and Trost, 2014)                                                           | (Rice and Trost, 2014)                                                         |                                       |                                     |
| **Interpersonal**                |                                                                                  |                                                                                 |                                       |                                     |
| Educator’s physical activity practices/behaviors | (Mazzucca et al., 2018)                | (Mazzucca et al., 2018)                                                        | 0/2 (0 %)                             | 0                                   |
|                                  | (Vanderloo et al., 2015)                                                        | (Vanderloo et al., 2015)                                                       |                                       |                                     |
|                                  | (Gunter et al., 2012)                                                           | (Gunter et al., 2012)                                                          | 1/1 (100 %)                            | +                                   |
|                                  | (Gunter et al., 2012)                                                           | (Gunter et al., 2012)                                                          | 0/1 (0 %)                             | 0                                   |
| **Organisational**               |                                                                                  |                                                                                 |                                       |                                     |
| Physical activity opportunities  |                                                                                  |                                                                                 |                                       |                                     |
| Time provided for physical activity | (Mazzucca et al., 2018)                | (Mazzucca et al., 2018)                                                        | 0/3                                   | 0                                   |
|                                  | (Vanderloo et al., 2015)                                                        | (Vanderloo et al., 2015)                                                       | (0 %)                                 | 0                                   |
| Structured physical activity provided daily| (Gunter et al., 2012)               | (Gunter et al., 2012)                                                          | 0/1 (0 %)                             | 0                                   |
| Active (free) play time is provided for all children for 60 min/day | (Gunter et al., 2012)               | (Gunter et al., 2012)                                                          | 0/1 (0 %)                             | 0                                   |
| Outdoor playtime                 | (Gunter et al., 2012)                                                           | (Mazzucca et al., 2018)                                                        | 1/2 (50 %)                            | ?                                   |
| Active play using portable play equipment provided daily | (Gunter et al., 2012)               | (Gunter et al., 2012)                                                          | 1/1 (100 %)                            | +                                   |
| **Physical activity environment** |                                                                                  |                                                                                 |                                       |                                     |
| Outdoor play environment         |                                                                                  |                                                                                 |                                       |                                     |
| Outdoor space                    | (Mazzucca et al., 2018)                                                         | (Mazzucca et al., 2018)                                                        | 0/1 (0 %)                             | 0                                   |
| Landscape attractiveness         | (Mazzucca et al., 2018)                                                         | (Mazzucca et al., 2018)                                                        | 0/1 (0 %)                             | 0                                   |
| Active landscape                 | (Mazzucca et al., 2018)                                                         | (Mazzucca et al., 2018)                                                        | 0/1 (0 %)                             | 0                                   |
| Indoor play space                | (Gunter et al., 2012)                                                           | (Gunter et al., 2012)                                                          | 2/2 (100 %)                            | +                                   |
| Physical activity equipment      |                                                                                  |                                                                                 |                                       |                                     |
| Portable play equipment          |                                                                                  |                                                                                 |                                       |                                     |
| Fixed play equipment available   |                                                                                  |                                                                                 |                                       |                                     |
| Indoor play equipment            |                                                                                  |                                                                                 |                                       |                                     |
| Physical activity promotion and education |                                                                                  |                                                                                 |                                       |                                     |
| Displays posters, pictures, or books about physical activity | (Gunter et al., 2012)               | (Gunter et al., 2012)                                                          | 0/2 (0 %)                             | 0                                   |
| Educator reads books or plays games about physical activity | (Neshteruk et al., 2018)            | (Neshteruk et al., 2018)                                                       | 0/1 (0 %)                             | 0                                   |
| Education about physical activity is offered to parents through flyers, handouts, brochures, newsletters | (Gunter et al., 2012)               | (Gunter et al., 2012)                                                          | 0/1 (0 %)                             | 0                                   |
| Sedentary and screen time practices |                                                                                  |                                                                                 |                                       |                                     |
| Sedentary opportunities          |                                                                                  |                                                                                 | 0/1 (0 %)                             | 0                                   |

(continued on next page)
Table 5 (continued)

| Correlate                                      | Found association with children’s physical activity (reference) | Association (±) | Found no association with children’s physical activity in ECEC service (reference) | Summary coding for row (n/N for row; %) | Summary code for association (−/+) |
|------------------------------------------------|---------------------------------------------------------------|-----------------|---------------------------------------------------------------------------------|----------------------------------------|----------------------------------|
| Sedentary environment                          | (Vanderloo et al., 2015)                                      |                 |                                                                                 |                                        |                                  |
| Children are seated (excluding nap time) more than 30 min at a time once per week or less | (Vanderloo et al., 2015)                                      | 0/1 (0 %)       |                                                                                 | 0                                      | 0                                |
| Screen time                                    | (Gunter et al., 2012)                                         |                 |                                                                                 |                                        |                                  |
| Children are allowed to use a computer for educational purposes or games<4 times per week | (Mazzucca et al., 2018)                                      | 0/1 (0 %)       |                                                                                 | 0                                      | 0                                |
| Children are allowed to watch TV, videos or play video games<4 times per week            | (Gunter et al., 2012)                                         | 0/1 (0 %)       |                                                                                 | 0                                      | 0                                |
| Television used rarely and only viewing for educational programs | (Gunter et al., 2012)                                         | 0/1 (0 %)       |                                                                                 | 0                                      | 0                                |
| Media                                          | (Gunter et al., 2012)                                         | 0/1 (0 %)       |                                                                                 | 0                                      | 0                                |
| Physical activity professional development 1 or more times per year | (Gunter et al., 2012)                                         | 1/1 (100 %)     |                                                                                 | +                                      |                                  |
| Physical activity policy                       | (Gunter et al., 2012)                                         | 0/1 (0 %)       |                                                                                 | 0                                      | 0                                |
| Screen time policy                             | (Vanderloo et al., 2015)                                      | 0/1 (0 %)       |                                                                                 | 0                                      | 0                                |
| Overall physical activity environment 4 ≥ significant promoting physical activity characteristics | (Gunter et al., 2012)                                         | 1/1 (100 %)     |                                                                                 | +                                      |                                  |

a- MVPA, b- light physical activity, c- healthy weight categories, d- overweight or obese categories, e- healthy weight compared to overweight/obese children aged 4–5 years, f- healthy weight compared to overweight/obese children aged 2–3 year old, g- active fixed play equipment, h- creative fixed play equipment, i- availability, j- accessibility, k- variety. Summary code: 0 no association, ? indeterminate association, + positive association, – negative association.

(Mazzucca et al., 2018; Neshteruk et al., 2018; Tucker et al., 2015; Vanderloo et al., 2015).

3.3.2. Intrapersonal variables

Four intrapersonal variables were assessed. Two studies found children’s age, sex, and body mass index (BMI) were associated with physical activity; however, the strength of associations was inconclusive. One study reported that girls had more short sedentary bouts and total sedentary bouts than boys (Chai et al., 2020) however these findings were not supported in other studies (Chai et al., 2020; Kang et al., 2021; Temple et al., 2009). Children’s age and ethnicity were not associated with sedentary behavior (Kang et al., 2021).

3.3.3. Interpersonal variables

Three interpersonal variables were assessed. The two studies that assessed educators’ physical activity practices reported no association with physical activity (Mazzucca et al., 2018; Vanderloo et al., 2015) and were negatively associated with sedentary behavior in one (Tucker et al., 2015) out of two studies (Mazzucca et al., 2018). Educators’ regular participation in active play was positively associated with children’s physical activity (Gunter et al., 2012) and negatively associated with the number of sedentary bouts and sedentary time in short and medium bouts (Chai et al., 2020).

3.3.4. Organizational variables

Thirty-three correlates were assessed at the organizational level. Six variables relating to physical activity opportunity were assessed. Outdoor play was associated with total physical activity in one (Gunter et al., 2012) out of two studies (Mazzucca et al., 2018). Providing daily active play using portable play equipment was associated with physical activity in the one study that it was assessed (Gunter et al., 2012). Daily outdoor activity play was associated with fewer sedentary bouts and less sedentary time in shorter bouts (Chai et al., 2020).

Five variables relating to the physical activity environment were assessed. Indoor play space was positively associated with physical activity in the only two studies that it was assessed (Gunter et al., 2012; Neshteruk et al., 2018) and negatively associated with sedentary time spent in medium bouts (Chai et al., 2020). Three variables assessed physical activity equipment. The availability of fixed play equipment was positively associated with physical activity in one (Gunter et al., 2012) out of four studies, and negatively associated with sedentary behavior in one (Chai et al., 2020) out of two studies (Tucker et al., 2015).

Three variables relating to physical activity promotion and education were assessed. One study reported reading books and playing games about physical activity and offering parents education about physical activity was negatively associated with sedentary behavior (Chai et al., 2020). Nine variables assessed sedentary and screen time practices was identified for physical activity,. Limiting computer use was negatively associated with sedentary behavior (Chai et al., 2020), and seated time was positively associated with sedentary behavior in one study (Chai et al., 2020).

Two variables relating to physical activity professional development were assessed. One out of two studies found that physical activity professional development was associated with physical activity (Gunter et al., 2012). Policies were not associated with children’s physical activity or sedentary behavior (Chai et al., 2020; Gunter et al., 2012; Mazzucca et al., 2018; Vanderloo et al., 2015). Two studies found that home-based childcare facilities four or more significant promoting physical activity characteristics were positively associated with physical activity
Table 6
Summary of reported correlates for children’s sedentary behavior in home-based childcare services.

| Correlate | Found association with children’s sedentary behavior in home-based childcares (reference) | Association (+/-) | Found no association with children’s sedentary behavior in ECEC service (reference) | Summary coding for row (n/N for row, %) | Summary code for association (-/+) |
|-----------|--------------------------------------------------------------------------------------------|-------------------|---------------------------------------------------------------------------------|----------------------------------------|----------------------------------|
| **Intrapersonal** |                                                                                               |                   |                                                                                  |                                        |                                  |
| Age       | Boys compared to girls (Kang et al., 2021)                                                   | –                 | (Kang et al., 2021)                                                            | 0/1 (0 %)                              | 0                                |
| Sex       | Boys compared to girls (Chai et al., 2020)                                                   | –                 | (Chai et al., 2020)                                                            | 3/11 (27 %)                            | 00                               |
| Ethnicity | Hispanic compared to non-Hispanic (Kang et al., 2021)                                       | 0/1 (0 %)         |                                                                                  |                                        |                                  |
| **Interpersonal** |                                                                                               |                   |                                                                                  |                                        |                                  |
| Educator’s physical activity practices/behaviors | (Tucker et al., 2015)                                                                         | –                 | (Mazzucca et al., 2018)                                                        | 1/2 (50 %)                             | ?                                |
| Educator routinely played with children during active free play time | (Chai et al., 2020)                                                                         | –                 | (Chai et al., 2020)                                                            | 3/3 (100 %)                            | –                                |
| **Organisational** |                                                                                               |                   |                                                                                  |                                        |                                  |
| Physical activity opportunities |                                                                                               |                   |                                                                                  |                                        |                                  |
| Time provided for physical activity | (Mazzucca et al., 2018)                                                                       | 0/1 (0 %)         |                                                                                  |                                        | 0                                |
| Structured physical activity provided daily | (Chai et al., 2020)                                                                         | 0/3 (0 %)         |                                                                                  |                                        | 0                                |
| Daily outdoor active play | (Chai et al., 2020)                                                                         | –                 | (Chai et al., 2020)                                                            | 2/3 (67 %)                             | –                                |
| Outdoor playtime | (Mazzucca et al., 2018)                                                                       | –                 |                                                                                  |                                        | 0                                |
| Active play using portable play equipment provided daily | (Chai et al., 2020)                                                                         | 3/3 (100 %)       |                                                                                  |                                        | –                                |
| Physical activity environment |                                                                                               |                   |                                                                                  |                                        |                                  |
| Outdoor play environment | (Mazzucca et al., 2018)                                                                       | –                 |                                                                                  |                                        | 0                                |
| Indoor play space available for all activities | (Chai et al., 2020)                                                                         | 0/1 (0 %)         | (Chai et al., 2020)                                                            | 1/3 (33 %)                             | 0                                |
| Portable play environment | (Tucker et al., 2015)                                                                        | –                 | (Chai et al., 2020)                                                            | 1/4 (25 %)                             | 0                                |
| Fixed play equipment | (Chai et al., 2020)                                                                         | 0/1 (0 %)         |                                                                                  |                                        | 0                                |
| Indoor play equipment | (Mazzucca et al., 2018)                                                                       | –                 |                                                                                  |                                        | 0                                |
| Physical activity professional development | (Mazzucca et al., 2018)                                                                       | 0/1 (0 %)         |                                                                                  |                                        | 0                                |
| Educator receives training or attend workshops on physical activity at least once a year | (Chai et al., 2020)                                                                         | 0/3 (0 %)         |                                                                                  |                                        | 0                                |
| Physical activity promotion and education |                                                                                               |                   |                                                                                  |                                        |                                  |
| Educator read books or plays games about physical activity | (Chai et al., 2020)                                                                         | –                 | (Chai et al., 2020)                                                            | 2/3 (67 %)                             | –                                |
| Education about physical activity was offered to parents | (Chai et al., 2020)                                                                         | –                 |                                                                                  |                                        | 0                                |
| Sedentary and screen time practices |                                                                                               |                   |                                                                                  |                                        |                                  |
| Sedentary Opportunities | (Tucker et al., 2015)                                                                       | 0/1 (0 %)         |                                                                                  |                                        | 0                                |
| Sedentary Environment | (Tucker et al., 2015)                                                                       | 0/1 (0 %)         |                                                                                  |                                        | 0                                |
| Children are seated (excluding nap time) for more than 30 min at a time once per week or less | (Chai et al., 2020)                                                                         | +                 |                                                                                  |                                        | +                                |
| Screen time | (Mazzucca et al., 2018)                                                                       | 0/0 (0 %)         |                                                                                  |                                        | 0                                |
| Screen time practices | (Mazzucca et al., 2018)                                                                       | 0/1 (0 %)         |                                                                                  |                                        | 0                                |
| Children are allowed to use a computer for educational purposes or games &lt; 4 times per week | (Chai et al., 2020)                                                                         | –                 | (Chai et al., 2020)                                                            | 2/3 (67 %)                             | –                                |
| Children are allowed to watch TV, videos or play video games &lt; 4 times per week | (Chai et al., 2020)                                                                         | 0/3 (0 %)         |                                                                                  |                                        | 0                                |

(continued on next page)
4. Discussion

This systematic review examined the correlates of children’s dietary intake, physical activity and sedentary behavior in home-based childcare. The findings suggest that home-based childcare services are associated with children’s health-related behaviors. However, no strong associations for children’s dietary intake, physical activity, or sedentary behavior in home-based childcare were found due to the wide variety of correlates and outcome variables assessed across studies.

All the studies that assessed children’s dietary intake were conducted in the United States as part of the Keys and Healthy Start interventions (Benjamin-Neelon et al., 2018; Cuadrado-Soto et al., 2019; Ramirez et al., 2020; Tovar et al., 2020, Tovar et al., 2018a; Tovar et al., 2018b). At the intrapersonal level, younger children had higher nutrient densities than older children for three out of the 22 micronutrients assessed. Consistent with these findings, a study assessing the food provided to children in Australian home-based childcare services found that younger children aged 11–23 months compared to those aged 2–5 years were more likely to be provided with food that met the dietary requirements for their age group (Kerr et al., 2020). This Australian study was excluded from the current review as it assessed food provision rather than consumption. Further, national dietary surveillance studies from the United States and Australia have found that children aged 2–3 years are more likely to meet dietary guidelines compared to children aged 4–8 years (Australian Institute of Health and Welfare, 2018; Martin et al., 2021).

At the interpersonal level, educators’ ethnicity, income and feeding practices were associated with dietary intake. Two studies from the Healthy Start intervention reported positive associations between educator’s ethnicity and children’s diet quality (Tovar et al., 2020), and food group components (Ramirez et al., 2020; Tovar et al., 2020). Legumes predominantly contributed to increased diet quality, which is unsurprising because legumes are an integral food component in the traditional Latino diet (Cuy Castellanos, 2015). Latino home-based childcare educators have reported stronger values and motivation to provide children with healthy foods compared to non-Latino educators (Lindsay et al., 2017; Tovar et al., 2015). However, the average serve of legumes consumed by children from Latino educators’ homes was small and any difference may not be meaningful (Ramirez et al., 2020). Future studies should explore the influence of different ethnic backgrounds because other studies have found that ethnicity is associated with better diet quality (van der Velde et al., 2019) and higher levels of childhood obesity (Hardy et al., 2019; Ogden et al., 2014).

Educators with lower incomes provided children with more green beans, total protein foods and seafood and plant proteins; however, there was no association with overall diet quality when adjusted for Child and Adult Care Food Program participation and ethnicity. Other home-based childcare studies have also found that educators who were Child and Adult Care Food Program participants (Erichosho et al., 2018; Lazarus et al., 2018; Monsivais et al., 2011; Williams et al., 2021) or from areas of low socio-economic status (SES) (Kerr et al., 2020) were more likely to provide healthy food. Nevertheless, low SES has been associated with poorer dietary behaviors (Mahmood et al., 2021; Spence et al., 2018) and higher levels of obesity in children (Woo Baidal et al., 2016), and interventions should prioritize reaching children from low socio-economic backgrounds.

Two studies from the Keys intervention assessed the influence of educators’ feeding practices on children’s dietary intake. Autonomy support practices were associated with increased diet quality (Tovar et al., 2018b) but not overall feeding practice scores (Benjamin-Neelon et al., 2018), coercive feeding practices or role modelling (Tovar et al., 2018b). Other systematic reviews have reported that center-based ECEC educators’ practices (Ward et al., 2015) and parental feeding practices (Mahmood et al., 2021; Shloim et al., 2015) influence children’s eating behaviors. Therefore, promoting positive feeding practices should be an integral component of nutrition interventions for home-based childcare services.

The overall nutrition environment, nutrition education, and nutrition policies of home-based childcare were all associated with diet quality. However, the two studies that assessed these organizational correlates used baseline data from the Keys intervention (Benjamin-Neelon et al., 2018; Tovar et al., 2018a). Therefore, it is important that
future research is conducted to determine if these findings are replicated in different population groups. Research in center-based ECEC services has also found that children’s diet intake is positively associated with the foods provided (Barnes et al., 2021; Nicklas et al., 2013). Nutrition policies have also been positively associated with the food provided in center-based studies (Bussell et al., 2018). Home-based childcare interventions that include nutrition professional development for educators have found significant improvements in nutrition-related practices (Bravo et al., 2008; De Silva-Sanigorski et al., 2011; Dev et al., 2018; Trost et al., 2011; Woodward-Lopez et al., 2018) and children’s overall diet quality (Ward et al., 2020). However, Ward et al., (2020) also found that the Keys intervention resulted in a reduction of children’s vegetable intake. Likewise, mixed results have been reported in center-based ECEC services, with some nutrition interventions reporting a positive impact on children’s diet quality (Bell et al., 2015; Seward et al., 2018), while others reported no impact (Jones et al., 2015; Sharma et al., 2019). Consistent with other reviews in center-based ECEC services, this review identified multiple correlates of children’s physical activity and

| Nutrition – Diet intake | Selection bias | Confounding bias | Attrition/exclusion bias | Detection bias (exposure) | Detection bias (outcome) | Selective reporting bias | Conflict of interest | Other bias |
|-------------------------|----------------|------------------|-------------------------|---------------------------|-------------------------|------------------------|---------------------|-----------|
| Benjamin-Neelon et al. 2018 | + | ++ | + | ++ | + | ++ | ++ | X* |
| Cuadrado-Soto et al. 2019 | + | – | NR | ++ | + | ++ | ++ | X* |
| Ramirez et al 2020 | + | ++ | + | ++ | + | ++ | ++ | X* |
| Tovar et al., 2018a | + | ++ | + | ++ | + | ++ | ++ | X* |
| Tovar et al., 2018b | + | ++ | + | ++ | + | ++ | ++ | X* |
| Tovar et al. 2020 | + | ++ | + | ++ | + | ++ | ++ | X* |

| Physical activity and sedentary behaviors |
|------------------------------------------|
| Chai et al., 2020 | ++ | – | – | – | ++ | – | ++ | + |
| Gunter et al., 2012 | ++ | ++ | + | – | ++ | ++ | ++ | + |
| Kang et al. 2021 | + | – | – | ++ | ++ | ++ | ++ | – |
| Mazzucca, et al. 2018 | + | ++ | + | ++ | ++ | ++ | ++ | X* |
| Neshteruk et al. 2018 | + | + | + | ++ | ++ | ++ | ++ | X* |
| Rice et al. 2014 | ++ | – | ++ | ++ | ++ | ++ | – | + |
| Temple et al. 2009 | + | – | – | ++ | ++ | – | ++ | – |
| Tucker et al. 2015 | – | + | + | ++ | ++ | ++ | ++ | – |
| Vanderloo et al. 2015 | – | + | + | ++ | ++ | ++ | ++ | – |

| Definitely low risk | Probably low risk | Probably high risk | Not reported | Definitely high risk |
|---------------------|-------------------|-------------------|-------------|---------------------|

* No other bias identified
sedentary behavior, particularly at the organizational level of the social ecological model (Torrón-Pérez et al., 2021; Tonge et al., 2016). While this review found inconclusive results related to age, sex and BMI, a review conducted in center-based services found a strong association between physical activity and children’s age and sex, but inconclusive findings related to BMI and ethnicity (Tonge et al., 2016). Similar to this review, the influence of educators’ behaviors on children’s physical activity was mixed in center-based studies (Tonge, 2019). However, none of the included studies assessed the quality of educator-to-child interactions in home-based childcare services, which has been associated with children’s physical activity in center-based ECCEC services (Tonge et al., 2019; Zhang et al., 2019).

At the organizational level, indoor play space was the only correlate that was positively associated with physical activity in more than one study (Gunter et al., 2012; Neshteruk et al., 2018) and was negatively associated with medium bouts of sedentary activity (Chai et al., 2020). Similarly, indoor space has been associated with children’s physical activity (Torrón-Pérez et al., 2021; Tonge et al., 2016; Zhang et al., 2021) but not indoor play equipment (Zhang et al., 2021) or indoor play environment in center-based services. Although home-based childcare educators may not be able to change their indoor space, educators can use strategies to promote movement and activity in small indoor spaces. This review identified no strong associations for physical activity or sedentary behavior; however, three studies identified associations for outdoor playtime, active play using portable play equipment, fixed play equipment, television time and more than four significant promoting physical activity characteristics (Chai et al., 2020; Gunter et al., 2012; Neshteruk et al., 2018). Increased sedentary behavior was also negatively associated with physical activity promotion and education and positively associated with extended sitting time and computer use (Chai et al., 2020). Reviews in center-based services have identified that physical activity was strongly associated with the outdoor environment (Torrón-Pérez et al., 2021; Tonge et al., 2016), large play spaces (Torrón-Pérez et al., 2021; Tonge et al., 2016) and active opportunities (Tonge et al., 2016). In contrast, mixed findings have been identified for portable and fixed play equipment (Torrón-Pérez et al., 2021; Tonge et al., 2016). Similar to our study, policies were not associated with any changes in children’s physical activity or sedentary behavior and mixed findings were found for professional development in center-based studies (Tonge et al., 2016). The current review found that professional development was only associated with physical activity in one study and not associated with reduced sedentary behavior. Similarly, the Keys professional development intervention did not increase children’s physical activity or reduce sedentary behavior (Ward et al., 2020). These findings support the need for further exploration into the home-based childcare environment.

Overall, the nutrition studies had a lower risk of bias compared to the studies assessing physical activity or sedentary behaviour. However, all six nutrition articles were from two main studies. For the physical activity and sedentary behavior studies, most of the significant correlates identified were assessed from the NAPSACC survey. Only two significant associations were identified for children’s physical activity and sedentary behavior out of the four studies that used direct observation methods. One study found that indoor space was positively associated with MVPA (Neshteruk et al., 2018), and one study found that educators’ behaviors was negatively associated with sedentary time (Tucker et al., 2015).

This systematic review has some limitations. First, we found few studies that assessed the same correlates, thereby limiting the potential for pooling the data in meta-analyses. Secondly, most of the studies were conducted in the United States and from the same population, limiting the generalizability of the findings. Further, no studies assessed children younger than 1.5 years old and studies not written in English were excluded. Another limitation is that children’s physical activity and sedentary behaviour were analysed using different epochs and cut points. It should also be noted that cross-sectional studies cannot determine causal relationships.

5. Conclusion

This systematic review summarises the evidence on the multiple influences of children’s dietary intake, physical activity and sedentary behavior in the home-based childcare setting, particularly at an organizational level. The findings highlight the need for high-quality studies conducted in different countries that assess the nutrition and physical activity environments in home-based childcare using reliable and consistent methods of assessment to enable direct comparison of results. Given the considerable amount of time some children spend in home-based childcare services, it is an important setting for educators to facilitate improvements to the nutrition and physical activity behaviors of young children. A greater understanding of how the home-based childcare environment and educators’ practices influence children’s behaviours is required to inform health-related professional development and interventions. Based upon the literature in center-based ECCEC services and the findings of this review, interventions should target the multiple layers of the social ecological model and consider low socio-economic and culturally diverse groups. For example, at the organizational level, interventions should target food provision, physical activity opportunities and creating healthy environments. At the interpersonal level, interventions should target educators’ behaviours, including feeding practices and engagement in physical activity. Further, strategies should address the challenges and structural barriers experienced by educators, such as budget, time, limited resources and supporting children with different abilities and developmental requirements.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

No data was used for the research described in the article.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.pmedr.2022.101999.

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