Preventive Medicine Reports 30 (2022) 101999

Contents lists available at ScienceDirect

Preventive Medicine Reports

journal homepage: www.elsevier.com/locate/pmedr

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

Erin M. Kerr [a,*], Lyndel Hewitt [c,d], Sarah T. Ryan [a], Jennifer Norman [a,b,c], Bridget Kelly [a], Megan L. Hammersley [a], Melanie Lum [e,f,g,h], Anthony D. Okely [a]

[a] Early Start, Faculty of the Arts, Social Sciences and Humanities, University of Wollongong, NSW, Australia
[b] Health Promotion Service, Illawarra Shoalhaven Local Health District, Wollongong, NSW, Australia
[c] Illawarra Health Medical Research Institute, Wollongong, NSW, Australia
[d] Illawarra Shoalhaven Local Health District, Wollongong Hospital, New South Wales 2500, Australia
[e] Hunter New England Population Health, Wallsend, New South Wales 2287, Australia
[f] School of Medicine and Public Health, University of Newcastle, Callaghan, New South Wales 2308, Australia
[g] Hunter Medical Research Institute, Newcastle, New South Wales 2300, Australia
[h] Priority Research Centre for Health Behaviour, University of Newcastle, Callaghan, New South Wales 2308, Australia

ARTICLE INFO

Keywords:
Home-based child care
Dietary intake
Physical activity
Sedentary behavior
Children

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 McLeroy's social 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,

* Corresponding author.
E-mail address: emk833@uowmail.edu.au (E.M. Kerr).

https://doi.org/10.1016/j.pmedr.2022.101999
Received 13 January 2022; Received in revised form 20 September 2022; Accepted 24 September 2022
Available online 27 September 2022

2016), 228,975 in Canada (Statistics Canada, 2020) and 107,670 children in Australia (Australian Government, 2020). The conditions in which home-based childcares operate, 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 distinct 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, mealtime 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 childcare 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.

Table 1
Search strategy.

S1 All fields	"home-based child care" OR "home-based childcare" OR "homebased childcare" OR "home based child care" OR "home-based education" OR "home-based early childhood education" OR "home child care" OR "family day care" OR "family daycare" OR "family child care" OR "family childcare" OR "child minder*" OR "childminder*" OR "child minding*" OR "childminding*"OR "family-based child care" OR "family based child care" OR "family-based childcare"
S2 All fields	"eat*" OR "nutrition*" OR "nutrient" OR "diet*" OR "feed*" OR "food" OR "meal*" OR "fruit*" OR "vegetable*" OR "physical activit*" OR "physical inactivit*" OR "movement" OR "sedent*" OR "gross motor" OR "exercise*" OR "motor activity" OR "physical education" OR "physical training" OR "sport*"
S3	Combine S1 and S2 with "AND"

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 McLeroy's social ecological framework domains (interpersonal, intrapersonal, organizational and policy) (McLeroy et al., 1988).

All exposure variables that had a reported significant association with children's physical activity or sedentary behavior were entered into

Table 2
Rules for classifying variables regarding consistency of association with children's physical activity and sedentary behavior in home-based childcare services.

Results supporting association (%)	Summary code	Explanation of code
0–33	0	No association
34–59	?	Indeterminate/inconclusive association
60–100	+	Positive association
60–100	–	Negative association

Note: If an outcome was found four or more times, it was coded as: 00 (no association);?? (indeterminate); ++ (positive association); or – – (negative association).

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

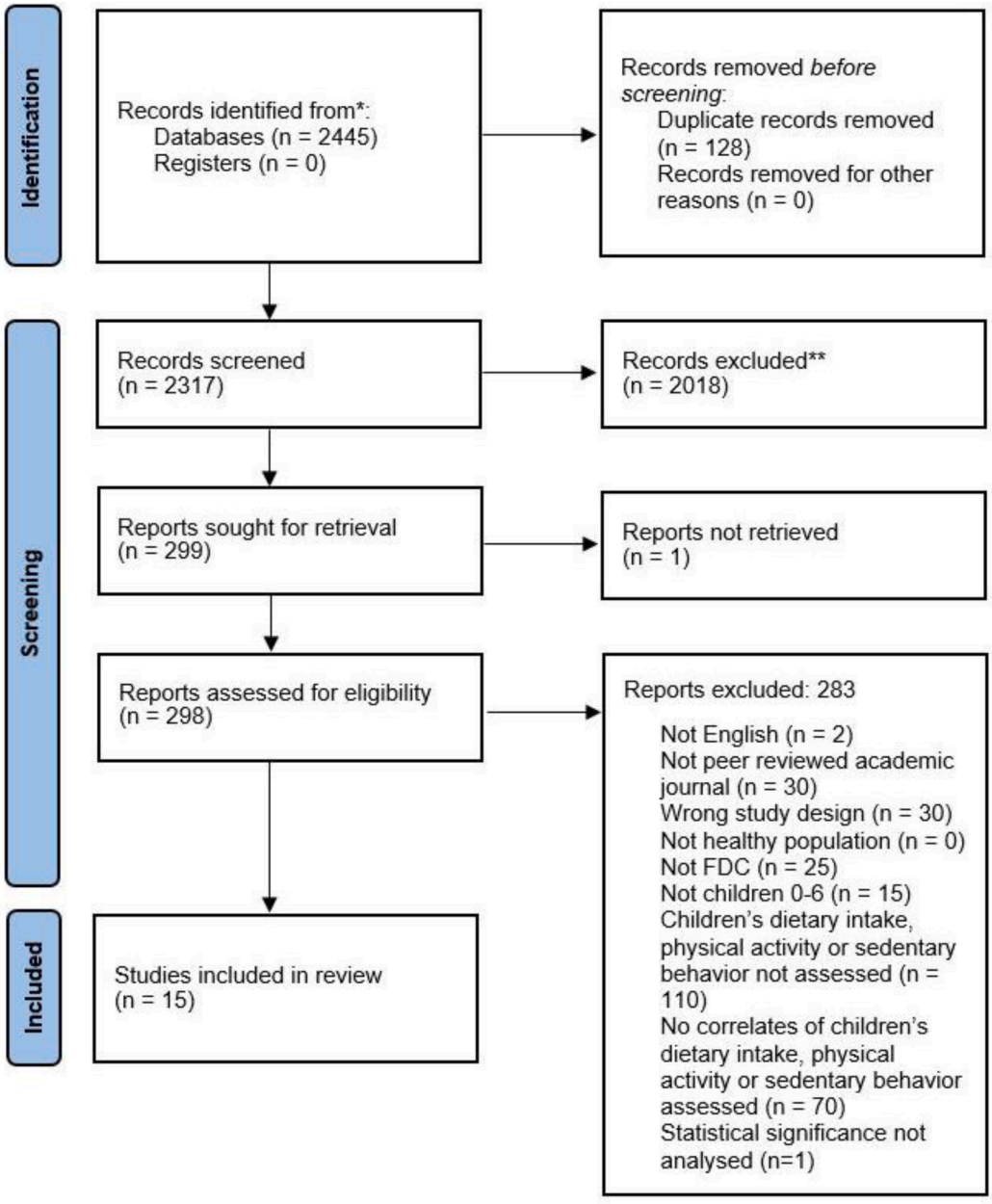

Fig. 1. Study flow diagram of search results and the selection process.

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 Mean critical nutrient density per 1000 kcal calculated for 12 vitamins and 10 minerals	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, $p < 0.05$)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, $p < 0.05$)	Intrapersonal
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 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	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), $p < 0.00$) 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 (0.13) vs 0.12 (0.19); $p < 0.00$)	Interpersonal
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 Diet quality calculated using the HEI	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
Tovar et al. 2020 Rhode Island, US	119 HBCC educators 374 children age 2–5 years	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 Variables assessed: gender, ethnicity, race, age, income, marital status, income, childcare experience, number of children in care, average hours of HBCC, CACFP participation, years in US, country of origin, language spoken at home, language spoken at HBCC	Higher child HEI-2015 scores positively associated with: 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	Interpersonal

(*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
				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), $p = 0.01$)	
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	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 yearsMean 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
Physical activity and sedentary behaviors					
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 epochsPate 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 NAPSACCPractices 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	Intrapersonal Organizational

(*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
				= 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*)

Table 3 (*continued*)

Author, date, location	Study population (educators, children)	Outcome assessment method	Correlates assessed	Correlates identified	Social Ecological Framework Domain Association
Kang et al. 2021 Rhode Island and Massachusetts, US	118 HBCC educators 342 aged 2–5 years	Triaxial GT3XTM ActiGraph accelerometers worn for 2 days 5 *sec* epochs Freedson et al. cut points *naptime included in analysis Correlates were reported for the full dataset and the upper median-half of wear time data set however only significant findings from the full dataset are reported in this review	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 (5.1 % 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, $p = 0.00$) % time in vigorous activity positively associated with: Older children 2-year olds vs 3-year olds vs 4–5 yr olds (2.3 % vs 3.1 % vs 3.9 %, $p < 0.00$)Males vs females (3.4 ± 1.5 vs 2.7 ± 1.4, $p = 0.00$)	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 Cauwnberghe 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 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	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	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)	Interpersonal Organizational

(*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
				0.002, $p = 0.00$)Active play using portable play equipment provided daily (31.7 (1.0) vs 29.3 (1.4) , $p = 0.04$)Indoor play space is available and suitable for all activities (33.6 (1.4) vs 31.0 (1.0) , $p = 0.03$) Educator often or always plays with children during active (free) play time (32.1 (1.1) vs 29.6 (1.2), $p = 0.01$) Educator receives training or attends workshops on PA 1 or more times per year (33.1 (1.2) vs 30.3 (1.1), $p = 0.01$) Four or more significant PPA characteristics (32.3 (1.1) vs 28.8 (1.2) , $p = 0.00$)	
Mazzucca, et al. 2018 North Carolina, US	165 HBCC educators rs 495 children aged 1.5–4.0 years	ActiGraph GT3X + accelerometers for 2 non-consecutive days. 15-second epoch.Pate et al. cut points	EPAO	No associations reached statistical significance	Interpersonal Organizational
Tucker et al. 2015 London, Ontario, Canada	11 HBCC educators 20 children aged 2.5–5 years	Actical™ accelerometers worn for 3–5 days during childcare hours. 15 *sec* epochs Pfeiffer et al. cut points	EPAO - five sedentarybehavior subscales examined during 1-day observation period	Sedentary time positively associated withstaff behavior scores* (β 1.45; 95 % CI: −0.17, 2.91; p = 0.03) * Higher scores indicated more sedentary environments	Interpersonal Organizational
Vanderloo et al. 2015 London, Ontario, Canada	11 HBCC educators 20 children aged 2.5–5 years	Actical™ accelerometers worn for 3–5 days during childcare hours. 15 *sec* epochs Pfeiffer et al. cut points	EPAO - eight physical activity subscales examined during 1-day observation period	No significant relationships were observed between the 8 EPAO subscales and children's physical activity	Interpersonal Organizational
Neshteruk et al. 2018, North Carolina, US	166 HBCC educators 496 children aged 1.5–4 years	ActiGraph GT3X + accelerometers for 2 non-consecutive days 15-second epochEvenson et al. and Pate et al. cut points	EPAO Indoor environment, portable play equipment, and the outdoor environment	Higher MVPA associated with indoor space available in the adjusted model (β = 0.33 (SE = 0.16); $p = 0.03$)	Organizational

Abbreviations: BMI- body mass index, DOCC- Diet Observation at Child Care, EPAO- Environment and Policy Assessment and Observation, HEI- healthy eating index, HBCC- home-based childcare, MVPA- moderate-to-vigorous physical activity, NAPSACC- Nutrition and Physical Activity Self- Assessment for Child Care, PPA- promoting physical activity.

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. Summarizing 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. Summarizing 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			
Interpersonal			
Educator ethnicity	Latino compared to non-Latino (Ramirez et al., 2020)[a]	+ Legumes + Oils + Vegetable oils - Total grain serves	(Ramirez et al., 2020)[a] No associations with 50 food group and food item variables
	(Tovar et al., 2020)[a]	+ Diet quality + Total vegetables + Greens/ beans + Total protein foods + Seafood and plant proteins + Lower refined grains	(Tovar et al., 2020) [a] No associations with 8 HEI-2015 component scores
Educator income	Lower income compared to higher income (Tovar et al., 2020)[a]	+ Greens/ beans + Total protein foods + Seafood and plant proteins	(Tovar et al., 2020) [a] No associations with 10 HEI-2015 components and overall diet quality score
Educator feeding practices	Higher autonomy support scores (Tovar et al., 2018b)[b]	+ Diet quality	(Benjamin-Neelon et al., 2018)[b] Feeding practices scores (Tovar et al., 2018b)[b] Coercive control/ indulgent feeding practices and negative role modelling
Organizational			
Overall nutrition environment	EPAO total nutrition score (Benjamin-Neelon et al., 2018)[b]	+ Diet quality	
Nutritional quality of food provided	Higher nutrition quality (Benjamin-Neelon et al., 2018; Tovar et al., 2018a)[b,c]	+ Diet quality	
Nutrition education and professional development	Higher nutrition educations scores (Benjamin-Neelon et al., 2018)[b]	+ Diet quality	
Nutrition policy	Higher nutrition policy scores (Benjamin-Neelon et al., 2018)[b]	+ Diet quality	
Beverages provided			(Benjamin-Neelon et al., 2018)[b] No associations with beverage scores and overall diet quality score
Feeding environment			(Benjamin-Neelon et al., 2018)[b] No associations with feeding environment scores and overall diet quality score
Menus and variety			(Benjamin-Neelon et al., 2018) [b] No associations with menus and variety scores and overall diet quality score

EPAO- Environment and Policy Assessment and Observation; HEI-Healthy Eating Index.
[a] Data from the Healthy Start/Comienzos Sanos intervention.
[b] Data from the Keys to Healthy Family Child Care Homes intervention.
[c] 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 (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 (–/+)
Intrapersonal					
Age	Older children compared to younger children (Kang et al., 2021)[a] (Rice and Trost, 2014)[a,c] (Rice and Trost, 2014)[c]	+	(Kang et al., 2021)[b] (Rice and Trost, 2014)[a,d] (Rice and Trost, 2014)[d]	3/6	?
Sex	Boys compared to girls (Kang et al., 2021)[a] (Rice and Trost, 2014)[a] (Rice and Trost, 2014)	+	(Kang et al., 2021)[b] (Temple et al., 2009)[b] (Temple et al., 2009)[a]	3/6 50 %	?
BMI	Healthy weight compared to overweight/obese children aged 4–5 years (Rice and Trost, 2014) (Rice and Trost, 2014)[a]	+ +	Healthy weight compared to overweight/obese children aged 2–3 year old (Rice and Trost, 2014) (Rice and Trost, 2014)[a]	2/4 (50 %)	?
Ethnicity			Hispanic compared to non-Hispanic (Kang et al., 2021)[a] (Kang et al., 2021)[b]	0/2	0
Interpersonal					
Educator's physical activity practices/ behaviors			(Mazzucca et al., 2018)[a] (Vanderloo et al., 2015) (Vanderloo et al., 2015)[a]	0/2 (0 %)	0
Educator routinely played with children during active free play time	(Gunter et al., 2012)	+		1/1 (100 %)	+
Educator never restricts active play time for children who misbehave			(Gunter et al., 2012)	0/1 (0 %)	0
Organisational					
Physical activity opportunities					
Time provided for physical activity			(Mazzucca et al., 2018)[a] (Vanderloo et al., 2015) (Vanderloo et al., 2015)[a]	0/3 (0 %)	0
Structured physical activity provided daily			(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)	0/1 (0 %)	0
Outdoor playtime	(Gunter et al., 2012)	+	(Mazzucca et al., 2018)[a]	1/2 (50 %)	?
Active play using portable play equipment provided daily	(Gunter et al., 2012)	+		1/1 (100 %)	+
Physical activity environment					
Outdoor play environment			(Mazzucca et al., 2018)[a]	0/1 (0 %)	0
Outdoor space			(Neshteruk et al., 2018)[a]	0/1 (0 %)	0
Landscape attractiveness			(Neshteruk et al., 2018)[a]	0/1 (0 %)	0
Active landscape			(Neshteruk et al., 2018)[a]	0/1 (0 %)	0
Indoor play space	(Gunter et al., 2012) (Neshteruk et al., 2018)[a]	+ +		2/2 (100 %)	+
Physical activity equipment					
Portable play equipment			(Vanderloo et al., 2015) (Vanderloo et al., 2015)[a] (Gunter et al., 2012) (Neshteruk et al., 2018)[a,i] (Neshteruk et al., 2018)[a,j] (Neshteruk et al., 2018)[a,k]	0/6 (0 %)	00
Fixed play equipment available	(Gunter et al., 2012)	+	(Mazzucca et al., 2018)[a] (Neshteruk et al., 2018)[a,g] (Neshteruk et al., 2018)[a,h] (Vanderloo et al., 2015) (Vanderloo et al., 2015) [a]	1/6 (17 %)	0
Indoor play equipment			(Mazzucca et al., 2018)[a]	0/1 (0 %)	0
Physical activity promotion and education					
Displays posters, pictures, or books about physical activity			(Gunter et al., 2012) (Neshteruk et al., 2018)[a]	0/2 (0 %)	0
Educator reads books or plays games about physical activity			(Gunter et al., 2012)	0/1 (0 %)	0
Education about physical activity is offered to parents through flyers, handouts, brochures, newsletters			(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 (–/+)
			(Vanderloo et al., 2015)		
			(Vanderloo et al., 2015) [a]		
Sedentary environment			(Vanderloo et al., 2015)	0/1 (0 %)	0
			(Vanderloo et al., 2015) [a]		
Children are seated (excluding nap time) more than 30 min at a time once per week or less			(Gunter et al., 2012)	0/1 (0 %)	0
Screen time			(Mazzucca et al., 2018) [a]	0/1 (0 %)	0
Screen time practices			(Mazzucca et al., 2018) [a]	0/1 (0 %)	0
Children are allowed to use a computer for educational purposes or games<4 times per week			(Gunter et al., 2012)	0/1 (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
Television used rarely and only viewing for educational programs			(Gunter et al., 2012)	0/1 (0 %)	0
Media			(Gunter et al., 2012[a]	0/1 (0 %)	0
Professional development					
Physical activity education and professional development			(Mazzucca et al., 2018) [a]	0/2 (0 %)	0
			(Vanderloo et al., 2015)		
			(Vanderloo et al., 2015) [a]		
Physical activity professional development 1 or more times per year	(Gunter et al., 2012)	+		1/1 (100 %)	+
Policy					
Physical activity policy			(Gunter et al., 2012)	0/1 (0 %)	0
			(Mazzucca et al., 2018)[a]		
			(Vanderloo et al., 2015)		
			(Vanderloo et al., 2015)[a]		
Screen time policy			(Mazzucca et al., 2018)[a]	0/1 (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 childcares with 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			(Kang et al., 2021)	0/1 (0 %)	0
Sex	Boys compared to girls (Chai et al., 2020)[a] (Chai et al., 2020)[b] (Chai et al., 2020)[f]	−	(Temple et al., 2009) (Kang et al., 2021) (Chai et al., 2020)[c] (Chai et al., 2020)[d] (Chai et al., 2020)[e] (Chai et al., 2020)[g] (Chai et al., 2020)[h] (Chai et al., 2020)[i]	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)[j]	−	(Mazzucca et al., 2018)	1/2 (50 %)	?
Educator routinely played with children during active free play time	(Chai et al., 2020)[a] (Chai et al., 2020)[f] (Chai et al., 2020)[g]	−		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)[a] (Chai et al., 2020)[f] (Chai et al., 2020)[g]	0/3 (0 %)	0
Daily outdoor active play	(Chai et al., 2020)[a] (Chai et al., 2020)[f]	−	(Chai et al., 2020)[g]	2/3 (67 %)	−
Outdoor playtime			(Mazzucca et al., 2018)		0
Active play using portable play equipment provided daily	(Chai et al., 2020)[a] (Chai et al., 2020)[f] (Chai et al., 2020)[g]	−		3/3 (100 %)	−
Physical activity environment					
Outdoor play environment			(Mazzucca et al., 2018)	0/1 (0 %)	0
Indoor play space available for all activities	(Chai et al., 2020)[g]	−	(Chai et al., 2020)[a] (Chai et al., 2020)[f]	1/3 (33 %)	0
Physical activity equipment					
Portable play environment			(Tucker et al., 2015)	0/1 (0 %)	0
Fixed play equipment	(Chai et al., 2020)[a]	−	(Chai et al., 2020)[f] (Chai et al., 2020)[g] (Tucker et al., 2015)	1/4 (25 %)	0
Indoor play equipment			(Mazzucca et al., 2018)	0/1 (0 %)	0
Physical activity professional development					
Physical activity education and 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)[a] (Chai et al., 2020)[f] (Chai et al., 2020)[g]	0/3 (0 %)	0
Physical activity promotion and education					
Educator read books or plays games about physical activity	(Chai et al., 2020)[a] (Chai et al., 2020)[f]	−	(Chai et al., 2020)[g]	2/3 (67 %)	−
Education about physical activity was offered to parents	(Chai et al., 2020)[a] (Chai et al., 2020)[f] (Chai et al., 2020)[g]	−		3/3 (100 %)	−
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)[a] (Chai et al., 2020)[f] (Chai et al., 2020)[g]	+		3/3 (100 %)	+
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<4 times per week	(Chai et al., 2020)[a] (Chai et al., 2020)[f]	−	(Chai et al., 2020)[g]	2/3 (67 %)	−
Children are allowed to watch TV, videos or play video games<4 times per week			(Chai et al., 2020)[a] (Chai et al., 2020)[f]	0/3 (0 %)	0

(*continued on next page*)

Table 6 (*continued*)

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 (–/+)
			(Chai et al., 2020)[g]		
Policy					
Physical activity policy			(Mazzucca et al., 2018) (Chai et al., 2020)[a] (Chai et al., 2020)[f] (Chai et al., 2020)[g]	0/4 (0 %)	0
Screen time policy			(Mazzucca et al., 2018)	0/1 (0 %)	0
Overall physical activity environment					
4 ≥ significant promoting physical activity characteristics	(Chai et al., 2020)[a] (Chai et al., 2020)[f] (Chai et al., 2020)[g]	–		3/3 (100 %)	–

a- number of total sedentary bouts, b- number of short sedentary bouts, c- number of medium sedentary bouts, d- number of long sedentary bouts, e- number of extended sedentary bouts, f- time spend in short sedentary bouts, g- time spend in medium sedentary bouts, h- time spend in long sedentary bouts, i- time spend in extended sedentary bouts, j- study reported a positive association; however, higher educators behavior scores indicated a more sedentary environment so the association was revered in the table.
Summary code: 0 no association,? indeterminate association, + positive association, – negative association.

(Gunter et al., 2012) and a negatively associated with sedentary behavior (Chai et al., 2020).

3.4. Risk of bias

The risk of bias results are summarized in Table 7, which provides additional details for each rating. For the nutrition studies, all studies were rated 'probably low risk' or 'definitely low risk'. The Diet Observation at Child Care methodology was rated probably low risk for the outcome detection bias due to the subjectivity of estimating foods and beverages, which is not as accurate as weighing foods (Sambell et al., 2019). All physical activity and sedentary behavior studies were rated low risk of detection bias for the outcome variable because they used accelerometers. Two studies found that home-based childcares with four or more significant promoting physical activity characteristics were positively associated with physical activity (Gunter et al., 2012) and a negatively associated with sedentary behavior (Chai et al., 2020).

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 (Erinosho 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 childcares 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

Table 7
Risk of bias.

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 a. 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 –– Definitely high risk
NR Not reported

* No other bias identified

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

sedentary behavior, particularly at the organizational level of the social ecological model (Terrón-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 ECEC 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 (Terrón-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 (Terrón-Pérez et al., 2021; Tonge et al., 2016), large play spaces (Terrón-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 (Terrón-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 ECEC services and the findings of this review, interventions should target the multiple layers of the social ecological model and consider low socioeconomic and culturally diverse groups. For example, at the organisation 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.

Acknowledgements

This work was supported by the Prevention Research Support Program, funded by the New South Wales Ministry of Health. This research has been conducted with the support of the Australian Government Research Training Program Scholarship.

Appendix A. Supplementary data

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

References

Australian Government, 2020. Child Care in Australia report March quarter 2020 [WWW Document]. Aust. Gov. Dep. Educ. Ski. Employ. URL https://www.dese.gov.au/key-official-documents-about-early-childhood/early-childhood-and-child-care-reports/child-care-australia/child-care-australia-report-march-quarter-2020.

Australian Institute of Health and Welfare., 2018. Physical activity across the life stages. Canberra: AIHW.

Barnes, C., Yoong, S.L., Wolfenden, L., Nathan, N., Wedesweiler, T., Kerr, J., Pearson, N., Grady, A., 2021. The association between australian childcare centre healthy eating practices and children's healthy eating behaviours: A cross-sectional study within lunchbox centres. Nutrients 13 (4), 1139.

Bell, L.K., Hendrie, G.A., Hartley, J., Golley, R.K., 2015. Impact of a nutrition award scheme on the food and nutrient intakes of 2- to 4-year-olds attending long day care. Public Health Nutr. 18, 2634–2642. https://doi.org/10.1017/S1368980014003127.

Benjamin-Neelon, S.E., Vaughn, A.E., Tovar, A., Østbye, T., Mazzucca, S., Ward, D.S., 2018. The family child care home environment and children's diet quality. Appetite 126, 108–113. https://doi.org/10.1016/j.appet.2018.03.024.

Bravo, A., Cass, Y., Tranter, D., 2008. Good food in family day care: Improving nutrition and food safety in family day care. Nutr. Diet. 65, 47–55. https://doi.org/10.1111/j.1747-0080.2007.00136.x.

Bussell, K., Francis, L., Armstrong, B., Kilby, S., Black, M.M., Hager, E.R., 2018. Examining Nutrition and Physical Activity Policies and Practices in Maryland's Child Care Centers. Child. Obes. 14, 403–411. https://doi.org/10.1089/chi.2018.0085.

Chai, L.K., Rice-McNeil, K., Trost, S.G., 2020. Patterns and Correlates of Sedentary Behavior in Children Attending Family Child Care. Int. J. Environ. Res. Public Health 17, 1–10. https://doi.org/10.3390/ijerph17020549.

Cuadrado-Soto, E., Risica, P.M., Gans, K.M., Mena, N.Z., Ellis, C., Araujo, C.D., Lofgren, I. E., Stowers, K.C., Tovar, A., 2019. Micronutrient adequacy in preschool children attending family child care homes. Nutrients 11, 1–15. https://doi.org/10.3390/nu11092134.

Cuy Castellanos, D., 2015. Dietary Acculturation in Latinos/Hispanics in the United States. Am. J. Lifestyle Med. 9, 31–36. https://doi.org/10.1177/1559827614552960.

De Silva-Sanigorski, A., Elea, D., Bell, C., Kremer, P., Carpenter, L., Nichols, M., Smith, M., Sharp, S., Boak, R., Swinburn, B., 2011. Obesity prevention in the family day care setting: Impact of the Romp & Chomp intervention on opportunities for children's physical activity and healthy eating. Child. Care. Health Dev. 37, 385–393. https://doi.org/10.1111/j.1365-2214.2010.01205.x.

Dev, D.A., Williams, N., Iruka, I., Garcia, A.S., Guo, Y., Patwardhan, I., Cummings, K., Rida, Z., Hulse, E., Sedani, A., 2018. Improving the nutrition and screen time environment through self-assessment in family childcare homes in Nebraska. Public Health Nutr. 21, 2351–2359. https://doi.org/10.1017/S1368980018001416.

Erinosho, T., Vaughn, A., Hales, D., Mazzucca, S., Gizlice, Z., Ward, D., 2018. Participation in the Child and Adult Care Food Program Is Associated with Healthier Nutrition Environments at Family Child Care Homes in Mississippi. J. Nutr. Educ. Behav. 50, 441–450. https://doi.org/10.1016/j.jneb.2017.11.004.

Fees, B., Trost, S., Bopp, M., Dzewaltowski, D.A., 2009. Physical Activity Programming in Family Child Care Homes: Providers' Perceptions of Practices and Barriers. J. Nutr. Educ. Behav. 41, 268–273. https://doi.org/10.1016/j.jneb.2008.01.013.

Francis, L., Shodeinde, L., Black, M.M., Allen, J., 2018. Examining the Obesogenic Attributes of the Family Child Care Home Environment: A Literature Review. J. Obes. 2018, 1–20. https://doi.org/10.1155/2018/3490651.

Gunter, K.B., Rice, K.R., Ward, D.S., Trost, S.G., 2012. Factors associated with physical activity in children attending family child care homes. Prev. Med. (Baltim) 54, 131–133. https://doi.org/10.1016/j.ypmed.2011.12.002.

Hardy, L.L., Jin, K., Mihrshahi, S., Ding, D., 2019. Trends in overweight, obesity, and waist-to-height ratio among Australian children from linguistically diverse backgrounds, 1997 to 2015. Int. J. Obes. 43, 116–124. https://doi.org/10.1038/s41366-018-0139-5.

Hinkley, T., Salmon, J., Okely, A.D., Trost, S.G., 2010. Correlates of sedentary behaviours in preschool children: a review. Int. J. Behav. Nutr. Phys. Act. 7, 1–10.

Jones, J., Wyse, R., Finch, M., Lecathelinais, C., Wiggers, J., Marshall, J., Falkiner, M., Pond, N., Yoong, S.L., Hollis, J., Fielding, A., Dodds, P., Clinton-McHarg, T., Freund, M., McElduff, P., Gillham, K., Wolfenden, L., 2015. Effectiveness of an intervention to facilitate the implementation of healthy eating and physical activity policies and practices in childcare services: A randomised controlled trial. Implement. Sci. 10, 1–15. https://doi.org/10.1186/s13012-015-0340-z.

Kang, A.W., Gans, K.M., von Ash, T., Castagneri, D., Dionne, L., Tovar, A., Risica, P.M., 2021. Physical Activity Levels among Preschool-Aged Children in Family Child Care Homes: A Comparison between Hispanic and Non-Hispanic Children Using Accelerometry. Children 8, 349. https://doi.org/10.3390/children8050349.

Kerr, E.M., Kelly, B., Hammersley, M.L., Hernandez, L., Norman, J., Furber, S., Vuong, C., Ryan, S., Wardle, K., Okely, A.D., 2020. Foods provided to children in family day care: An observational study. Public Health Nutr. 24, 3196–3204. https://doi.org/10.1017/S1368980021001506.

Layzer, J.I., Burstein, N., 2007. National study of child care for low-income families patterns of child care use among low-income families: final report, Abt Associates Inc.

Lazarus, M.A., Tandon, P.S., Otten, J.J., 2018. Examining Relationships between Food Procurement Characteristics and Nutritional Quality in Washington State Child Care Settings. Child. Obes. 14, 429–439. https://doi.org/10.1089/chi.2018.0090.

Lindsay, A.C., Greaney, M.L., Wallington, S.F., Wright, J.A., 2017. Easier said than done: A qualitative study conducted in the USA exploring Latino family child care home providers as role models for healthy eating and physical activity behaviours. BMJ Open 7 (11), e018219.

Mahmood, L., Flores-Barrantes, P., Moreno, L.A., Manios, Y., Gonzalez-Gil, E.M., 2021. The influence of parental dietary behaviors and practices on children's eating habits. Nutrients 13, 1–13. https://doi.org/10.3390/nu13041138.

Martin, C.L., Steinfeldt, L.C., Goldman, J.D., Moshfegh, A.J., 2021. Usual intakes of food pattern components by U.S. children: WWEIA, NHANES 2013–2016. J. Food Compos. Anal. 102, 104063. https://doi.org/10.1016/j.jfca.2021.104063.

Mazzucca, S., Neshteruk, C., Burney, R., Vaughn, A.E., Hales, D., Østbye, T., Ward, D., 2018. Physical activity and sedentary behaviors of children in family child care homes: Are there opportunities for improvement? Pediatr. Exerc. Sci. 30, 529–536. https://doi.org/10.1123/pes.2018-0040.

McLeroy, K.R., Bibeau, D., Steckler, A., Glanz, K., 1988. An Ecological Perspective on Health Promotion Programs. Health Educ. Q. 15, 351–377. https://doi.org/10.1177/109019818801500401.

Monsivais, P., Kirkpatrick, S., Johnson, D.B., 2011. More Nutritious Food Is Served in Child-Care Homes Receiving Higher Federal Food Subsidies. J. Am. Diet. Assoc. 111, 721–726. https://doi.org/10.1016/j.jada.2011.02.007.

National Center on Early Childhood Quality Assurance, 2016. Characteristics of Home-Based Early Care and Education Providers: Initial Findings from the National Survey of Early Care and Education. Washington, DC.

Neshteruk, C.D., Mazzucca, S., Østbye, T., Ward, D.S., 2018. The physical environment in family childcare homes and children's physical activity. Child. Care. Health Dev. 44, 746–752. https://doi.org/10.1111/cch.12578.

Nicklas, T.A., Liu, Y., Stuff, J.E., Fisher, J.O., Mendoza, J.A., O'Neil, C.E., 2013. Characterizing lunch meals served and consumed by pre-school children in Head Start. Public Health Nutr. 16, 2169–2177. https://doi.org/10.1017/S1368980013001377.

O'Connor, J.P., Temple, V.A., 2005. Constraints and Facilitators for Physical Activity in Family Day Care. Australas. J. Early Child. 30, 1–9. https://doi.org/10.1177/183693910503000402.

OECD, 2021. PF3 . 2 : Enrolment in childcare and pre-school, OECD Family Database.

Office of Health Assessment and Translation, 2019. Handbook for conducting a literature-based health assessment using OHAT approach for systemic review and evidence integration, Division of the National Toxicology Program.

Ogden, C.L., Carroll, M.D., Kit, B.K., Flegal, K.M., 2014. Prevalence of childhood and adult obesity in the United States, 2011–2012. JAMA - J. Am. Med. Assoc. 311, 806–814. https://doi.org/10.1001/jama.2014.732.

Ouzzani, M., Hammady, H., Fedorowicz, Z., Elmagarmid, A., 2016. Rayyan-a web and mobile app for systematic reviews. Syst. Rev. 5, 1–10. https://doi.org/10.1186/s13643-016-0384-4.

Page, M.J., Moher, D., Bossuyt, P.M., Boutron, I., Hoffmann, T.C., Mulrow, C.D., Shamseer, L., Tetzlaff, J.M., Akl, E.A., Brennan, S.E., Chou, R., Glanville, J., Grimshaw, J.M., Hróbjartsson, A., Lalu, M.M., Li, T., Loder, E.W., Mayo-Wilson, E., Mcdonald, S., Mcguinness, L.A., Stewart, L.A., Thomas, J., Tricco, A.C., Welch, V.A., Whiting, P., Mckenzie, J.E., 2021. PRISMA 2020 explanation and elaboration: Updated guidance and exemplars for reporting systematic reviews. BMJ 372. https://doi.org/10.1136/bmj.n160.

Ramirez, A., Vadiveloo, M., Risica, P.M., Gans, K.M., Greaney, M.L., Mena, N.Z., Stowers, K.C., Tovar, A., 2020. Dietary Contributors to Food Group Intake in Preschool Children Attending Family Childcare Homes: Differences between Latino and Non-Latino Providers. Nutrients 12, 1–15.

Rice, K.R., Trost, S.G., 2014. Physical Activity Levels Among Children Attending Family Day Care. J. Nutr. Educ. Behav. 46, 197–202. https://doi.org/10.1016/j.jneb.2013.09.001.

Sambell, R., Wallace, R., Costello, L., Lo, J., Devine, A., 2019. Measuring food provision in Western Australian long day care (LDC) services: a weighed food record method/protocol at a service level. Nutr. J. 18, 1–11. https://doi.org/10.1186/s12937-019-0462-2.

Seward, K., Wolfenden, L., Finch, M., Wiggers, J., Wyse, R., Jones, J., Yoong, S.L., 2018. Improving the implementation of nutrition guidelines in childcare centres improves child dietary intake: Findings of a randomised trial of an implementation intervention. Public Health Nutr. 21, 607–617. https://doi.org/10.1017/S1368980017003366.

Sharma, S.V., Vandewater, E., Chuang, R.J., Byrd-Williams, C., Kelder, S., Butte, N., Hoelscher, D.M., 2019. Impact of the coordinated approach to child health early childhood program for obesity prevention among preschool children: The Texas childhood obesity research demonstration study. Child. Obes. 15, 1–13. https://doi.org/10.1089/chi.2018.0010.

Shloim, N., Edelson, L.R., Martin, N., Hetherington, M.M., 2015. Parenting styles, feeding styles, feeding practices, and weight status in 4–12 year-old children: A systematic review of the literature. Front. Psychol. 6 https://doi.org/10.3389/fpsyg.2015.01849.

Spence, A.C., Campbell, K.J., Lioret, S., McNaughton, S.A., 2018. Early Childhood Vegetable, Fruit, and Discretionary Food Intakes Do Not Meet Dietary Guidelines, but Do Show Socioeconomic Differences and Tracking over Time. J. Acad. Nutr. Diet. 118, 1634–1643. https://doi.org/10.1016/j.jand.2017.12.009.

Statistics Canada, 2020. Survey on Early Learning and Child Care Arrangements, 2020 [WWW Document]. Stat. Canada. URL https://www150.statcan.gc.ca/n1/daily-quotidien/210407/t001b-eng.htm.

Stitou, M., Bourgeault, I.-L., Kohen, D., 2018. The job content, context, and requirements of regulated home-based childcare workers. NEW Solut. A J. Environ. Occup. Heal. Policy 27, 607–628. https://doi.org/10.1177/1048291117739417.

Temple, V.A., Naylor, P.-J., Rhodes, R.E., Higgins, J.W., 2009. Physical activity of children in family child care. Appl. Physiol. Nutr. Metab. 34, 794–798. https://doi.org/10.1139/H09-061.

Terrón-Pérez, M., Molina-García, J., Martínez-Bello, V.E., Queralt, A., 2021. Relationship Between the Physical Environment and Physical Activity Levels in Preschool Children: A Systematic Review. Curr. Environ. Heal. Reports 8, 177–195. https://doi.org/10.1007/s40572-021-00318-4.

Tonge, K.L., Jones, R.A., Okely, A.D., 2016. Correlates of children's objectively measured physical activity and sedentary behavior in early childhood education and care services: A systematic review. Prev. Med. (Baltim) 89, 129–139. https://doi.org/10.1016/j.ypmed.2016.05.019.

Tonge, K.L., Jones, R.A., Okely, A.D., 2019. Quality Interactions in Early Childhood Education and Care Center Outdoor Environments. Early Child. Educ. J. 47, 31–41. https://doi.org/10.1007/s10643-018-0913-y.

Tonge, K.L., 2019. The Relationship between Educator Engagement & Interaction and Children ' s Physical Activity in Early Childhood Education and Care Services The Relationship between Educator Engagement & Interaction and Children ' s Physical Activity in Early Childhood E.

Tonyan, H.A., Paulsell, D., Shivers, E.M., 2017. Understanding and Incorporating Home-Based Child Care Into Early Education and Development Systems. Early Educ. Dev. 28, 633–639. https://doi.org/10.1080/10409289.2017.1324243.

Tovar, A., Risica, P., Mena, N., Lawson, E., Ankoma, A., Gans, K.M., 2015. An Assessment of Nutrition Practices and Attitudes in Family Child-Care Homes: Implications for Policy Implementation. Prev. Chronic Dis. 12, E88. https://doi.org/10.5888/pcd12.140587.

Tovar, A., Benjamin-Neelon, S.E., Vaughn, A.E., Tsai, M., Burney, R., Østbye, T., Ward, D. S., 2018a. Nutritional Quality of Meals and Snacks Served and Consumed in Family Child Care. J. Acad. Nutr. Diet. 118, 2280–2286. https://doi.org/10.1016/j.jand.2018.08.154.

Tovar, A., Vaughn, A.E., Fisher, J.O., Benjamin Neelon, S.E., Burney, R., Webster, K., Liu, T., Ostbye, T., Ward, D.S., 2018b. Modifying the Environment and Policy Assessment and Observation (EPAO) to better capture feeding practices of family childcare home providers. Public Health Nutr. 22, 223–234. https://doi.org/10.1017/s1368980018002665.

Tovar, A., Risica, P.M., Ramirez, A., Mena, N., Lofgren, I.E., Cooksey Stowers, K., Gans, K.M., 2020. Exploring the Provider-Level Socio-Demographic Determinants of Diet Quality of Preschool-Aged Children Attending Family Childcare Homes. Nutrients 12, 1368. https://doi.org/10.3390/nu12051368.

Trost, S.G., Messner, L., Fitzgerald, K., Roths, B., 2011. A nutrition and physical activity intervention for family child care homes. Am. J. Prev. Med. 41, 392–398. https://doi.org/10.1016/j.amepre.2011.06.030.

Tucker, P., Vanderloo, L.M., Burke, S.M., Irwin, J.D., Johnson, A.M., 2015. Prevalence and influences of preschoolers' sedentary behaviors in early learning centers: A cross-sectional study. BMC Pediatr. 15 https://doi.org/10.1186/s12887-015-0441-5.

van der Velde, L.A., Nguyen, A.N., Schoufour, J.D., Geelen, A., Jaddoe, V.W.V., Franco, O.H., Voortman, T., 2019. Diet quality in childhood: the Generation R Study. Eur. J. Nutr. 58, 1259–1269. https://doi.org/10.1007/s00394-018-1651-z.

Vanderloo, L.M., Tucker, P., Johnson, A.M., Burke, S.M., Irwin, J.D., 2015. Environmental influences on preschoolers' physical activity levels in various early-learning facilities. Res. Q. Exerc. Sport 86, 360–370. https://doi.org/10.1080/02701367.2015.1053105.

Wallace, R., Mills, B., 2019. A study of the food environment at Australian family day care. Nutrients 11, 2395. https://doi.org/10.3390/nu11102395.

Ward, S., Bélanger, M., Donovan, D., Carrier, N., 2015. Systematic review of the relationship between childcare educators' practices and preschoolers' physical activity and eating behaviours. Obes. Rev. 16, 1055–1070. https://doi.org/10.1111/obr.12315.

Ward, D.S., Vaughn, A.E., Burney, R.V., Hales, D., Benjamin-Neelon, S.E., Tovar, A., Østbye, T., 2020. Keys to healthy family child care homes: Results from a cluster randomized trial. Prev. Med. Baltim). 132, 105974 https://doi.org/10.1016/j.ypmed.2019.105974.

WHO, 2017. Report of the Commission on Ending Childhood Obesity., Implementation Plan: Executive summary,. doi:10.1016/j.jhep.2013.02.018.

Williams, B.D., Sisson, S.B., Padasas, I.O., Dev, D.A., 2021. Food Program Participation Influences Nutrition Practices in Early Care and Education Settings. J. Nutr. Educ. Behav. 53, 299–308. https://doi.org/10.1016/j.jneb.2021.01.012.

Williamson, L., Davis, E., Priest, N., Harrison, L., 2011. Australian family day care educators: A snapshot of their qualifications, training and perceived support. Aust. J. Early Child. 36 (4), 63–68.

Wolfenden, L., Barnes, C., Jones, J., Finch, M., Rj, W., Kingsland, M., Tzelepis, F., Grady, A., Rk, H., Booth, D., Sl, Y., Wolfenden, L., Barnes, C., Jones, J., Finch, M., Rj, W., Kingsland, M., Tzelepis, F., Grady, A., Rk, H., Booth, D., Sl, Y., 2020. Strategies to improve the implementation of healthy eating, physical activity and obesity prevention policies, practices or programmes within childcare services (Review). doi:10.1002/14651858.CD011779.pub3.www.cochranelibrary.com.

Woo Baidal, J.A., Locks, L.M., Cheng, E.R., Blake-Lamb, T.L., Perkins, M.E., Taveras, E. M., 2016. Risk Factors for Childhood Obesity in the First 1,000 Days: A Systematic Review. Am. J. Prev. Med. 50, 761–779. https://doi.org/10.1016/j.amepre.2015.11.012.

Woodward-Lopez, G., Kao, J., Kuo, E.S., James, P., Lenhart, K., Becker, C., Boyle, K., Williamson, D., Rauzon, S., 2018. Changes in Nutrition Policies and Dietary Intake in Child Care Homes Participating in Healthy Eating and Active Living Initiative. Am. J. Prev. Med. 54, S170–S177. https://doi.org/10.1016/j.amepre.2018.01.007.

Yoong, S.L., Lum, M., Jones, J., Kerr, E., Falkiner, M., Delaney, T., McCrabb, S., Chai, L. K., Seward, K., Grady, A., 2020. A systematic review of interventions to improve the dietary intake, physical activity and weight status of children attending family day care services. Public Health Nutr. 23, 2211–2220. https://doi.org/10.1017/S1368980019005275.

Zhang, Z., Sousa-Sá, E., Pereira, J.R., Okely, A.D., Feng, X., Santos, R., 2019. The associations between environmental characteristics of early childhood education and care centers and 1-year change in toddlers' physical activity and sedentary behavior. J. Phys. Act. Heal. 16, 1000–1006. https://doi.org/10.1123/jpah.2019-0066.

Zhang, Z., Kuzik, N., Adamo, K.B., Ogden, N., Goldfield, G.S., Okely, A.D., Crozier, M., Hunter, S., Predy, M., Carson, V., 2021. Associations Between the Child Care Environment and Children's In-Care Physical Activity and Sedentary Time. Heal. Educ. Behav. 48, 42–53. https://doi.org/10.1177/1090198120972689.