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Review

Multilevel, Actionable Factors Related to Adolescent Dairy Intake: A Scoping Review Guided by the Social Ecological Model

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A B S T R A C T

Globally, adolescents are not meeting recommended nutrient or food group intakes. Adolescence is a period often characterized by rapid biological growth and increased autonomy, both of which strongly influence dietary intake, highlighting a critical stage that presents opportunities to shape healthy eating patterns. This scoping review aimed to identify actionable factors that contribute to adolescent dairy consumption patterns as a proxy for calcium adequacy, to inform future interventions and policies for improving diet-related health outcomes. A comprehensive search of PubMed, Excerpta Medica Database (Embase), Web of Science, and the Cumulative Index to Nursing and Allied Health Literature was performed in April 2025, yielding 11,691 potential articles. Following title and abstract screening conducted in duplicate, with conflicts resolved by a (MDR), data were extracted from the 181 articles that met the inclusion criteria. The Social Ecological Model (SEM) was then applied as a framework to identify the multilevel approaches related to dairy intake. Findings from this review underscore the importance of targeted interventions that encompass each sphere of SEM influence: *1*) individual factors, such as nutrition knowledge and food literacy; *2*) interpersonal factors, including the impact of family and peers; *3*) institutional factors as with the school environment; *4*) community factors comprising the availability and access to dairy foods; and *5*) policies, including school-based policies and food assistance resources. There is a need for research and interventions that address the various determinants of intake across multiple levels of the SEM to support meaningful improvements in adolescents' behaviors and promote alignment with dietary recommendations. This study was registered on Open Science Framework: https://doi.org/10.17605/OSF.IO/ARP45.

Keywords: dairy, dairy intake, adolescents, social ecological model, actionable factors

Introduction

Over one-third of adolescents, defined by the WHO as individuals between the ages of 10 and 19 y, are not achieving adequate nutrition [1,2]. Adolescence is a critical developmental stage characterized by accelerated physical, psychosocial, and cognitive growth that requires increased nutrients to support heightened metabolic demands [3]. This period also serves as a formative phase for developing and establishing autonomous and persistent health-related behaviors; therefore, inadequate nutrition during adolescence has been associated with an increased risk for chronic disease later in life [4,5]. Identifying and increasing the consumption of nutrient-rich foods while reducing the risk of overnutrition during adolescence is essential to optimize physical, cognitive, and developmental health outcomes [6].

One area of adolescent diet that requires further exploration is calcium intake. Adolescence represents a critical window for bone development, and inadequate intake during this period may increase the risk of adverse adult outcomes, such as

Abbreviations: RCT, randomized controlled trial; RTEC, ready-to-eat cereal; SEM, Social Ecological Model; SNAP, Supplemental Nutrition Assistance Program.

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osteoporosis and suboptimal peak bone mass [7,8]. Despite its importance, globally, calcium intake among adolescents is consistently below recommended amounts [9,10]. Calcium can be obtained from a variety of dietary sources, including plant-based foods like tofu and broccoli, or fortified options, such as fruit juice and cereals, as well as dairy products [11–13]. Although multiple dietary pathways to achieving calcium adequacy exist, dairy intake remains particularly relevant from both a nutritional and methodological perspective. Dairy provides a concentrated and bioavailable source of calcium, is widely consumed across diverse populations, and is consistently captured in a variety of dietary assessment tools and surveillance [14-16]. As a result, dairy intake can be used as a proxy indicator for calcium consumption in adolescent populations.

In recognition of dairy's role in supporting calcium adequacy during this life stage, dietary guidelines in >100 countries include recommendations for dairy consumption [17]. Despite its importance, evidence suggests that many adolescents worldwide fail to meet recommended intake levels [18-20]. In the United States, 2020 NHANES data indicate that many adolescents do not meet recommended daily dairy intakes, a gap of particular concern given dairy's role as a primary source of nutrients essential for growth and development [21]. These classifications provide context for recommended intake patterns; however, assisting individuals in meeting these, or dietary recommendations overall, is often challenging, as diet is shaped by a combination of dynamic, interrelated influences [22-24].

Globally, dietary patterns vary widely because of factors, such as household resources, local food environments, cultural beliefs and practices, and individual health considerations [22-24]. Dairy is no exception, with research indicating that dairy intake varies among adolescents in relation to factors such as access and affordability; parental education level; genetics; sociodemographic characteristics; geographic context; health beliefs and biological factors, such as lactose intolerance [18, 20, 25-33]. The distribution of lactose intolerance across populations underscores the importance of understanding the broader conditions that shape how adolescents can meet calcium needs in practice and the identification of determinants that can be influenced through intervention. Furthermore, many factors influencing dietary intake present challenges for public health and nutrition interventions, as these determinants are often not easily altered through traditional nutrition programming [34]. This limitation highlights the importance of identifying modifiable external and environmental factors that may serve as actionable intervention targets [35].

Thus, characterizing the multilevel determinants of dairy intake, as a proxy for calcium, among adolescents is warranted to inform research and interventions aimed at supporting dietary improvements and subsequent nutritional health outcomes. The Social Ecological Model (SEM) provides a useful framework for understanding the interconnectedness between internal and external factors that shape dietary intake [36]. In the context of examining adolescent dairy intake, the SEM may offer a conceptual structure for elucidating and synthesizing influences across individual, interpersonal, institutional, community, and policy levels, which collectively shape or constrain nutritional behaviors [37]. Therefore, a systematic scoping review was conducted to identify actionable factors that contribute to adolescent dairy consumption patterns, organized using the SEM framework, to inform future interventions and policies aimed at improving overall health outcomes in this population.

Methods

Search strategy

A comprehensive literature search of PubMed, Excerpta Medica Database (Embase), Web of Science, and the Cumulative Index to Nursing and Allied Health Literature was performed on April 10, 2025, to identify articles focused on factors associated with bovine dairy intake among adolescents aged 10 to 19. The applied search strategy utilized an adapted version of the Population, Exposure, Comparator, and Outcome approach, emphasizing various spheres of potential determinants aligned with the SEM and the relative impact on adolescent dairy intake (Supplemental Table 1). All articles published between 2010 and 2025 that met the initial eligibility criteria were uploaded into Covidence (Veritas Health Innovation Ltd), a management platform for conducting systematic and scoping reviews, in-depth screening, and subsequent data extraction. A lower time bound of 2010 was selected for this review as the WHO launched a 2010 strategic initiative to support adolescent health, prioritizing nutrition as an area for concerted action [1].

Eligibility criteria

Articles were eligible for inclusion if the study was conducted in an adolescent population (10–19 y). To ensure that the study population aligned with the WHO guidelines for adolescent populations, studies that included a spectrum of ages, including those spanning infancy through older adults, were eligible for inclusion provided that the reported mean age and standard deviation fell within the adolescent range of 10 y and maximum 19 y of age for inclusion or if results were reported separately by age group (e.g., adolescents, adults, and children).

Articles that included any form(s) of bovine dairy, such as milk, yogurt, cheese, cream cheese, cottage cheese, ice cream, butter, or mixed dishes containing dairy, were eligible for inclusion. The specific quantity of overall dairy intake or individual dairy products must have been explicitly stated as servings per timeframe, cup equivalents per day, or other measured intakes. Articles that examined dietary patterns that included dairy as a component but did not quantify dairy independent of other foods in the pattern were excluded, as it was not possible to discern if dairy intake was driving the dietary pattern score. Although dairy from other mammals, such as goat, sheep, camel, or donkey, are important cultural and nutritional components across global populations, they were excluded from this review, as the nutrient content of these products differs from cows [38]. One exception was made for milk alternatives. In countries such as Canada, where dietary guidelines include both milk and fortified [39] milk alternatives, studies in which milk and milk alternative consumption were grouped together were included where applicable.

The SEM was used to guide the categorization of actionable influencing factors of global adolescent dairy intake. Although factors were categorized into specific levels of the SEM for analysis clarity, many determinants of adolescents' dairy intake operate across multiple levels and interact dynamically rather

than functioning in isolation. Influencing factors could be within any of the 5 spheres of the SEM (individual, interpersonal, institutional, community, or policy) and needed to be identified as actionable, such that the factor could be realistically modified or addressed through behavior change, direct intervention, or policy. Importantly, this review does not seek to minimize the role of structural and biological determinants. Rather, these factors are recognized as fundamental influences on adolescent behavior and dietary patterns, thereby limiting the feasibility of individuals meeting their dietary recommendations. However, as many of these structural factors cannot be reasonably altered, the aim of this review was to identify factors that could be practically, ethically, and appropriately modified within an intervention with the goal of improving calcium adequacy and serving as a potential framework for overall dietary intake. Therefore, nonmodifiable factors influencing adolescent dairy intake, including but not limited to, genetic predisposition, lactose intolerance, parental education or income, or geographic climate conditions, were not included. Further, it must be acknowledged that although these determinants were not classified as actionable within this article's framework, they remain critical contextual factors that often influence actionable outcomes, individual behaviors, and intervention effectiveness.

Articles were confined by neither study type nor geographical location, such that study designs included observational and experimental studies from various countries. Articles were excluded if they were not original peer-reviewed research studies, conducted in nonhuman populations or in vitro models, or were published in a language other than English.

Screening and data extraction

Articles that met the initial eligibility criteria were then reviewed in duplicate by 2 individuals, randomly assigned from a team of trained reviewers (E.S., G.G., B.L., R.C., S.Z.C., and R.E.S.) with conflict resolution performed by a third reviewer (M.D.R.). The title and abstract screening were intentionally broad; articles were advanced to full-text review if they met the core eligibility criteria related to publication year, inclusion or possible inclusion of bovine dairy intake (total dietary intake), and appropriate age range. Because this scoping review used an inductive thematic approach within this phase, nonactionable factors were not an eligibility determinant to ensure that review was conducted within the full text, rather than abstracts alone, to drive the identification of relevant factors and reduce the likelihood that potentially relevant determinants were excluded prematurely. A detailed summary of the review protocol, screening, and extraction methods is included in Supplemental File 1.

Prior to independent full-text review, a training stage in which all reviewers extracted the same 6 articles and discussed eligibility criteria was completed. Following training, 2 reviewers (E.S., G.G., B.L., R.C., S.Z.C., and R.E.S.) independently assessed the full text to verify all criteria were present for final inclusion, and any conflicts were resolved by a third reviewer (M.D.R.).

A similar process was applied to data extraction, such that the data elements pertinent to this scoping review were extracted independently by 2 randomly selected reviewers (E.S., G.G., B.L., R.C., S.Z.C., and R.E.S.), and any discrepancies in data reporting were resolved by a third reviewer (M.D.R.). The following components from each article was extracted: study design, the country in which the study was conducted, the type of dairy consumed, the factor(s) influencing dairy intake, the association of each factor on dairy intake (positive, negative, or no association), and the sphere(s) of the SEM with which each factor aligned.

Synthesis of data

A thematic analysis was applied to the extracted data, and broad patterns were grouped into overarching themes or categories of determinants associated with dairy intake. A final compiled list of common factors reported across articles associated with dairy intake was documented upon completion of the full-text review. The list of factors identified during this phase was reviewed and discussed by the authors and systematically compared across included studies to identify commonalities, differences, and recurring concepts. Using an iterative and inductive synthesis process, conceptually similar factors were grouped into high-order thematic categories using a detailed checklist (Supplemental File 1). A total of 15 categories, including an "other" category, were established for the data extraction phase. During extraction, studies reporting factors that did not align with the predefined thematic framework were categorized as "other," with detailed notes recorded to capture the relevant factor and context. Forty-four factors were initially coded within the "other" category. Following completion of data extraction, these factors were reviewed to determine whether they overlapped conceptually with existing categories, fit within a refined subcategory, or represented a distinct thematic category. Upon completion of data extraction, the thematic structure was revisited and refined to ensure consistency, clarity, and comprehensive coverage of the evidence base as described in Supplemental File 1. As part of this refinement process, the initially extracted categories were grouped into 17 subcategories and further consolidated into 7 broader overarching categories. The following overarching categories were identified: acculturation and assimilation; dietary intake and meal environment; food access, availability, and insecurity; lifestyle and health behaviors; psychosocial and intrinsic factors; nutrition knowledge and educational programming; and policy. Within each category, influencing factors were arranged based on the subsequent impact on the directionality of dairy intake. Each factor was analyzed and assigned 1 or more corresponding spheres of the SEM. The findings of this scoping review were reported in accordance with the PRISMA for Scoping Reviews. The study protocol and statistical analysis plan were registered on Open Science Framework [40].

Results

Using the selected search terms, 11,691 records were retrieved for screening. After removing duplicates ($n = 2599$), 9092 records remained. The initial title and abstract screening identified 512 potential articles for inclusion, which were further assessed for eligibility within the full-text review phase. Of the full-text articles reviewed, 333 were excluded due to lack of dairy intake as an outcome ($n = 165$), a lack of an actionable or a modifiable factor ($n = 111$), wrong age group (not 10–19 y; $n = 49$), not available in English ($n = 4$), or wrong type of article

(not peer-reviewed, review article, etc.; $n = 4$). In total, 179 articles were included for extraction. A hand search (January 2026) identified 2 relevant articles published after the initial search period, resulting in a total of 181 articles included in the review. The title/abstract, full text, and reasons for exclusion are presented in a PRISMA flow diagram (Figure 1).

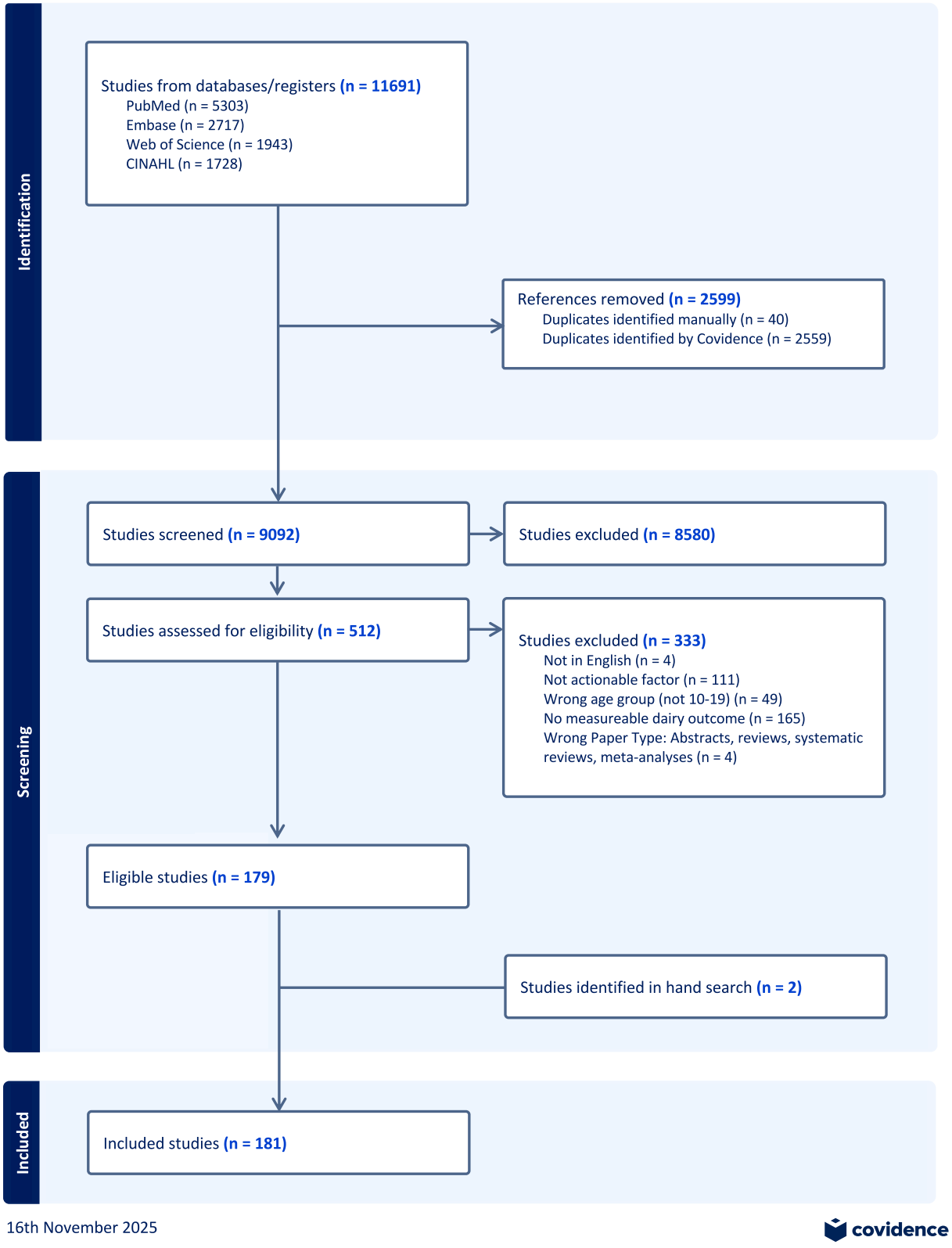


FIGURE 1. PRISMA diagram of study inclusion process. CINAHL, Cumulative Index to Nursing and Allied Health Literature.

Study characteristics

Across the included articles, most used a cross-sectional design (n = 129), followed by a quasi-experimental approach (n = 35), randomized controlled trials (RCTs; n = 15), and 2 studies used an observational approach. Studies originated from 42 countries, indicating broad geographic coverage with the highest representation from the United States (n = 59), Canada (n = 19), and the Republic of Korea (n = 9). The geographic distribution of the included studies is presented in Figure 2, with the number of articles for each country indicated in Figure 3. The included articles examined a wide range of dairy products, including milk (type not specified), low-fat/reduced-fat/nonfat milk (1%, 2%, and skim), flavored milk (e.g., chocolate, strawberry), cheese, yogurt, ice cream, and butter, with the majority focusing on total dairy intake.

The included articles were organized by each observed actionable factor into 7 categories and 17 subcategories, which together capture the breadth of determinants reported in the literature:

1. Acculturation and/or assimilation: This category includes articles examining acculturation and/or assimilation (n = 3) [41-43] (Table 1).
2. Dietary intake and meal environment: This category includes articles examining breakfast and/or cereal consumption (n = 20) [44-63]; dietary pattern adherence (n = 3) [64-66]; and various aspects of the meal environment, such as meal skipping, eating with friends, family, or alone; and other social or environmental determinants (n = 12) [54, 60, 67-76] (Table 2).
3. Food access, availability, and insecurity: This category encompasses articles addressing both food access and/or availability (n = 17) [43, 59, 66, 77-90] as well as articles focused on food insecurity (n = 13) [43, 60, 91-101] (Table 3).
4. Lifestyle and health behaviors: This category includes articles focused on general health behaviors (n = 12) [30, 51, 60, 102-110], physical activity (n = 23) [66, 73, 107, 110-129], sleep (n = 9) [73, 107, 112, 125, 130-134], and screen time (n = 12) [51, 107, 112-114, 135-141)] (Table 4).
5. Psychosocial and intrinsic factors: This category encompasses articles examining intrinsic factors (n = 7) [132, 142-147], such as food choice motivators and appetitive traits, perceptions of body weight or body image (n = 9) [66, 148-155], and self-efficacy (n = 10) [110, 144, 156-163)] (Table 5).
6. Nutrition knowledge and educational programming: This category includes articles that focused on assessing nutrition knowledge (n = 6) [30, 73,164-167], and the impact of education interventions (n = 30) (nutrition education interventions (n = 16) [84, 148, 168-181]; nutrition education and lifestyle interventions (n = 14) [95, 127, 156, 182-192] (Table 6).
7. Policy: This category includes articles focused on school-based policy (n = 17) [66, 193-208] as well as other governmental policies (n = 13) [66, 209-220] (Table 7).

Acculturation and/or assimilation

In total, 3 studies examined the association of diet-related acculturation and/or assimilation on dairy intake (Table 1). All studies used a cross-sectional design. Two measured the relationship between acculturation and/or assimilation on total dairy consumption [41, 42], whereas 1 reported low-fat/reduced-fat/nonfat milk [43]. Two studies were conducted in Canada [42, 43], and 1 study was conducted in the

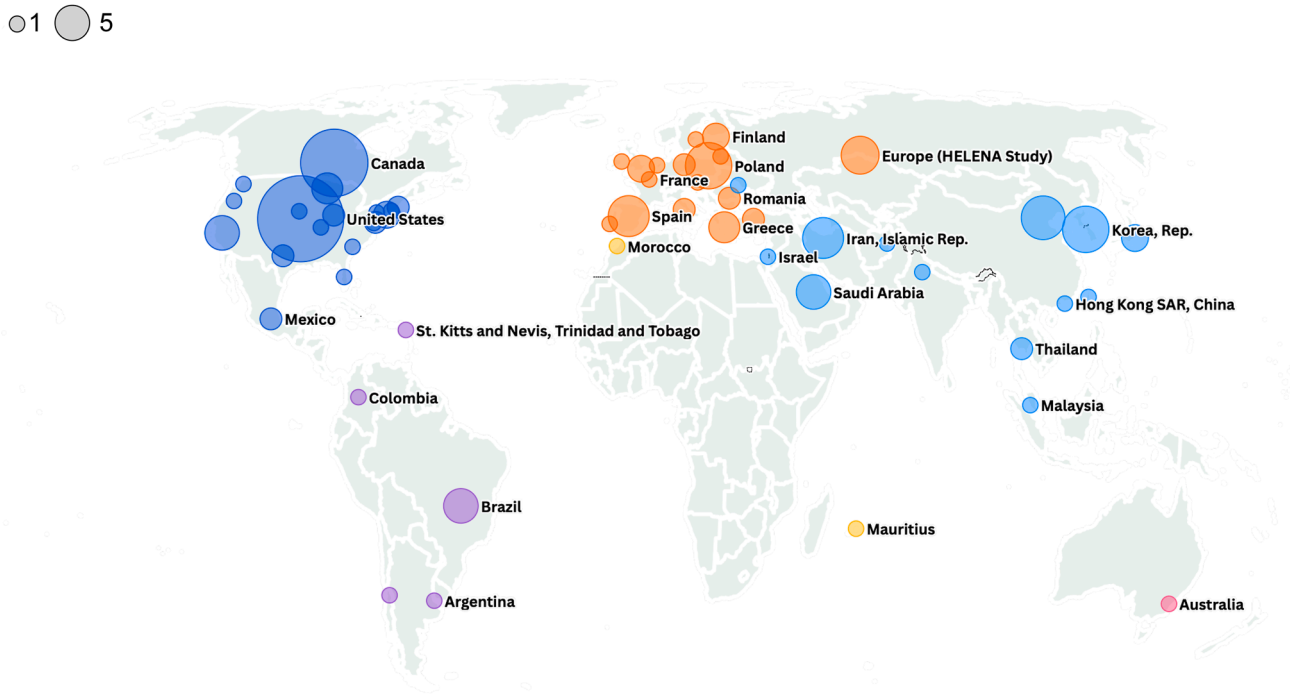


FIGURE 2. Geographic proportional symbol map of included studies.

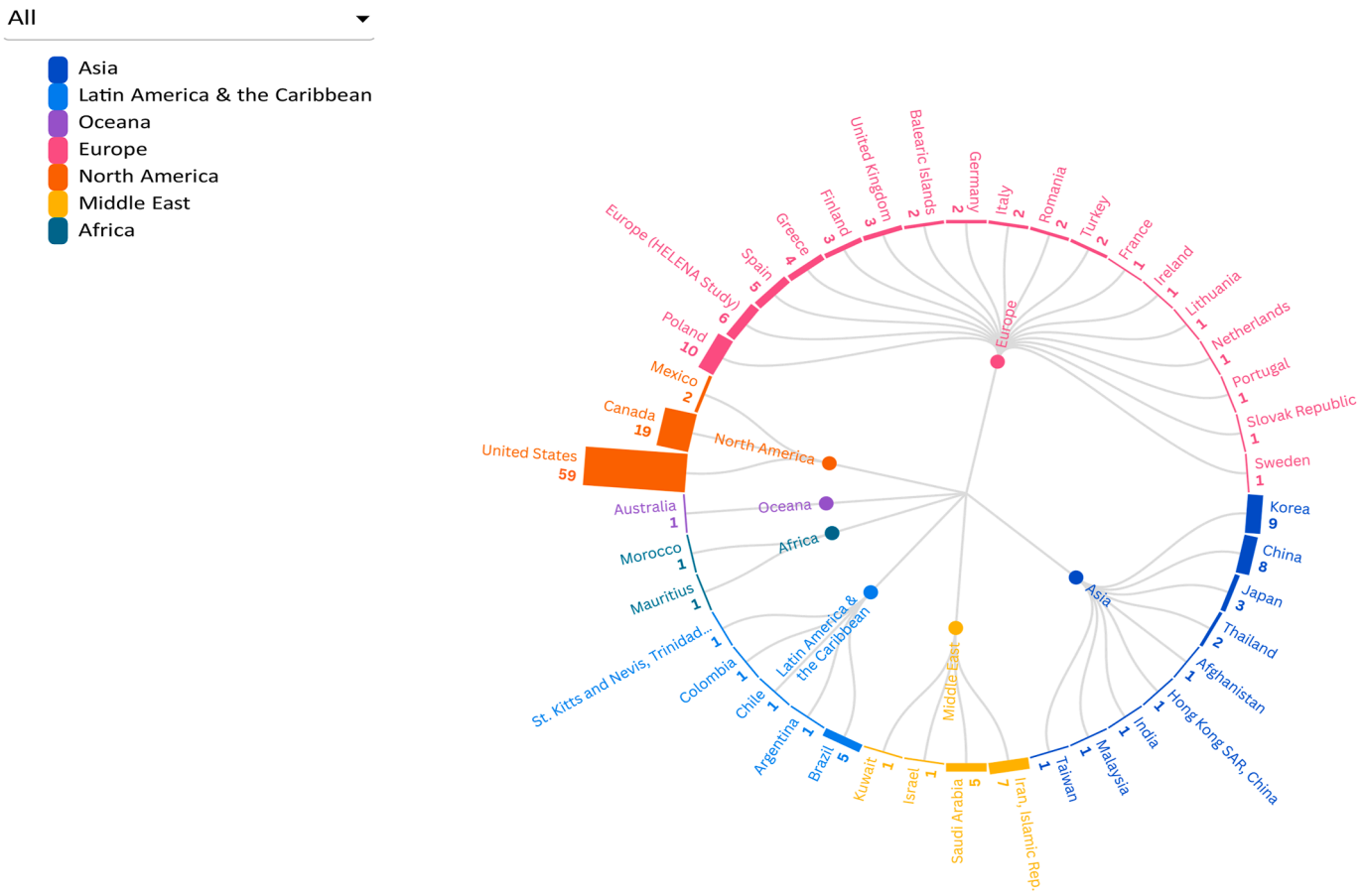


FIGURE 3. Radial tree of the geographic location of included studies.

United States [41]. The United States study reported significantly lower total dairy consumption among individuals categorized as "assimilated," "integrated," or separated" from the host country culture, with no significant differences among those in the "marginalization" acculturation status (rejecting both native and host cultures) [41]. Both Canadian studies reported no significant association between acculturation or assimilation and dairy consumption [42, 43].

Dietary pattern adherence and meal environment

The relationship between dietary pattern adherence and an individual's meal environment was examined across 33 studies (Table 2). Thirty-two articles used a cross-sectional design, and 1 article was a quasi-experimental prospective cohort study design [66]. This table lists articles that focus on overall dietary patterns compared with recommendations, articles on breakfast and ready-to-eat cereal (RTEC) consumption, and the meal environment, including with whom meals were consumed and meal skipping.

Breakfast and/or cereal consumption

Twenty cross-sectional studies investigated the relationship between breakfast and/or RTEC consumption and dairy intake [44-63]. The included studies spanned 10 individual countries as well as the Healthy Lifestyle in Europe by Nutrition in Adolescence study. Nearly all these studies reported that breakfast or RTEC consumption was associated with greater dairy intake (n = 19). However, 1 study observed a positive relationship only between RTEC and milk consumption, but no significant association with yogurt [57], whereas another found no significant relationship [60].

Dietary pattern adherence

Three studies investigated the association between dietary pattern adherence and dairy intake [64-66]. Research was conducted in Germany [64], Canada [66], and the United States [65]. The study conducted in Canada was a quasi-experimental prospective cohort study that examined the relationship between adherence to Canadian food guidelines and dairy or milk alternative consumption [66]. Individuals who met their fruit and vegetable, meat, and grain guidelines were more likely to consume more servings of milk and milk alternatives [66]. Two cross-sectional studies investigated differences in dairy consumption among individuals following vegetarian diets, and both reported lower dairy intake compared with omnivores [64, 65].

Meal environment

Twelve cross-sectional studies explored the association of the meal environment with dairy consumption [54, 60, 67-76]. Two studies examined the association of meal skipping on dairy intake [54, 67], with 1 study noting a negative relationship with white milk consumption but no significant change in flavored milk consumption [67]. The other study examined meal timing and found that skipping breakfast was associated with reduced milk and dairy intake, whereas skipping dinner was linked to

TABLE 1
Associations between acculturation and/or assimilation and dairy intake among adolescents ($n = 3$)

Author	Year	Country	Study design	Type of dairy	Social ecological model determinants	Subfactor
No Association						
Lovan [41]	2024	United States (Florida)	Cross-sectional	Total dairy	Interpersonal Community	Country of origin
Noor [42]	2020	Canada	Cross-sectional	Total dairy	Individual Interpersonal	Immigration status
Velazquez [43]	2015	Canada	Cross-sectional	Low-fat/reduced fat/nonfat milk (1%, 2%, skim, etc.)	Individual Interpersonal Institutional Community	Country of origin
Negative association						
Lovan [41]	2024	United States (Florida)	Cross-sectional	Total dairy	Interpersonal Community	Acculturation

increased dairy intake, and skipping lunch showed no significant association [54]. Seven studies examined how eating with friends or family, compared with eating alone, was associated with dairy intake [60, 68, 71, 73-76]. Of these studies, 4 reported a positive association between eating with others and dairy consumption [71, 73, 74, 76]. In contrast, 1 study noted a negative relationship between family meals and milk consumption [75]. One study reported a significant positive association between dairy intake and eating with friends [71]. Conversely, another study identified a negative relationship between dairy consumption and eating with friends at dinner for boys and at breakfast for girls, compared with eating with family [68]. No significant associations were observed when participants ate alone, with others, or when boys and girls ate with friends at other meals [68]. A third study found no significant differences in dairy consumption based on family meal patterns [60].

Food access, availability, and insecurity

Twenty-nine studies examine the link between food access, availability, and insecurity, with dairy consumption (Table 3). Studies were mainly cross-sectional ($n = 24$), with 4 studies that were quasi-experimental [66, 84, 85, 87] and 1[66, 84, 85, 87] and 1 study that was an RCT [95].

Food access and availability

Seventeen studies explored the link between food access and availability and dairy intake [43, 59, 66, 77-90]. The majority of these studies used a cross-sectional design ($n = 13$), and 4 used a quasi-experimental approach [66, 84, 85, 87]. One component of food access investigated across studies ($n = 14$) was meal practices or location, most often comparing dairy consumption when eating at home or bringing a packed lunch versus eating a school lunch [43, 59, 66, 77-80, 82, 83, 86-90]. Five studies reported a negative association in dairy intake when eating at school compared with at home or bringing lunch from home [66, 78, 83, 88, 90]. In 1 study, this negative association was evident among younger students (8–11 y) but was not significant among older students (12–16 y) [80]. Conversely, 3 studies noted greater dairy intake when consuming school lunch [59, 77, 82]. One of these studies reported a discrepancy by dairy type, with higher yogurt consumption among students who ate a packed lunch compared with those eating free school lunch [82]. Finally, 2 studies reported no significant associations between meal location and dairy intake [86, 89]. One study identified a negative association between the effect of selling flavored milk in schools and total milk consumption [66]. In addition, several components of food access and availability, including receipt of fruit and vegetable prescriptions redeemable at farmers' markets or via mobile delivery [85], use of a "convenience line" [87], purchasing snacks from vending machines [66], and holding a graduated driver's license [81], were positively associated with dairy intake.

Food insecurity

Thirteen studies investigated the relationship between food insecurity and dairy consumption [43, 60, 91-101]. Of these, 12 used a cross-sectional design, and 1 utilized an RCT [95]. Seven studies identified a negative association between food insecurity and dairy consumption [91, 92, 94, 96-98, 100]. One study conducted in the United States reported that children from households with very low food security consumed less dairy than children from households with high food security [96]. One study identified a significant negative association between food insecurity and milk intake among girls, whereas no significant association was observed for boys [91]. In contrast, 6 other studies reported no significant associations between food insecurity and dairy consumption [43, 60, 93, 95, 99, 101].

Lifestyle and health behaviors

Forty-five studies investigated the association between lifestyle and health behaviors and dairy intake (Table 4). Nearly all studies employed a cross-sectional ($n = 39$) approach, with 1 study using an observational prospective longitudinal cohort design [106], with the exception of 5 quasi-experimental studies [66, 102, 118, 123, 127]. This table includes articles that are focused on physical activity, screen time, sleep, and other health behaviors, such as smoking, alcohol, and sugar-sweetened beverage consumption.

Physical activity

Twenty-three studies examined the relationship between physical activity and dairy consumption [66, 73, 107, 110-129]. Nineteen of these studies utilized a cross-sectional design, whereas 4 studies used a quasi-experimental approach [66, 118, 123, 127]. Across 17 studies, physical activity was positively associated with dairy intake [66, 73, 111-120, 122, 123, 125,

TABLE 2
Associations between dietary intake or meal environment and dairy intake among adolescents ($n = 33$)

Author	Year	Country	Study design	Type of dairy	Social ecological model determinants	Subfactor
Positive association						
Michels [44]	2015	Europe (HELENA Study)	Cross-sectional	Milk (type not specified), yogurt	Individual	Breakfast/ready-to-eat cereal
Michels [45]	2016	Europe (HELENA Study)	Cross-sectional	Milk (type not specified), yogurt	Individual	Breakfast/ready-to-eat cereal
Tin [46]	2011	Hong Kong	Cross-sectional	Milk (type not specified)	Individual Interpersonal	Breakfast/ready-to-eat cereal
Matsumoto [47]	2020	Japan	Cross-sectional	Total dairy	Individual	Breakfast/ready-to-eat cereal
Holmes [48]	2012	United Kingdom	Cross-sectional	Milk (type not specified)	Individual	Breakfast/ready-to-eat cereal
Hopkins [61]	2017	United States (Maryland)	Cross-sectional	Total dairy	Individual	Breakfast/ready-to-eat cereal
Peters [49]	2011	Brazil	Cross-sectional	Total dairy	Individual	Breakfast/ready-to-eat cereal
Kaoutar [50]	2023	Morocco	Cross-sectional	Total dairy	Individual Institutional	Breakfast/ready-to-eat cereal
Al-Hazzaa [51]	2011	Saudi Arabia	Cross-sectional	Total dairy	Individual	Breakfast/ready-to-eat cereal
Yeo [52]	2024	Malaysia	Cross-sectional	Total dairy	Individual	Breakfast/ready-to-eat cereal
Haire-Joshu [53]	2011	United States (Missouri)	Cross-sectional	Milk (type not specified)	Individual	Breakfast/ready-to-eat cereal
Melo Rodrigues [54]	2017	Brazil	Cross-sectional	Total dairy	Individual	Breakfast/ready-to-eat cereal
Arora [55]	2012	India	Cross-sectional	Total dairy	Individual	Breakfast/ready-to-eat cereal
Smith [56]	2019	United States (NHANES)	Cross-sectional	Total dairy, milk (type not specified)	Individual	Breakfast/ready-to-eat cereal
Ramsay [58]	2018	United States (NHANES)	Cross-sectional	Total dairy	Individual	Breakfast/ready-to-eat cereal
Demissie [59]	2015	United States (National Youth Physical Activity and Nutrition Study)	Cross-sectional	Total dairy	Individual	Breakfast/ready-to-eat cereal
Wang [62]	2016	China	Cross-sectional	Milk (type not specified)	Individual	Breakfast/ready-to-eat cereal
Zhu [63]	2023	United States (NHANES)	Cross-sectional	Total dairy	Individual	Breakfast/ready-to-eat cereal
Smith [57]	2022	United States (NHANES)	Cross-sectional	Total dairy, milk (type not specified)	Individual	Breakfast/ready-to eat cereal
Ruhee [74]	2015	Mauritius	Cross-sectional	Whole milk (full fat), cheese, yogurt	Individual Interpersonal	Meal environment (family cohesion)
Ruhee [74]	2015	Mauritius	Cross-sectional	Whole milk (full fat), cheese, yogurt	Individual Interpersonal	Meal environment (eating with family and/or friends, or alone)
Hamulka [73]	2024	Poland	Cross-sectional	Total dairy	Interpersonal	Meal environment (eating with family and/or friends, or alone)
Bruening [71]	2012	United States (Minnesota)	Cross-sectional	Total dairy	Individual Interpersonal	Meal environment (eating with family, friends, or alone)
Leme [76]	2024	Brazil	Cross-sectional	Total dairy	Individual Interpersonal	Meal environment (eating with family, friends, or alone)
He [72]	2014	China	Cross-sectional	Total dairy	Interpersonal Institutional	Social or environmental influences (teacher health behaviors)
Butler [66]	2020	Canada	Quasi-experimental (Prospective cohort pre–post intervention)	Milk (type not specified)	Individual Interpersonal Institutional Policy	Dietary pattern adherence (milk and milk alternative guidelines)

(*continued on next page*)

TABLE 2 (*continued*)

Author	Year	Country	Study design	Type of dairy	Social ecological model determinants	Subfactor
No association						
Jackson [60]	2015	United States (Oregon)	Cross-sectional	Total dairy	Individual	Breakfast/ready-to-eat cereal
Smith [57]	2022	United States (NHANES)	Cross-sectional	Yogurt	Individual	Breakfast/ready-to-eat cereal
Martinez-Lacoba [70]	2020	Spain	Cross-sectional	Total dairy	Individual	Meal environment (cooks for him/herself)
Santaliestra-Pasias [68]	2022	Europe (HELENA)	Cross-sectional	Total dairy, milk (type not specified),	Individual Interpersonal	Meal environment (eating with family, friends, or alone)
Jackson [60]	2015	United States (Oregon)	Cross-sectional	Total dairy	Individual Interpersonal	Meal environment (eating with family and/or friends, or alone)
Melo Rodrigues [54]	2017	Brazil	Cross-sectional	Total dairy	Individual	Meal environment (meal skipping)
Kim [67]	2012	Korea	Cross-sectional	Flavored Milk (chocolate, strawberry, etc.)	Individual	Meal environment (Meal skipping)
Vågstrand [69]	2010	Sweden	Cross-sectional	Milk (type not specified), yogurt	Individual Interpersonal	Social or environmental influences (Parent behavior)
Segovia-Siapco [65]	2019	United States (Michigan; California)	Cross-sectional	Total dairy	Individual	Dietary pattern adherence (Vegetarian, vegan, omnivore)
Negative association						
Santaliestra-Pasias [68]	2022	Europe (HELENA)	Cross-sectional	Total dairy, milk (type not specified),	Individual Interpersonal	Meal environment (Eating with family, friends, or alone)
Zafar [75]	2022	Kuwait	Cross-sectional	Milk (type not specified)	Individual Interpersonal	Meal environment (Eating with family, friends, or alone)
Melo Rodrigues [54]	2017	Brazil	Cross-sectional	Total dairy	Individual	Meal environment (Meal skipping)
Kim [67]	2012	Korea	Cross-sectional	Milk (type not specified)	Individual	Meal environment (Meal skipping)
Segovia-Siapco [65]	2019	United States (Michigan; California)	Cross-sectional	Milk (type not specified), cheese, ice cream	Individual	Dietary pattern adherence (Vegetarian, vegan, omnivore)
Alexy [64]	2022	Germany	Cross-sectional	Total dairy	Individual	Dietary pattern adherence (Vegetarian, vegan, omnivore)

Abbreviation: HELENA, Healthy Lifestyle in Europe by Nutrition in Adolescence.

127, 129]. Of these, 1 study reported that higher physical activity was associated with greater cheese and yogurt intake among girls; however, no significant associations were observed for boys or for other dairy products [115]. Another study reported a positive association between physical activity and cottage cheese consumption but no associations with other types of dairy products [118]. Participation in physical education courses or sports clubs was positively associated with dairy consumption in 3 studies [118-120]. In contrast, 6 studies found no significant associations between physical activity and dairy intake [107, 110, 121, 124, 126, 128], whereas 2 studies reported significant negative relationships [120, 122]. In one of these, physical activity was associated with lower cheese intake but greater milk consumption [122].

Screen time

Twelve studies investigated the association between screen time and dairy consumption, all employing a cross-sectional design [51, 107, 112, 113, 135-141]. The majority of studies ($n = 7$) observed no association between screen time and dairy intake [51, 107, 112, 114, 135, 138, 140]. Notably, 1 study found that midweek online browsing was positively associated with dairy intake, whereas no associations were observed for playing games, watching movies or TV, or using online chats [141]. Four studies reported a negative relationship between screen time and dairy intake.

Sleep

Nine studies explored the relationship between sleep and dairy intake, all through a cross-sectional design [73, 107, 112, 125, 130-134]. Seven studies reported a positive association between sleep and dairy consumption [73, 107, 125, 130, 131, 133, 134]. One study examined both sleep quality and sleep duration, finding that each was positively associated with dairy intake [134]. Another study identified a positive relationship between sleep and dairy consumption in boys, with no

TABLE 3
Associations between food access, availability, and insecurity and dairy intake among adolescents ($n = 29$)

Author	Year	Country	Study design	Type of dairy	Social ecological model determinants	Subfactor
Positive association						
Haney [80]	2022	United Kingdom (NDNS)	Cross-sectional	Total dairy	Individual Institutional	Food Availability/ Access (Meal location)
Au [77]	2016	United States (California)	Cross-sectional	Total dairy	Individual Institutional Policy	Food availability/ access (meal location)
Demissie [59]	2015	United States (National Youth Physical Activity and Nutrition Study)	Cross-sectional	Total dairy	Individual	Food availability/ access (Meal location)
Butler [66]	2020	Canada	Quasi-experimental (prospective cohort pre–post intervention)	Milk (type not specified)	Individual Interpersonal	Food availability/ access (meal location)
Hanks [87]	2012	United States (New York)	Quasi-experimental (prospective cohort pre–post intervention)	Low-fat/reduced-fat/nonfat milk (1%, 2%, skim, etc.), "flavored milk (chocolate, strawberry, etc.)"	Institutional	Food availability/ access (meal practices)
Butler [66]	2020	Canada	Quasi-experimental (prospective cohort pre–post intervention)	Milk (type not specified)	Individual Institutional	Food availability/ access (meal practices)
Stevens [82]	2011	United Kingdom	Cross-sectional	Ice cream, milk (type not specified), yogurt	Institutional	Food availability/ access (meal practices)
Qiu [81]	2021	United States (YRBSS)	Cross-sectional	Milk (type not specified)	Individual Interpersonal Policy	Food availability/ access
Kastorini [84]	2015	Greece	Quasi-experimental (prospective cohort pre–post intervention study)	Low-fat/reduced fat/nonfat milk (1%, 2%, skim, etc.), yogurt	Individual Institutional	Food availability/ access
Saxe-Custack [85]	2021	United States (Michigan)	Quasi-experimental (Prospective cohort pre–post intervention study)	Total dairy	Individual Institutional Community	Food availability/ access
No association						
Haney [80]	2022	United Kingdom (NDNS)	Cross-sectional	Total dairy	Individual Institutional	Food availability/ access (meal location)
Golper [86]	2021	United States (NHANES)	Cross-sectional	Total dairy	Individual Interpersonal	Food availability/ access (meal location)
Tugault-Lafleur [89]	2020	Canada	Cross-sectional	Milk (type not specified), other	Individual Institutional	Food availability/ access (meal location)
Demissie [59]	2015	United States (National Youth Physical Activity and Nutrition Study)	Cross-sectional	Total dairy	Individual	Food availability/ access (meal practices)
Lane [93]	2019	Canada	Cross-sectional	Total dairy	Individual Interpersonal Institutional Community Policy	Food insecurity
Stotz [95]	2023	United States (multisite)	Randomized controlled trial	Milk (type not specified)	Individual Interpersonal Institutional Community Policy	Food insecurity
Mumena [101]	2021	Trinidad and Tobago, St. Kitts, and Nevis	Cross-sectional	Milk (type not specified)	Individual Interpersonal Institutional Community Policy	Food insecurity
	2015	Canada	Cross-sectional			Food insecurity

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TABLE 3 (*continued*)

Author	Year	Country	Study design	Type of dairy	Social ecological model determinants	Subfactor
Velazquez [43]				Low-fat/reduced-fat/nonfat milk (1%, 2%, skim, etc.)	Individual Interpersonal Institutional Community Policy	
Nakitto [99]	2017	Korea	Cross-sectional	Total dairy	Individual Interpersonal Institutional Community Policy	Food insecurity
Jackson [60]	2015	United States (Oregon)	Cross-sectional	Total dairy	Individual Interpersonal Institutional Community Policy	Food insecurity
Mark [91]	2012	Canada	Cross-sectional	Milk (type not specified)	Individual Interpersonal Institutional Community Policy	Food insecurity
Negative association						
Powell [79]	2013	United States (NHANES)	Cross-sectional	Milk (type not specified)	Individual Community	Food availability/ access (meal location)
Tugault-Lafleur [78]	2017	Canada	Cross-sectional	Milk (type not specified)	Individual Interpersonal Institutional	Food availability/ access (meal location)
Rongen [83]	2019	The Netherlands	Cross-sectional	Total dairy	Individual Institutional	Food availability/ access (meal location)
Polsky [88]	2021	Canada	Cross-sectional	Milk (type not specified)	Individual	Food availability/ access (meal location)
Losasso [90]	2015	Italy	Cross-sectional	Low-fat/reduced-fat/nonfat milk(1%, 2%, skim, etc.), whole milk (full fat), Ice cream	Individual Institutional Community	Food availability/ mccess (Meal location)
Velazquez [43]	2015	Canada	Cross-sectional	Low-fat/reduced-fat/nonfat milk (1%, 2%, skim, etc.)	Individual Interpersonal	Food availability/ access (meal practices)
Demissie [59]	2015	United States (National Youth Physical Activity and Nutrition Study)	Cross-sectional	Total dairy	Individual	Food availability/ access (meal practices)
Butler [66]	2020	Canada	Quasi-experimental (Nonrandomized, prospective cohort pre– post intervention study)	Milk (type not specified)	Individual Interpersonal	Food availability/ access (beverage availability)
Mark [91]	2012	Canada	Cross-sectional	Milk (type not specified)	Individual Interpersonal Institutional Community Policy	Food insecurity
Rodriguez [92]	2016	Mexico	Cross-sectional	Total dairy	Individual Interpersonal Institutional Community Policy	Food insecurity
Basiry [94]	2024	Afghanistan	Cross-sectional	Milk (type not specified), cheese, yogurt	Individual Interpersonal Institutional Community Policy	Food Insecurity

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TABLE 3 (*continued*)

Author	Year	Country	Study design	Type of dairy	Social ecological model determinants	Subfactor
Soldavini [96]	2021	United States (multisite)	Cross-sectional	Total dairy	Individual Interpersonal Institutional Community Policy	Food insecurity
Duke [97]	2021	United States (Minnesota)	Cross-sectional	Milk (type not specified)	Individual Interpersonal Institutional Community Policy	Food insecurity
Mumena [98]	2020	Saudi Arabia	Cross-sectional	Total dairy	Individual Interpersonal Institutional Community Policy	Food insecurity
Farzaneh [100]	2017	Iran	Cross-sectional	Milk (type not specified), yogurt, cheese	Individual Interpersonal Institutional Community Policy	Food insecurity

TABLE 4
Associations between lifestyle and health behaviors and dairy intake among adolescents ($n = 45$)

Author	Year	Country	Study design	Type of dairy	Social ecological model determinants	Sub-factor
Positive association						
Nicklas [108]	2017	United States (NHANES)	Cross-sectional	Milk (type not specified), "Flavored milk (chocolate, strawberry, etc.)"	Individual	Health behaviors (Flavored Milk consumption)
Zahid [30]	2017	United States (Minnesota)	Cross-sectional	Milk (type not specified)	Individual Interpersonal	Health Behaviors (Dairy beverage consumption)
Ranjit [109]	2010	United States (Texas)	Cross-sectional	Milk (type not specified)	Individual	Health Behaviors (Flavored sports drink consumption)
Jansen [107]	2021	Mexico	Cross-sectional	Milk (type not specified)	Individual	Health Behaviors (Water consumption)
Zou [141]	2023	China	Cross-sectional	Total dairy	Individual	Screen time
Mozaffarian [130]	2020	Iran	Cross-sectional	Milk (type not specified), cheese, yogurt	Individual	Sleep
Jansen [107]	2021	Mexico	Cross-sectional	Milk (type not specified)	Individual	Sleep
Min [134]	2018	Korea	Cross-sectional	Milk (type not specified)	Individual	Sleep
Hong [133]	2017	Korea	Cross-sectional	Milk (type not specified)	Individual	Sleep
Gong [131]	2017	China	Cross-sectional	Milk (type not specified)	Individual	Sleep
Hamulka [73]	2024	Poland	Cross-sectional	Total dairy	Individual	Sleep
Yim [125]	2021	Korea	Cross-sectional	Milk (type not specified)	Individual	Sleep
Heikkilä [111]	2021	Finland	Cross-sectional	Low-fat/reduced fat/ nonfat milk (1%, 2%, skim, etc.)	Individual	Physical activity
Xiang [112]	2025	United States (YRBSS)	Cross-sectional	Milk (type not specified)	Individual	Physical activity
Moradell [113]	2023	Europe (HELENA)	Cross-sectional	Milk (type not specified), yogurt	Individual	Physical activity
Al-Hazzaa [114]	2014	Saudi Arabia	Cross-sectional	Milk (type not specified)	Individual	Physical activity

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TABLE 4 (*continued*)

Author	Year	Country	Study design	Type of dairy	Social ecological model determinants	Sub-factor
Bibiloni [115]	2012	Balearic Islands (Spain)	Cross-sectional	Yogurt, cheese	Individual	Physical activity
Gaylis [116]	2019	United States (California)	Cross-sectional	Whole milk (full fat), low-fat/reduced-fat/ nonfat milk (1%, 2%, skim, etc.)	Individual	Physical activity
Manz [117]	2019	Germany	Cross-sectional	Total dairy, milk (type not specified)	Individual	Physical activity
Ługowska [119]	2020	Poland	Cross-sectional	Total dairy, milk (type not specified)	Individual Interpersonal Institutional	Physical activity
Ługowska [118]	2024	Poland	Quasi-experimental (Prospective cohort study)	Other (cottage cheese)	Individual Institutional	Physical activity
Hamulka [73]	2024	Poland	Cross-sectional	Total dairy	Individual	Physical activity
Chen [120]	2013	United States (Early Childhood Longitudinal Survey)	Cross-sectional	Milk (type not specified)	Individual	Physical activity
Ottevaere [122]	2011	Europe (HELENA)	Cross-sectional	Milk (type not specified)	Individual	Physical activity
Kolanowski [123]	2022	Poland	Quasi-experimental (nonrandomized, observational cohort study)	Total dairy, milk (type not specified)	Individual Institutional	Physical activity
Yim [125]	2021	Korea	Cross-sectional	Milk (type not specified)	Individual	Physical activity
Arenaza [127]	2020	Spain	Quasi-experimental (nonrandomized pre–post intervention study)	Low-fat/reduced fat/ nonfat milk (1%, 2%, skim, etc.)	Individual Interpersonal Institutional	Physical activity
Bell [129]	2023	Canada	Cross-sectional	Total dairy	Individual	Physical activity
Butler [66]	2020	Canada	Quasi-experimental (nonrandomized prospective cohort pre–post intervention)	Milk (type not specified)	Individual	Physical activity
No Association						
Ioannou [102]	2024	Greece	Quasi-experimental (Nonrandomized prospective cohort pre–post intervention)	Milk (type not specified), yogurt, “flavored milk (chocolate, strawberry, etc.)”	Individual Interpersonal Institutional	Health behaviors (lifestyle intervention)
Jackson [60]	2015	United States (Oregon)	Cross-sectional	Total dairy	Individual	Health behaviors (soda consumption)
Shokrvash [110]	2015	Iran	Cross-sectional	Total dairy	Individual	Health behaviors (Sweet food intake)
Zahid [30]	2017	United States (Minnesota)	Cross-sectional	Milk (type not specified)	Individual Interpersonal	Health behaviors (Beverage availability)
Ranjit [109]	2010	United States (Texas)	Cross-sectional	Milk (type not specified)	Individual	Health behaviors (Sugar Sweetened beverage consumption)
Jansen [107]	2021	Mexico	Cross-sectional	Milk (type not specified)	Individual	Health behaviors (Sweetened milk, fruit juice, flavored water)
Fan [135]	2022	United States (YRBSS)	Cross-sectional	Milk (type not specified)	Individual	Screen time
Xiang [112]	2025	United States (YRBSS)	Cross-sectional	Milk (type not specified)	Individual	Screen time
Jansen [107]	2021	Mexico	Cross-sectional	Milk (type not specified)	Individual	Screen time
Ng [138]	2010	Canada	Cross-sectional	Milk (type not specified)	Individual	Screen time
Al-Hazzaa [51]	2011	Saudi Arabia	Cross-sectional	Total dairy	Individual	Screen time
Al-Hazzaa [114]	2014	Saudi Arabia	Cross-sectional	Milk (type not specified)	Individual	Screen time
Zou [141]	2023	China	Cross-sectional	Total dairy	Individual	Screen time
Lee [140]	2013	Korea	Cross-sectional	Total dairy	Individual	Screen time

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TABLE 4 (*continued*)

Author	Year	Country	Study design	Type of dairy	Social ecological model determinants	Sub-factor
Xiang [112]	2025	United States (YRBSS)	Cross-sectional	Milk (type not specified)	Individual	Sleep
Jansen [107]	2021	Mexico	Cross-sectional	Milk (type not specified)	Individual	Sleep
Depboylu [132]	2025	Turkey	Cross-sectional	Total dairy	Individual	Sleep
Jansen [107]	2021	Mexico	Cross-sectional	Milk (type not specified)	Individual	Physical activity
Bibiloni [115]	2012	Balearic Islands (Spain)	Cross-sectional	Milk (type not specified), other, yogurt, cheese	Individual	Physical activity
Lugowska [118]	2024	Poland	Quasi-experimental (Nonrandomized prospective pre– post cohort intervention)	Milk (type not specified), Yogurt, Cheese	Individual Institutional	Physical activity
Shokrvash [110]	2015	Iran	Cross-sectional	Total Dairy	Individual	Physical activity
Vondrava [121]	2024	Slovakia (YABS)	Cross-sectional	Total Dairy	Individual	Physical activity
Dmitruk [124]	2016	Poland	Cross-sectional	Total Dairy	Individual	Physical activity
Al-Hazzaa [126]	2021	Saudi Arabia	Cross-sectional	Total Dairy	Individual	Physical activity
Grams [128]	2022	Spain and Germany	Cross-sectional	Total Dairy, Yogurt, Cheese	Individual	Physical activity
Negative Association						
Boonchooduang [103]	2019	Thailand	Cross-sectional	Milk (type not specified)	Individual	Health behaviors (Alcohol consumption)
Wang [104]	2017	China	Cross-sectional	Milk (type not specified)	Individual	Health behaviors (Smoking)
Jansen [107]	2021	Mexico	Cross-sectional	Milk (type not specified)	Individual	Health behaviors (Smoking)
Boonchooduang [103]	2019	Thailand	Cross-sectional	Milk (type not specified)	Individual	Health behaviors (Smoking)
Lee [105]	2016	Korea	Cross-sectional	Total Dairy, Milk (type not specified)	Individual	Health behaviors (Smoking)
Ioannou [102]	2024	Greece	Quasi-experimental (Nonrandomized prospective cohort pre–post intervention)	Cheese	Individual Interpersonal Institutional	Health behaviors (Lifestyle intervention)
Al-Hazzaa [51]	2011	Saudi Arabia	Cross-sectional	Milk (type not specified)	Individual	Health behaviors (energy drinks, fast food/French fry consumption)
Ranjit [109]	2010	United States (Texas)	Cross-sectional	Milk (type not specified)	Individual	Health behaviors (Soda consumption)
Fiorito [106]	2010	United States (Pennsylvania)	Observational prospective longitudinal cohort study	Milk (type not specified)	Individual Interpersonal	Health behaviors (Soda consumption)
Jansen [107]	2021	Mexico	Cross-sectional	Milk (type not specified)	Individual	Health Behaviors (Soda, coffee, and tea consumption)
Jensen [136]	2022	Chile	Cross-sectional	Milk (type not specified), Yogurt	Individual	Screen time
Demissie [137]	2013	United States (National Youth Physical Activity and Nutrition Study)	Cross-sectional	Milk (type not specified)	Individual	Screen time
Myszkowska-Ryciak [139]	2020	Poland	Cross-sectional	Milk (type not specified)	Individual	Screen time
Moradell [113]	2023	Europe (HELENA study)	Cross-sectional	Milk (type not specified), Yogurt	Individual	Screen time
Chen [120]	2013	United States (Early Childhood Longitudinal Survey)	Cross-sectional	Milk (type not specified)	Individual Institutional	Physical activity
Ottevaere [122]	2011	Europe (HELENA)	Cross-sectional	Cheese	Individual	Physical activity

Abbreviation: HELENA, Healthy Lifestyle in Europe by Nutrition in Adolescence.

TABLE 5
Associations between psychosocial and intrinsic factors and dairy intake among adolescents ($n = 25$)

Author	Year	Country	Study design	Type of dairy	Social ecological model determinants	Subfactor
Positive Association						
Liu [149]	2023	China	Cross-sectional	Milk (type not specified)	Individual	Perceptions of body weight or body image
Rosemond [157]	2014	United States; South Carolina	Quasi-experimental (Nonrandomized pre–post intervention study)	Milk (type not specified)	Individual Interpersonal Institutional	Self-efficacy
Hall [158]	2015	United States (Nebraska)	Cross-sectional	Total dairy	Individual	Self-efficacy
Ozawa [159]	2023	Japan	Cross-sectional	Milk (type not specified)	Individual	Self-efficacy
Keshani [144]	2018	Iran	Cross-sectional	Total dairy	Individual	Self-efficacy
Gacek [160]	2013	Poland	Cross-sectional	Other	Individual	Self-efficacy
Gacek [161]	2013	Poland	Cross-sectional	Low-fat/reduced-fat/ nonfat milk (1%, 2%, skim, etc.), cheese, Butter	Individual Interpersonal	Self-efficacy
Miri [162]	2019	Iran	Randomized controlled trial	Total dairy	Individual	Self-efficacy
Guzek [142]	2021	Poland	Cross-sectional	Total dairy	Individual	Intrinsic factors (Appetitive traits)
Yoshiko [143]	2022	Japan	Cross-sectional and longitudinal studies	Total dairy	Individual	Intrinsic factors (Sense of coherence)
No association						
Liu [149]	2023	China	Cross-sectional	Milk (type not specified)	Individual	Perceptions of body weight or body image
Bibiloni [150]	2013	Balearic Islands (Spain)	Cross-sectional/observational/ cohort	Ice cream, yogurt, milk (type not specified), cheese	Individual	Perceptions of body weight or body image
Sirirassamee [151]	2018	Thailand	Cross-sectional/observational/ cohort	Milk (type not specified)	Individual	Perceptions of body weight or body image
Mays [156]	2011	United States (Washington DC)	Randomized controlled trial	Milk (type not specified)	Individual	Self-efficacy
Shokrvash [110]	2015	Iran	Cross-sectional	Total Dairy	Individual	Self-efficacy
Gacek [160]	2013	Poland	Cross-sectional	Other	Individual	Self-efficacy
Gacek [161]	2013	Poland	Cross-sectional	Other	Individual Interpersonal	Self-efficacy
Guzek [142]	2021	Poland	Cross-sectional	Total dairy	Individual	Intrinsic factors (Appetitive traits)
Keshani [144]	2018	Iran	Cross-sectional	Total dairy	Individual	Intrinsic factors (Cues to action)
Daly [145]	2023	Ireland	Cross-sectional	Milk (type not specified), Yogurt	Individual	Intrinsic factors (Food choice motivators)
Daly [145]	2023	Ireland	Cross-sectional	Cheese	Individual	Intrinsic factors (Food choice motivators)
Maneschy [147]	2022	Europe (HELENA)	Cross-sectional	Total dairy, butter	Individual	Intrinsic factors (Food choice motivators)
Depboylu [132]	2025	Turkey	Cross-sectional	Total dairy	Individual	Intrinsic factors (Hedonic hunger)
Negative association						
Hermosa-Bosano [163]	2025	Spain	Cross-sectional	Other (Ultra-processed dairy products)	Individual	Self-efficacy
Trandafir [148]	2024	Romania	Quasi-experimental, (Nonrandomized, controlled pre–post longitudinal study)	Total Dairy	Individual Institutional Policy	Perceptions of body weight or body image
Chen [155]	2012	United States (Illinois)	Cross-sectional	Milk (type not specified)	Individual	Perceptions of body weight or body image

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TABLE 5 (*continued*)

Author	Year	Country	Study design	Type of dairy	Social ecological model determinants	Subfactor
Madalosso [152]	2020	Brazil	Cross-sectional	Total Dairy, Cheese	Individual	Perceptions of body weight or body image
Jankauskiene [153]	2019	Lithuania	Cross-sectional	Milk [type not specified), Cheese, Yogurt	Individual	Perceptions of body weight or body image
Ursoniu [154]	2010	Romania	Cross-sectional	Total Dairy	Individual	Perceptions of body weight or body image
Butler [66]	2020	Canada	Quasi-experimental (Nonrandomized, prospective cohort pre–post intervention)	Total Dairy	Individual	Perceptions of body weight or body image
Guzek [142]	2021	Poland	Cross-sectional	Total Dairy	Individual	Intrinsic factors (Appetitive traits)
Yang [146]	2023	China	Cross-sectional	Milk (type not specified)	Individual	Intrinsic factors (Chronotype)
Maneschy [147]	2022	Europe (HELENA)	Cross-sectional	Total Dairy, Butter	Individual	Intrinsic factors (Food choice motivators)
Daly [145]	2023	Ireland	Cross-sectional	Milk (type not specified), Yogurt	Individual	Intrinsic factors (Food choice motivators)
Daly [145]	2023	Ireland	Cross-sectional	Cheese	Individual	Intrinsic factors (Food choice motivators)

corresponding relationship observed in girls [107]. In contrast, 2 studies observed no significant relationship between sleep and dairy consumption [112, 132].

Health behaviors

Twelve studies investigated the link between health behaviors and dairy consumption [30, 51, 60, 102-110]. Across the 12 studies, 10 used a cross-sectional design, 1 study used a quasi-experimental approach [102], and 1 study utilized an observational prospective longitudinal cohort design [106]. Four studies examined the relationship between dairy intake and smoking, all of which reported negative associations [103-105, 107]. One study also investigated alcohol consumption and identified a negative association with milk intake [103]. In addition, 8 studies explored the association of other dietary trends with dairy intake. Consumption of flavored milk [108], dairy beverages [30], water [107], and flavored sports drinks [109] was positively associated with dairy consumption. In contrast, intake of soda [106, 107, 109] coffee and tea [107], energy drinks [51], French fries, and fast food was negatively associated with dairy intake [51]. One study, using a longitudinal cross-sectional design, found that greater soda consumption predicted lower dairy intake [106]. Several studies reported nonsignificant associations with sugar-sweetened beverage consumption [30, 109], including soda [60], sweetened milk, fruit juice, flavored water [107], orange juice [30], and sweet food intake [110].

Psychosocial and intrinsic factors

Twenty-five studies investigated the relationship between dairy intake and psychosocial and intrinsic factors (Table 5). These factors included perceptions of body weight or body image but specifically did not evaluate the relationship of dairy intake with anthropometrics. This also included self-efficacy and other intrinsic factors. Of the included studies, 20 were cross-sectional, 2 were RCTs [156, 162], and 3 were quasi-experimental [66, 148, 157].

Perceptions of body weight or body image

Nine studies investigated the relationship between perceptions of body weight or body image on dairy consumption [66, 148-155]. Of the 9 studies, 7 used a cross-sectional design, and 2 used quasi-experimental methodology [66, 148]. Six studies identified a negative association between perceptions of body weight or body image, specifically the perception of being overweight or needing to lose weight, and dairy intake [66, 148, 152-155]. Notably, 1 study reported opposing findings: individuals who were normal weight or overweight but perceived themselves as overweight or obese tended to consume more milk, whereas no significant relationship with dairy intake was observed among underweight individuals with similar perceptions [149]. Two studies reported no significant relationship between perceptions of body weight or body image and dairy intake [150, 151].

Self-efficacy

The association between self-efficacy and dairy consumption was examined in 10 studies [110, 144, 156-163], most of which employed a cross-sectional design ($n = 7$). Two studies used RCTs [156, 162], and 1 study utilized a quasi-experimental design [157]. Of these 10 studies, 7 identified a positive relationship between self-efficacy and dairy intake [144, 157-162]. The quasi-experimental study, which examined pre- compared with postintervention dairy consumption following a nutrition promotion curriculum focused on building self-efficacy, reported a significant increase in dairy intake [157]. Similarly,

TABLE 6
Associations between nutrition knowledge and education programming and dairy intake among adolescents ($n = 36$)

Author	Year	Country	Study design	Type of dairy	Social ecological model determinants	Subfactor
Positive association						
Lee [165]	2021	Korea	Cross-sectional	Milk (type not specified)	Individual	Nutrition knowledge
Joulaei [164]	2018	Iran	Cross-sectional	Total dairy	Individual	Nutrition knowledge
Hamulka [73]	2024	Poland	Cross-sectional	Total dairy	Individual	Nutrition knowledge
Ren [166]	2024	China	Cross-sectional	Total dairy	Individual	Nutrition knowledge
Zahid [30]	2017	United States (Minnesota)	Cross-sectional	Milk (type not specified)	Interpersonal	Nutrition knowledge (Parent knowledge)
Turnin [176]	2016	France	Quasi-experimental (Nonrandomized, pre–post intervention study)	Total Dairy	Individual Institutional	Nutrition education intervention
Ralston [173]	2014	United States (Florida)	Quasi-experimental (Nonrandomized, pre–post intervention study)	Total Dairy	Individual Interpersonal Institutional	Nutrition education intervention
Freedman [172]	2010	United States (California)	Quasi-experimental (Nonrandomized, pre–post intervention study, with follow-up)	Milk (type not specified)	Individual Interpersonal Institutional Community	Nutrition education intervention
Drapeau [171]	2016	Canada	Randomized Controlled Trial	Total dairy	Individual Interpersonal Institutional	Nutrition education intervention
Kastorini [84]	2015	Greece	Quasi-experimental (Nonrandomized, prospective cohort pre–post intervention study)	Low-fat/reduced-fat/ nonfat milk (1%, 2%, skim, etc.), Yogurt	Individual Institutional	Nutrition education intervention
Suarez-Gonzalez [174]	2020	Spain	Quasi-experimental (Nonrandomized, prospective pre–post intervention study)	Yogurt	Individual	Nutrition education intervention
Chamberland [170]	2017	Canada	Randomized Controlled Trial	Milk (type not specified), Other	Individual	Nutrition education intervention
Bozkurt [169]	2024	Turkey	Quasi-experimental (Nonrandomized, pre–post intervention study)	Total Dairy	Individual	Nutrition education intervention
Baldasso [168]	2016	Brazil	Quasi-experimental (Nonrandomized, pre–post intervention study)	Total Dairy	Individual Institutional	Nutrition education intervention
Tan [175]	2022	Australia	Quasi-experimental (Nonrandomized, pre–post intervention study)	Milk (type not specified)	Individual	Nutrition education intervention
Pampaloni [181]	2015	Italy	Quasi-experimental (Nonrandomized, pre–post intervention study)	Milk (type not specified), Cheese	Individual Institutional	Nutrition education intervention
Zota [190]	2016	Greece	Randomized Controlled Trial	Low-fat/reduced-fat/ nonfat milk (1%, 2%, skim, etc.), Yogurt	Individual Institutional	Nutrition education and lifestyle intervention
Mays [156]	2011	United States (Washington D. C.)	Randomized Controlled Trial	Milk (type not specified)	Individual	Nutrition education and lifestyle intervention
Yang [189]	2015	Taiwan	Quasi-experimental (Cluster-randomized controlled pre–post intervention study)	Total Dairy	Individual Interpersonal Institutional	Nutrition education and lifestyle intervention
Hoelscher [187]	2016	United States (multisite)	Quasi-experimental (Noncontrolled pre–post intervention study with repeated cross-sectional data)	Total dairy	Individual Interpersonal Institutional	Nutrition education and lifestyle intervention
Bahathig [186]	2023	Saudi Arabia	Randomized Controlled Trial	Total Dairy	Individual Interpersonal Institutional	Nutrition education and lifestyle intervention
Herscovici [191]	2013	Argentina	Randomized Controlled Trial	Low-fat/reduced-fat/ nonfat milk (1%, 2%, skim, etc.)	Individual	Nutrition education and lifestyle intervention
Vieira [192]	2021	Portugal	Quasi-experimental (Nonrandomized repeated time–series intervention study)	Milk (type not specified)	Individual Interpersonal Institutional	Nutrition education and lifestyle intervention

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TABLE 6 (*continued*)

Author	Year	Country	Study design	Type of dairy	Social ecological model determinants	Subfactor
Nozari [188]	2019	Iran	Randomized Controlled Trial	Milk (type not specified), Cheese, Yogurt, Other	Individual Institutional	Nutrition education and lifestyle intervention
Arenaza [127]	2020	Spain	Quasi-experimental (Nonrandomized pre–post intervention study)	Low-fat/reduced-fat/ nonfat milk (1%, 2%, skim, etc.)	Individual Interpersonal Institutional	Nutrition education and lifestyle intervention (Parent and child)
Sallinen [184]	2022	Finland	Randomized Controlled Trial	Cheese, Butter	Individual	Nutrition education and lifestyle intervention (Parent and child)
No association						
Pfledderer [167]	2024	United States (Texas)	Cross-sectional	Flavored Milk (chocolate, strawberry, etc.), Milk (type not specified), Yogurt, Cheese	Individual	Nutrition knowledge
Zahid [30]	2017	United States (Minnesota)	Cross-sectional	Milk (type not specified)	Interpersonal	Nutrition knowledge (Parent knowledge)
Trandafir [148]	2024	Romania	Quasi-experimental (Nonrandomized, controlled pre–post longitudinal study)	Total Dairy	Individual Institutional Policy	Nutrition education intervention
D'Adamo [177]	2016	United States (Maryland)	Quasi-experimental (Nonrandomized, controlled pre–post intervention study)	Total Dairy	Individual	Nutrition education intervention
Tilles-Tirkkonen [179]	2018	Finland	Cross-sectional	Total Dairy	Individual Institutional	Nutrition education intervention
Freedman [172]	2010	United States (California)	Quasi-experimental (Nonrandomized, pre–post intervention study, with follow-up)	Milk (type not specified)	Individual Interpersonal Institutional Community	Nutrition education intervention
Drapeau [178]	2022	Canada	Randomized Controlled Trial	Total Dairy	Individual Interpersonal	Nutrition education intervention (Family)
Stotz [95]	2023	United States (multi-site)	Randomized Controlled Trial	Milk (type not specified)	Individual	Nutrition education and lifestyle intervention
Siega-Riz [185]	2011	United States (multisite)	Randomized Controlled Trial	Low-fat/reduced-fat/ nonfat milk (1%, 2%, skim, etc.), Whole Milk (full fat)	Individual Institutional Policy	Nutrition education and lifestyle intervention
Berger [182]	2021	Israel	Quasi-experimental (intervention, but not RCT)	Milk (type not specified), Other	Individual Institutional	Nutrition education and lifestyle intervention
Sallinen [184]	2022	Finland	Randomized controlled trial	Whole milk (full fat), Low-fat/reduced-fat/ nonfat milk (1%, 2%, skim, etc.), Other, Ice Cream	Individual	Nutrition education and lifestyle intervention (Parent and child)
Negative association						
Turnin [176]	2016	France	Quasi-experimental (Nonrandomized, pre–post intervention study)	Cheese	Individual Institutional	Nutrition education intervention
Suarez-Gonzalez [174]	2020	Spain	Quasi-experimental (Nonrandomized, prospective pre–post intervention study)	Milk (type not specified), Other, Cheese	Individual	Nutrition education intervention
Restrepo-Mesa [180]	2023	Columbia	Quasi-experimental (Nonrandomized controlled intervention study)	Total Dairy	Individual Interpersonal	Nutrition education intervention
Greene [183]	2017	United States (New York)	Randomized Controlled Trial	Milk (type not specified)	Individual Institutional	Nutrition education and lifestyle intervention

TABLE 7
Associations between policy and dairy intake among adolescents ($n = 29$)

Author	Year	Country	Study Design	Type of Dairy	Social Ecological Model Determinants	Sub-factor
Positive association						
Mullally [194]	2010	Canada	Quasi-experimental, (Nonrandomized controlled intervention study)	Milk (type not specified)	Institutional Policy	School-based policy
Fung [199]	2013	Canada	Cross-sectional	Milk (type not specified)	Institutional Policy	School-based policy
Gates [200]	2013	Canada	Quasi-experimental (Nonrandomized controlled pre–post intervention study)	Milk (type not specified)	Individual Interpersonal Institutional	School-based policy
Caspi [201]	2017	United States (Minnesota)	Randomized Controlled Trial	Total Dairy	Individual Institutional Community	School-based policy
Wordell [196]	2012	United States (Washington)	Quasi-experimental (Nonrandomized controlled cross-sectional study)	Milk (type not specified)	Individual Institutional	School-based policy
Sliwa [197]	2017	United States (YRBSS)	Cross-sectional	Milk (type not specified)	Institutional	School-based policy
Skinner [208]	2012	Canada	Quasi-experimental (Nonrandomized, pre–post study, repeated cross-sectional study)	Milk (type not specified)	Individual Institutional	School-based policy
Lee [205]	2019	Korea	Cross-sectional	Milk (type not specified)	Institutional	School-based policy
Henry [202]	2015	Canada	Quasi-experimental (Nonrandomized crossover intervention study)	Milk (type not specified), "Flavored Milk (chocolate, strawberry, etc.)'	Individual Institutional	School-based policy
Ritchie [212]	2018	United States (multi-site)	Cross-sectional	Low-fat/reduced fat/ nonfat milk (1%, 2%, skim, etc.)	Institutional Community Policy	Policy (Community programs and policies)
Androutsos [214]	2021	Greece	Cross-sectional	Total Dairy	Individual Community Policy	Policy (COVID lockdown policy)
Hanson [215]	2013	United States (NHANES)	Cross-sectional	Milk (type not specified)	Institutional Policy	Policy (School meals)
Au [217]	2018	United States (California)	Cross-sectional	Total Dairy	Institutional Policy	Policy (School meals)
Gearan [218]	2021	United States (School Nutrition and Meal Cost Study)	Cross-sectional	Total Dairy	Institutional Policy	Policy (School meals)
Smith [210]	2024	United States (NHANES)	Cross-sectional	Total Dairy	Policy	Policy (School meals)
Chen [220]	2021	United States (NHANES)	Cross-sectional	Total Dairy	Institutional Policy	Policy (National School Lunch Program)
Butler [66]	2020	Canada	Quasi-experimental (Prospective cohort pre– post intervention)	Milk (type not specified)	Individual Institutional Policy	Policy (School Breakfast Program)
No Association						
Burg [193]	2021	United States (Illinois)	Randomized Controlled Trial	Milk (type not specified)	Institutional	School-based policy
Gates [200]	2013	Canada	Quasi-experimental (Nonrandomized controlled pre–post, intervention study)	Milk (type not specified)	Individual Interpersonal Institutional	School-based policy
Sliwa [197]	2017	United States (YRBSS)	Cross-sectional	Milk (type not specified)	Institutional	School-based policy
Elbel [204]	2015	United States (New York)	Quasi-experimental (Nonrandomized control trial longitudinal pre–post with multiple follow-ups)	Milk (type not specified)	Individual Institutional Community	School-based policy
Quinn [206]	2018	United States (Washington)	Quasi-experimental (Nonrandomized controlled, pre–post intervention study	Low-fat/reduced-fat/ nonfat milk (1%, 2%, skim, etc.)	Individual Institutional	School-based policy

(*continued on next page*)

TABLE 7 (*continued*)

Author	Year	Country	Study Design	Type of Dairy	Social Ecological Model Determinants	Sub-factor
Edmondson [209]	2021	United States (multi-site)	Cross-sectional	Milk (type not specified)	Policy	Policy (Sugar sweetened beverage tax)
Schwartz [211]	2015	United States (Connecticut)	Observational longitudinal cohort study	Milk (type not specified)	Individual Institutional Policy	Policy (National School Lunch Program)
Chen [220]	2021	United States (NHANES)	Cross-sectional	Total Dairy	Institutional	Policy (National School Lunch Program)
Fernandes [213]	2012	United States (Early Childhood Longitudinal Survey)	Cross-sectional	Milk (type not specified)	Policy	Policy (Supplemental Nutrition Assistance Program)
Sanjeevi [216]	2021	United States (NHANES)	Cross-sectional	Total dairy	Policy	Policy (Supplemental Nutrition Assistance Program)
Negative association						
Cohen [195]	2016	United States (Massachusetts)	Cross-sectional	Milk (type not specified)	Institutional	School-based policy
Mann [198]	2017	United States (Rural Appalachia)	Quasi-experimental, (Noncontrolled pre–post, repeated cross-sectional study)	Low-fat/reduced-fat/ nonfat milk (1%, 2%, skim, etc.)	Institutional	School-based policy
Thompson [207]	2020	United States (California)	Quasi-experimental (Quasi-randomized controlled cluster study)	Low-fat/reduced-fat/ nonfat milk (1%, 2%, skim, etc.)	Institutional Policy	School-based policy
Sliwa [197]	2017	United State (YRBSS)	Cross-sectional	Milk (type not specified)	Institutional	School-based policy
Elbel [204]	2015	United States (New York)	Quasi-experimental (Nonrandomized control trial longitudinal pre–post with multiple follow-ups)	Milk (type not specified)	Individual Institutional Community	School-based policy
Henry [202]	2015	Canada	Quasi-experimental (Nonrandomized crossover intervention study)	Milk (type not specified), Flavored Milk (chocolate, strawberry, etc.)	Individual Institutional	School-based policy
Henry [203]	2016	Canada	Quasi-experimental (Nonrandomized crossover intervention study)	Milk (type not specified), Flavored Milk (chocolate, strawberry, etc.)	Individual Institutional	School-based policy
Butler [66]	2020	Canada	Quasi-experimental (Nonrandomized prospective cohort, pre–post intervention study)	Milk (type not specified)	Institutional Policy	School-based policy
Sanjeevi [216]	2021	United States (NHANES)	Cross-sectional	Total dairy	Policy	Policy (Supplemental Nutrition Assistance Program)
Cohen [219]	2014	United States (Massachusetts)	Quasi-experimental (Nonrandomized, pre–post, repeated cross-sectional study)	Low-fat/reduced-fat/ nonfat milk (1%, 2%, skim, etc.)	Policy	Policy (USDA meal patterns)

adolescents who participated in a cognitive behavioral therapy–based intervention designed to promote self-efficacy demonstrated greater dairy consumption than those in the control group [162]. Two studies conducted in Poland found that self-efficacy was positively associated with low-fat milk and high-fat cottage cheese consumption; however, no significant relationships were observed for other dairy items such as fermented dairy products [160, 161]. In contrast, 2 studies reported no significant associations between self-efficacy and dairy intake [110, 156]. Notably, 1 study investigated self-efficacy related to cooking skills and consumption of ultra-processed dairy products, reporting a negative association between cooking self-efficacy and ultraprocessed dairy intake [163].

Intrinsic factors

Seven studies examined the association of intrinsic factors with dairy consumption [132, 142-147]. All 7 studies used a cross-sectional design, with 1 article also reporting findings from a longitudinal study [143]. One study investigated the relationship between several appetitive traits and dairy intake, reporting a positive association with "hunger," "food responsiveness," "emotional overeating," "enjoyment of food," and "emotional undereating" [142]. In contrast, "food fussiness" was negatively associated with dairy intake, whereas "satiety response" and "slowness in eating" showed no significant associations [142]. Two studies examined food choice motivators [145, 147]. One found no significant relationship between dairy consumption and motivators, such as "sensory appeal,"

"price and availability," "health and natural content," "familiarity," "ease of preparation," and "weight control" but reported negative associations with "familiarity," "mood," and "ethical concerns" [145]. A separate study identified a positive association between sense of coherence (stress/resilience) and dairy consumption [143]. Other studies reported nonsignificant findings, including one that investigated the relationship between dairy intake and hedonic hunger [132] and another that examined "Cue to Action" from the health behavior model and its relationship to dairy intake [144]. One article explored the role of chronotype and found that being a "nonmorning" chronotype was associated with lower milk consumption [146].

Nutrition knowledge and educational programming

Thirty-six studies examined the link between nutrition knowledge and dairy consumption [30, 73, 84, 95, 127, 148, 156, 164-192] (Table 6). Methodology varied across studies; the majority of studies employed a quasi-experimental design (n = 17), followed by RCTs (n = 12) and cross-sectional or observational designs (n = 7).

Nutrition knowledge

Six articles, all using a cross-sectional design, explored the relationship between nutrition knowledge and dairy consumption [30, 73, 164-167]. Four studies highlighted the positive relationship between nutrition knowledge and dairy intake [73, 164-166]. One study examining the link between parent knowledge and adolescent dairy intake reported that greater parental knowledge about sugar in beverages was positively associated with adolescent dairy intake [30]. However, parental knowledge on dairy and calcium showed no significant relationship with adolescent dairy consumption [30]. Similarly, a study exploring how food label use related to food choice reported no significant associations between the use of food labels and dairy consumption [167].

Educational programming

Thirty studies explored the impact of educational programming on dairy intake. Of these, 1 study used a cross-sectional design [179], 17 articles employed a quasi-experimental, and 12 used an RCT. Among the quasi-experimental and RCT studies, 27 investigated the impact of nutrition education or nutrition education and lifestyle interventions, programs, or initiatives on dairy intake. Of these studies, 17 were associated with significant increases in dairy consumption. However, several studies noted differential effects across dairy products, with increases in some dairy items and decreases or no change in others [172, 174, 176, 184]. For example, 1 study implemented a kiosk to guide food selection and increase nutrition knowledge and awareness, which in turn led to higher overall dairy intake but reduced cheese consumption [176]. Eight studies reported no significant associations between nutrition knowledge and dairy intake [95, 148, 167, 177-179, 182, 185]. Four studies demonstrated negative associations [176, 180, 183, 184]. Of these, 2 studies reported a reduction in sugary dairy desserts [174, 176], and sugary yogurt [174] following intervention, 1 reported a decrease in high-fat dairy [180], whereas another observed a decrease in milk consumption [183].

Policy

Twenty-nine articles investigated the role of policy and its relationship with dairy consumption (Table 7). Of these studies, the majority used a cross-sectional design (n = 15), 1 study used an observational longitudinal cohort design [211], whereas several others used quasi-experimental approaches (n = 12), and 2 used RCTs. Studies that examined the impact of the National School Lunch Program were categorized as governmental policy studies as this program is implemented nationwide in the United States and thus is not a school-specific policy.

School-based policy

Seventeen studies investigated the relationship between school-based policy and dairy intake [66, 193-208]. A small portion of these studies (n = 4) used a cross-sectional or observational design, 11 studies used a quasi-experimental approach, and 2 studies were RCTs. Several types of school-based polices were investigated, including lunch duration (n = 2) [193, 195]; smart snack initiatives (n = 4) [196, 198, 200, 208]; beverage availability, policies, and/ or restrictions (n = 7) [197, 200, 202-205, 207]; school nutrition standards/policy (n = 3) [66, 194, 199]; school breakfast program [201]; and a behavioral economics intervention [206].

The effect of lunch duration was assessed in 2 studies, 1 cross-sectional [195] and 1 RCT [193]. The cross-sectional study reported that shorter lunch periods were associated with lower dairy intake [195], whereas the RCT, which compared 10- with 20-min lunch periods observed no significant differences in milk consumption [193].

Smart snack initiatives, which included snack programs, snack provisions, and "healthy" vending machines, were evaluated across 4 studies [196, 198, 200, 208]. Among 2 studies implementing interventions, 1 reported a positive relationship with milk intake [196], whereas the other showed no significant relationship between the snack program and milk intake [200]. Similarly, a quasi-experimental study found no significant change [208], and a cross-sectional study observed lower intake of low-fat/reduced-fat/nonfat milk [198].

Beverage-related policies were examined in 7 studies. Three studies that either completely removed or replaced chocolate milk with reduced-sugar chocolate milk consistently reported lower milk consumption among adolescents [202, 203, 207]. One study found that participation in the school milk program was positively associated with milk intake [205]. Another study reported that having an open campus was associated with lower milk consumption, whereas sugar-sweetened beverage restrictions were linked to higher milk consumption [197]. A quasi-experimental study of water availability, through the installation of water fountains, observed an initial decrease in milk consumption but no long-term changes at follow-up [204]. A behavioral economics intervention designed to shape food choices found no significant changes in milk intake [206]. Three studies explored other school-based nutrition policies, with 2 reporting positive associations with milk consumption [199, 200], whereas 1 that investigated staff nutrition training reported a negative association [66].

State, government, other policy

Thirteen studies examined the association of state, government, or other policy/policies and dairy consumption

[66, 209-220]. Of these studies, 10 used cross-sectional, 1 study used an observational longitudinal cohort design [211] and 2 utilized a quasi-experimental approach [66, 219], with policy types varying across studies. Two studies examined the effects of the Supplemental Nutrition Assistance Program (SNAP) on dairy consumption [213, 216]. One reported no significant change in dairy intake among individuals receiving SNAP benefits [213]. In another study, participants who lost their SNAP benefits within the past year reported no significant change in milk intake, whereas those who had been cut off for more than a year reported decreased milk intake [216]. Seven studies explored the impact of the United States National School Lunch or Breakfast Program and related policies including the Healthy, Hunger-Free Kids Act on dairy intake [66, 210, 211, 215, 217, 218, 220]. Of these studies, 5 reported significant positive associations between school meal participation and dairy intake [66, 210, 215, 217, 218]. Notably, 1 study observed a significant association in the overall student sample, but this effect was no longer significant when analyses were restricted to high school students [220]. One study evaluating dietary changes following the Healthy, Hunger-Free Kids Act found no significant changes in milk intake [211]. One study investigating community programs aimed at reducing or eliminating childhood obesity reported a positive association with low-fat/reduced-fat/nonfat milk intake [212]. Another study evaluating a sweetened beverage tax found no significant association with milk consumption [209]. Finally, 1 study in Greece, assessing the effects of COVID lockdown policies (April–May 2020), reported a positive relationship with dairy intake [214].

SEM

The SEM was used as a framework to identify the level(s) of influence with which each actionable factor aligned (Figure 4). The majority of factors mapped onto the individual level, with emphasis on health behaviors, such as nutrition knowledge and educational programming (n = 5), nutrition education and lifestyle interventions (n = 30), food access and availability (n = 15), physical activity (n = 23), screen time (n = 12), among other health behaviors (n = 12). Several factors aligned with the interpersonal level, reflecting the influence of family through acculturation (n = 3) and peer or family engagement in the meal environment (n = 9). The institutional level also included multiple actionable factors, given the significant role of the school environment on food choices. At the institutional level, the inclusion of nutrition (n = 10) and nutrition and lifestyle interventions in schools (n = 10), along with physical activity requirements (n = 4), were prominent factors associated with dairy intake in this population. Fewer factors were situated at the community level, such as food insecurity (n = 13) and the limited availability of healthy food options (n = 3). Only a limited number of factors were identified at the policy level, including broader systemic considerations, such as school-based policies (n = 4) and state, government, or other policies (n = 17).

Discussion

This scoping review advances the literature by using the SEM to identify actionable factors that shape adolescent dairy intake, providing a structured approach to understanding how dietary behaviors are related to various social, behavioral, and environmental factors across multiple levels. By focusing on modifiable influences, this review highlights potential avenues for improving dietary patterns and supporting nutrient adequacy in adolescents. Through the identification of actionable factors, this review highlights opportunities for intervention that can serve as the impetus to improving diet quality within the context of broader systemic and structural determinants that are not amenable to change. Further it offers a framework that can be applied to other calcium-rich foods and nutrients to inform more comprehensive strategies and the design of effective interventions. A total of 181 articles examining actionable factors associated with dairy intake were identified. Within these 181

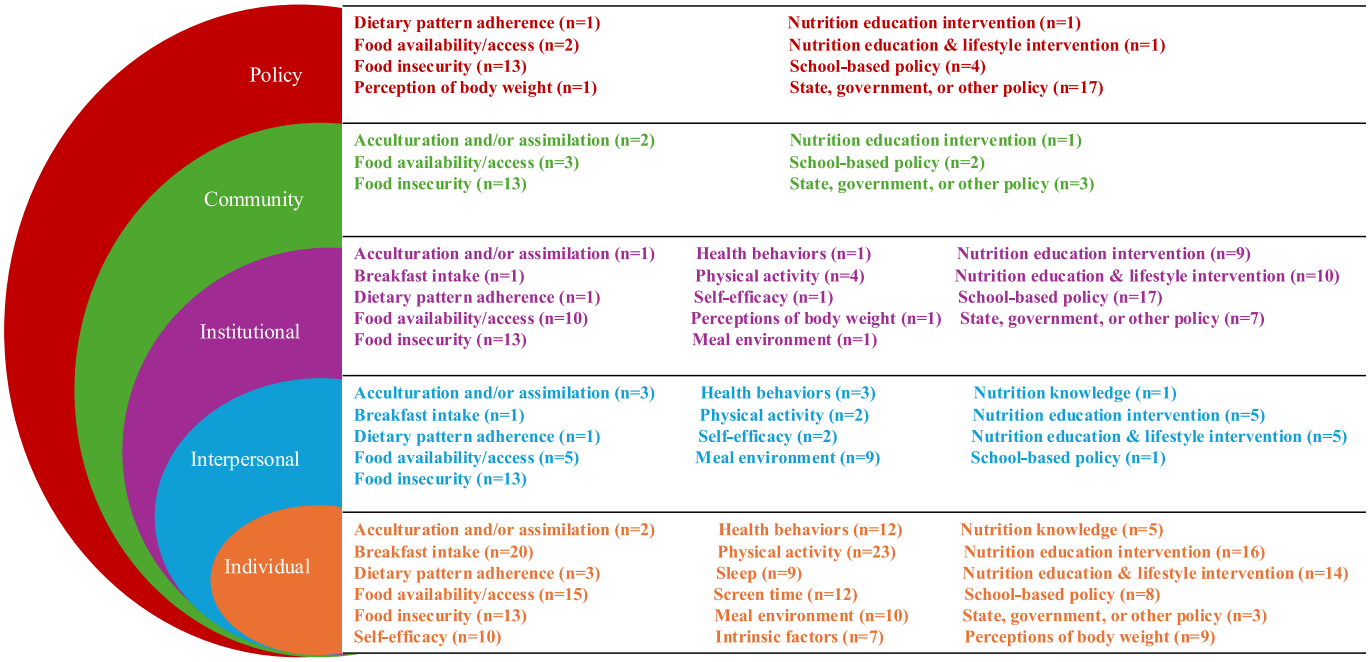


FIGURE 4. Mapping of the actionable influences of adolescent dairy intake to the different spheres of the Social Ecological Model.

articles, 7 broad thematic factor categories and 17 subfactor categories were identified. The majority of the studies included were cross-sectional in nature, with some factors examined only using correlational analyses, limiting the ability to make causal inferences about the relationships between identified factors and adolescent dairy intake.

Within this review, several actionable factors tended to be positively associated with dairy intake in adolescents, including nutrition knowledge and educational programming, consuming breakfast, sleep, physical activity, and availability of dairy in both the home and school settings. These findings highlight that these factors should be further explored in causal research settings to understand their role in positively influencing dairy intake, overall diet quality, and well-being. In contrast, there were several factors that tended to be negatively associated with dairy intake, including food insecurity, body image perceptions and weight stigma, and screen time. Understanding the underlying mechanisms through which these factors influence dairy intake is critical in developing interventions that are equitable, feasible, and responsive to the diverse contexts in which adolescents make food choices.

Other factors demonstrated more variable associations with dairy intake. For example, interactions with peers and family, characterized in the interpersonal sector of the SEM, demonstrated varied associations with adolescent dairy intake. As demonstrated by this review, shared mealtimes with peers may be one approach to enhance adolescents' exposure to dairy products. Peer dynamics were generally positively associated with adolescent dairy consumption, with shared meals occurring in school, at home, or during social environments potentially increasing familiarity and acceptability through social modeling [68, 71, 221]. In addition to peers, adolescent dietary patterns were shown to be strongly associated with family dynamics, with parents shaping their children's food choices through their role as the primary food providers and meal preparers, often modeling behaviors that either promote or discourage dairy intake at home [29, 30]. Several studies assessed family meal practices, such as shared family meals, which demonstrated variable associations on adolescent dairy intake [68, 73-76]. Similarly, multiple studies that aimed at exploring the association of adolescent nutrition knowledge and/or nutrition education and dairy intake also included parents and other household members [30, 127, 178, 184]. While results varied, these findings suggest that household behaviors may play a meaningful role in shaping adolescent dietary behaviors and should be considered in the design of future research and interventions.

Studies examining policy-level factors related to adolescent dairy intake, including school-based and broader organizational or governmental policies, showed considerable variability across both the types of policies examined and their reported associations with intake. Within school settings, policies, such as lunch duration, smart snack initiatives, beverage availability, and school nutrition policies, were evaluated; however, associations varied across studies, with no consistent patterns observed [193, 195, 197-200, 202-204, 208]. Similarly, a broader examination of policies at the state and federal levels, including SNAP participation, the National School Breakfast Program, and school meal participation, showed findings differing across articles [66, 211-213, 216]. Taken together, these findings demonstrate the complexity of policy-level factors associated with dairy intake and diet and highlight that policies may function differently across populations and contexts. It is important to note that nearly all policy-focused studies included in this review were conducted in the United States, which limits the extent to which findings can be applied to other countries, especially those with substantially different demographic characteristics, cultural contexts, and resources. Further research in other countries is needed to examine how policy-level factors relate to adolescent dairy intake and how contextual conditions influence policy implementation and associated outcomes.

Many of the identified subfactor categories were characterized across multiple levels of the SEM, alluding to the importance of integrating more than 1 level of influence to effectively address the complexities of dietary behavior change. The integration of actionable factors associated with dairy intake into the SEM showed that most factors were concentrated at the individual and institutional levels. These findings demonstrate that the institutional or school environment represents a promising setting for delivering targeted nutrition and lifestyle-based interventions for improving dairy consumption as a means of increasing calcium intake, given the reach and influence on adolescent dietary behaviors. Considering that adolescents spend the majority of their day in school, this review suggests that the school environment may play a critical role in supporting adolescent nutrition, through nutrition education in the classroom, related activities, and school meal programs [222]. However, given the high global prevalence of the development of lactose intolerance in adulthood and the diversity of cultural dietary patterns, approaches to improving calcium adequacy within schools should be flexible and inclusive, supporting a range of nutrient sources that align with the needs, preferences, and access of the populations served [223]. For instance, lactose intolerance represents an important biological determination of dairy intake within populations, as it may contribute to reduced dairy consumption and avoidance of dairy products [25, 223]. Although there is a gap in recent research exploring the global rates of lactose intolerance in adolescence, it is estimated that ~75% of adults' worldwide experience lactose intolerance, with prevalence varying substantially by demographic group and geographic region [224]. As such, reliance on dairy as a primary source of calcium may not be feasible or appropriate for all adolescents. Future research is needed to explore if similar actionable factors are related to the consumption of other calcium-rich foods. Further, it is important to consider that meaningful research and intervention opportunities that support adolescent dietary behavior change also exist across interpersonal, community, and policy domains and nonmodifiable factors not highlighted within this review. In tandem with direct nutrition education, integrating nutrient-dense school meals at the state/province or national level, supporting adequate sleep behaviors, and encouraging regular physical activity within a comprehensive health education framework may have synergistic effects that promote dairy intake [225]. Together, these findings underscore the need for research approaches that not only quantify associations but also elucidate the underlying mechanisms and experiences shaping dietary behaviors, thereby supporting the development of interventions that are contextually relevant and aligned with adolescents' realities and environments.

Future directions

One notable research gap identified in this review relates to the influence of social media on adolescent dairy consumption. Although the review examined studies focused on exploring the association between screen time and dairy intake, there was a dearth of research that examined the relationship or impact of social media use. Research has shown that social media has the potential to serve as an influential determinant of both positive and negative outcomes with some studies demonstrating supportive environments for sharing dietary experiences, whereas others promote self-harming dietary behaviors [226]. Given the ubiquitous use among adolescents, social media serves as a potential mitigating factor to explore with respect to its relationship with overall diet quality, including dairy intake in this population [227].

Limitations

This review was limited to studies that explicitly reported dairy intake, including a quantitative metric in servings, cup equivalents, or other measurable quantities. Studies utilizing composite dietary quality indices, such as the Mediterranean dietary pattern scores, that included dairy as a component, were excluded because changes in these aggregate measures may not directly reflect dairy consumption. Thus, this exclusion criterion may have resulted in the omission of studies that reported meaningful changes in adolescent dairy intake. To ensure broad coverage of potentially relevant articles during the title and abstract screening phase, studies examining calorie-dense dairy products (e.g., ice cream, butter) were included. Although these foods contain calcium and other nutrients, they are also often sources of added sugars, saturated fat, and excess calories and are generally recommended to be consumed in limited amounts within a healthy dietary pattern [21]. As such, their inclusion represents a limitation of this review. However, examining factors associated with the consumption of these products may still offer useful insights into dietary behaviors and underlying determinants. For example, although there has been a decline in unflavored milk intake among adolescents, consumption of beverages that contain dairy, such as boba milk tea, coffee-based drinks, and other sugar-sweetened beverages has increased [228, 229]. Understanding the attributes that are associated with consuming these products may inform future research on overall dietary patterns and related factors.

Additionally, in order to align with the WHO strategic initiative for supporting adolescent nutrition released in 2010, and to avoid geographical restrictions in the search strategy, eligible studies were limited to those published between 2010 and 2025. Restricting the literature search to a specific lower time bound may have resulted in the omission of relevant studies published prior to 2010. The majority of studies included in this review were cross-sectional, which limits inferences regarding the directionality of observed relationships. Although some quasi-experimental and RCTs were included, additional research is needed to further examine the directionality of these factors. Additionally, studies not written or translated into English were excluded, which may have led to the underrepresentation of research from non–English-speaking countries. Of the 181 articles included in this review, there was only 1 study from Australia, 2 studies from Africa, and 9 from Latin and South America that met eligibility criteria. During the screening process, it was documented that 85 of the studies excluded for nonactionable factors, such as socioeconomic status or living environment (urban compared with rural), which may not be fiscally possible for intervention, nor ethical for the researchers to address, were conducted outside the United States. It is important to acknowledge that the actionable factors identified in this review are still shaped by nonactionable, unmodifiable factors, such as those listed above, and should be recognized when planning future research or interventions. For a deeper understanding of global adolescent dairy intake, an expanded review that is inclusive of nonactionable factors and investigates other types of dairy beyond bovine dairy would be required.

In conclusion, calcium is an essential nutrient for supporting physical growth and bone development during adolescence; however, evidence indicates that adolescents globally are not meeting recommended calcium intakes. Although calcium can be obtained from a range of dietary sources, dairy products are widely recognized as a key contributor to calcium intake, are commonly captured in dietary intake measures, and can be used in research as an indicator of calcium-rich food consumption [12, 14-16]. Therefore, examining factors that influence adolescent dairy intake can provide important insight into barriers and facilitators related to calcium intake and overall dietary intake. Before impactful research and interventions aimed at increasing adolescent dairy intake and improving overall diet can be designed, factors influencing intake, particularly those that are modifiable, must be identified. Developing multisectorial approaches to address actionable influencing factors for improving dairy intake and overall diet quality requires comprehensive, coordinated engagement and effort across the various spheres of the SEM. Findings from this scoping review emphasize the importance of developing and implementing interventions to address determinants of dietary intake across multiple levels of the SEM, serving as an effective strategy for targeting actionable factors and improving dietary behaviors in this population. Collaborations among governments, organizations, industry, and communities are required to support adolescent health and ensure nutritional adequacy.

Author contributions

The authors' responsibilities were as follows — RES and SZC: conceptualized the review; RES: secured funding; MDR, SZC, RES: conducted the literature search; MDR, ES, GLG, BML, RHC, SZC, RES: reviewed the titles and abstracts, extracted data, and performed quality assessment; MDR and ES: drafted the manuscript, tables, and figures under the guidance of RES and SZC; and all authors:provided constructive edits, and reviewed and approved the final manuscript. Figure graphics were created using Flourish (www.flourish.studio).

Declaration of Generative AI and AI-Assisted Technologies in the Writing Process

The authors declare that no generative AI or AI-assisted technologies were used in the writing of this manuscript.

Conflicts of interest

The authors report no conflicts of interest.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.cdnut.2026.109385.

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