



A novel ecological model of holistic early childhood workforce well-being: The utilization of an ai-assisted systematic review

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ABSTRACT

A critical factor in promoting quality practices in early care and education (ECE) settings is educator well-being, a multi-dimensional construct influenced by a variety of contextual factors. There has yet to be consensus on conceptualizing early childhood workforce well-being in a way that encompasses multiple factors and complex dynamics among them. Designed by an interdisciplinary group of scholars, this study aimed to develop a novel conceptual model, the *Ecological Model of Holistic ECE Workforce Well-Being*, that captures multiple layers of well-being. In addition, this new model was validated using an AI-assisted systematic review that identified 345 studies published between 1990 and 2023 for inclusion. We examined four core domains of ECE workforce well-being (i.e., physical, psychological, and professional well-being and health behaviors) and how these have been studied in the literature with regards to relational well-being and contextual factors. While our systematic review covers literature published between 1990 and 2023, it is noteworthy that there has been growing attention to ECE workforce well-being since 2019. However, most studies focused on one or two indicators of well-being using descriptive or correlational methods. This study provides future directions for ECE workforce well-being research and practice by identifying gaps in the literature that could support efforts to professionalize the ECE workforce and, ultimately, enhance the quality of care and learning for young children.

The study was pre-registered at osf.io/awcyn. This study uses an open-source AI-aided screening tool: Active Learning for Systematic Reviews (ASReview) designed and validated to support screening of materials. ASReview assisted the screening process of our systematic review.

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Educators play a critical role in scaffolding and providing quality learning experiences for children aged birth to five in various early care and education (ECE) settings (Kwon et al., 2019). One critically important factor known to support the quality of classroom practices is ECE educators' well-being (Jeon et al., 2014). Accumulative research evidence shows that ECE educators' well-being, mostly focusing on suboptimal well-being or ill-being (e.g., depressive symptoms, stress), is significantly associated with turnover and is directly and/or indirectly associated with educator practices as well as children's development and learning (Jeon et al., 2014; Kwon et al., 2019; Kwon, Jeon, et al., 2021; Roberts et al., 2016).

Educators' well-being is multi-dimensional, embedded in and interacting with various contextual factors (Gallagher & Roberts, 2022; Jennings & Greenberg, 2009; Kwon, Ford, et al., 2021). Additionally, well-being is unique to each individual and may need to be supported by multiple strategies and processes. Due to these complexities, there is no consensus on how to define early childhood workforce well-being (Cumming & Wong, 2019; Wilson et al., 2023). Although studies have been conducted to conceptualize early childhood workforce well-being through literature reviews, most have focused on only one aspect of well-being (e.g., psychological well-being in Wilson et al., 2023; work-related well-being in Cumming & Wong, 2019), or the scope of the review was limited. A recent framework on early childhood workforce well-being (Ford et al., 2024; Kwon et al., 2022) addresses the multi-faceted and holistic nature of well-being, and incorporates various working conditions such as job demands and resources, supported by empirical data. However, the model was not accompanied by a comprehensive literature review to support or validate its development. Also, this model did not account for multiple contextual factors that have the potential to interact with individual characteristics, working conditions, and workforce well-being.

Thus, our understanding of ECE educator well-being, specifically, the key factors that define the construct and the factors that support or hinder it, remains limited. Educators' well-being is shaped by a wide range of influences within and beyond their workplaces (Jennings & Greenberg, 2009) including individual characteristics, working conditions, and broader contextual factors that are intertwined and may interact with one another to influence ECE educator well-being. There is a critical need to deepen our understanding of the multiple layers of proximal and distal factors on ECE well-being in order to effectively support this essential workforce. Guided by an interdisciplinary group of

scholars, this study aimed to develop a novel conceptual model of ECE workforce holistic well-being encompassing these multiple layers, and to validate the model through an AI-assisted systematic review.

1. Conceptual framework of holistic early childhood education workforce well-being

This study introduces a new conceptual framework, the *Ecological Model of Holistic ECE Workforce Well-Being* (Fig. 1), developed by the Head Start-University Partnership Early Head Start (EHS)/Head Start (HS) Workforce Well-Being Consortium. This interdisciplinary group comprises scholars from six University teams: Georgetown University Medical Center, University of Colorado Anschutz Medical Campus, University of Nebraska Lincoln, University of Oklahoma, University of Texas Health Science Center at Houston, and University of Virginia. The model emphasizes the critical role of multiple, interrelated environmental and contextual factors that shape early childhood educators' well-being. Inspired by Bronfenbrenner's ecological systems theory (1994), our new model centers on the nested contexts (e.g., micro-system, macrosystem) that influence individual development. The model also draws upon four other existing theoretical frameworks on educator well-being to define holistic well-being and factors in the work and broader environment (e.g., proximal and distal environmental systems) that influence ECE educators working with children aged birth to 5 years old in center-based settings.

First, the Prosocial Classroom Model (Jennings & Greenberg, 2009) highlights the relationship between teachers' social-emotional competence and the learning environment, proposing that diminished educator well-being may lead to burnout and negative classroom practices. This model also recognizes the various program, school, and community contextual factors that influence this process. While valuable, this model was developed for K-12 contexts and is limited to social-emotional well-being.

The Whole Teacher and Leader Well-Being Models (Ford et al., 2024; Kwon, Ford, et al., 2021; Kwon et al., 2022), developed within the ECE context, proposes a holistic view of early childhood teachers' well-being, including psychological, professional, and physical well-being, from an interdisciplinary perspective. In addition, these models address a myriad of working conditions such as physical, psychological, professional, and organizational job resources and demands that have a unique impact on ECE educators' well-being. The models offer a novel and deeper

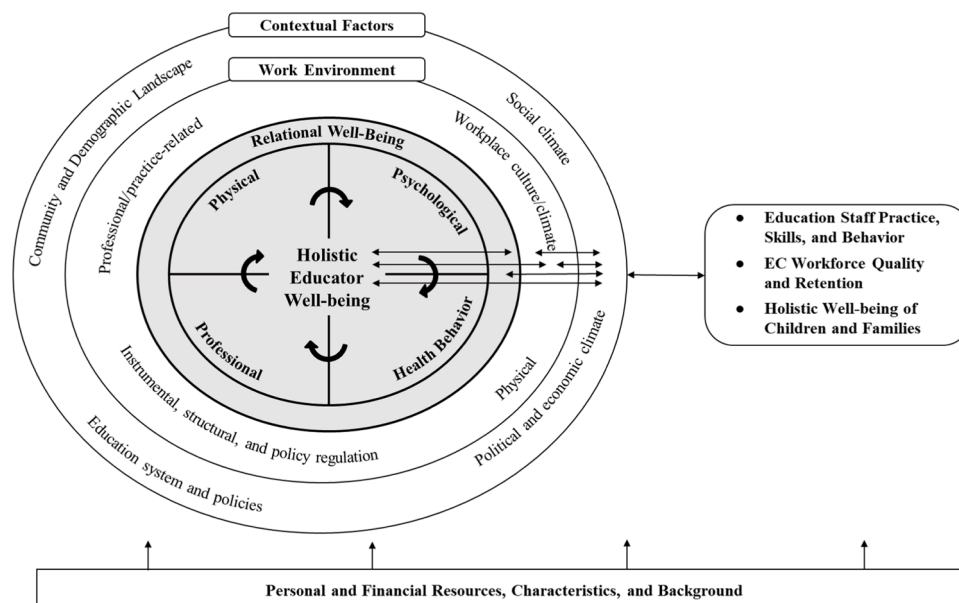


Fig. 1. Conceptual framework on holistic educator well-being.

understanding of ECE educators' holistic well-being and working conditions; however, they do not fully integrate broader contextual influences or specific predictors and consequences of well-being across ecological layers.

Another model developed within the ECE context, the Early Childhood Workforce Well-being Model (Gallagher & Roberts, 2022), focuses on professional well-being as a foundation for supporting child development and caregiver-child relationships. The model extensively identifies individual- and contextual-level factors beyond the workplace that influence ECE educators' well-being. However, this model lacks a comprehensive and integrative framework for defining holistic ECE workforce well-being.

From the public health field, the National Institute for Occupational Safety and Health (NIOSH) Worker Well-Being Framework (Chari et al., 2018) provides a holistic conceptualization of worker well-being as a subjective and objective phenomenon inclusive of experiences within and beyond work contexts. This holistic framework has an accompanying questionnaire, the Worker Well-Being Questionnaire, that operationalizes and measures the domains of well-being in the model. Though this model has been adapted for ECE contexts (Farewell et al., 2023), it does not fully address the distinctive characteristics and challenges within the ECE workforce (Farewell et al., 2024).

Building on the strengths and addressing the limitations of these prior frameworks, the Ecological Model of Holistic ECE Workforce Well-Being was developed through an iterative and collaborative process. As shown in Fig. 1 and Table 1, in this model, ECE educators' holistic well-being is placed at the center of the model and categorized into four core well-being domains: (a) psychological well-being, (b) physical well-being, (c) professional well-being, and (d) health behaviors. Surrounding these domains is a newly introduced layer of relational well-being that interconnects with educators' holistic well-being, which has been largely absent from previous models. In addition, our model identifies two environmental factors: (a) work environment, which may directly impact educators' core domains of well-being and relational well-being within their workplace, and (b) contextual factors, broader contexts that may directly and/or indirectly impact ECE educators' well-being.

In this conceptual model, we also identify proximal and distal outcomes that educators' well-being may influence. These include staff's practice, skills, and behavior in ECE settings, workforce quality and retention, and the holistic well-being of children and families served. We acknowledge that individual members of the workforce are impacted by their personal resources, financial resources, individual characteristics, and background. Finally, we recognize the importance of a dimension of time, often referred to as the chronosystem in the ecological systems theory (Bronfenbrenner, 1994), such as sociohistorical events that

impact ECE educators' well-being (e.g., COVID-19). Below, we operationalize each of the four core well-being domains, discuss examples of indicators, and describe the importance of these domains in improving classroom practices and child outcomes.

1.1. Psychological well-being

The first domain, *Psychological Well-Being*, is educators' multi-dimensional mental health state and the quality of their emotional functioning. It encompasses various aspects of positive or negative emotions that individuals may experience, such as depressive symptoms, anxiety, stress, and happiness. At the same time, it reflects individuals' psychological and emotional strengths to cope with stress, regulate their emotions, recognize others' emotions, bounce back from a stressful situation (resilience), and experience a sense of purpose and fulfillment. Previous studies have shown that when ECE educators experience depressive symptoms, stress, or emotional exhaustion, they tend to demonstrate lower-quality practices in their classrooms (Roberts et al., 2016) and are more likely to have intentions to leave their jobs (Grant et al., 2019; Kwon, Jeon, et al., 2021). On the other hand, when they are self-efficacious, hopeful, resilient, and optimistic, they demonstrate a higher quality of work life and a greater commitment to the occupation (Cheng & Gan, 2020). Promising findings also suggest that ECE educators' mindfulness and compassion are associated with decreased emotion dysregulation and workplace exhaustion (Jennings, 2015) and increased child outcomes (Jeon et al., 2022). Although psychological well-being has been widely studied in literature, the studies tend to have a narrow scope, mostly focusing on negative aspects of well-being, such as stress and depressive symptoms. Additional research that examines more positive aspects of this dimension is needed to gain a more comprehensive understanding.

1.2. Professional well-being

The second domain, *Professional Well-Being*, addresses the emotions ECE educators experience as a function of their job (e.g., compassion satisfaction, occupational burnout), work engagement, and perceptions of workplace conditions. While teaching young children is rewarding, the work can be stressful if job demands and sources of stress, such as children's behavior, outweigh feelings of efficacy and control (Schaak et al., 2020). In ECE, rates of occupational burnout, a work-related syndrome resulting from chronic stress, are reported to be as high as 56% (Koch et al., 2015). Job stress and burnout undermine how teachers interact with children in the classroom, contributing to lower levels of quality (Roberts et al., 2016). These workplace emotions can also

Table 1
Conceptual framework domain, dimension, and example indicators.

Domain	Dimension	Example Indicators
Holistic WB	Psychological WB	Resilience, stress, coping, mindfulness, depressive symptoms
	Physical WB	Ergonomic pains, work-related injuries
	Professional WB	Job commitment, self-efficacy, burnout, job satisfaction
	Health Behavior	Sleep, nutrition, self-care practices
	Relational WB	Relationships with children, families, and co-workers, personal relationships, interpersonal skills, communication skills
Work Environment	Workplace Culture/Climate	Relational climate, organizational culture, collaborative climate, wellness culture, workplace support, fairness, sense of belonging
	Physical Environment	Furniture, space for teachers, physical safety
	Professional and Practice Related	Class size/ratio, family engagement, leadership, children and families enrolled, program vision
	Instrumental, Structural, Policy	Compensation and benefits, QRIS, COVID related provisions
	Regulation	
Contextual Factors	Political and Economic Climate	Federal/state policy, cost of living
	Social Climate	Media portrayal, public view, social expectations, respect for individual differences
	Education System and Policies	Educator preparation related policies
	Community and Demographic Landscape	Population shift and community composition
Personal and Financial Resources, Characteristics, and Background		Demographics, financial security and resources, professional background & beliefs, teaching role, educational background, teaching experience

Note. WB = well-being

influence teachers' decision to leave the profession (Schaak et al., 2020). Educator efficacy and job satisfaction are protective factors that can buffer the effects of job strain (Bakker & Demerouti, 2007). Like psychological well-being, professional well-being has been widely studied. However, most studies focus on a limited set of indicators, such as job satisfaction, burnout, and teaching efficacy, rather than exploring a range of complex emotions experienced by educators in their workplace. In addition, there needs to be an effort to understand professional well-being within the workplace context.

1.3. Physical well-being

The third domain, *Physical Well-being*, encompasses a variety of indicators of physical functioning and general health conditions, including underlying health issues. There is accumulating evidence that ECE educators engage in less exercise and have higher rates of sedentary behavior, obesity, and chronic disease as compared to similar groups in the general population (Kwon et al., 2022; Otten et al., 2019; Randall et al., 2023; Shreedar et al., 2023). It is also well-known that ECE educators engage in many high-risk, repetitive activities as they care for children, such as lifting and carrying children, bending, squatting, pushing and pulling, and sitting on the floor or in child-sized furniture (Kwon et al., 2022; Randall et al., 2023). These repetitive activities place them at risk for injury and other musculoskeletal trauma (Labaj et al., 2016). Musculoskeletal injuries comprise a third of work-related problems in education settings, with 81% of ECE teachers reporting low back pain, followed by 59% with neck and shoulder pain (Chiasson et al., 2012). Broader studies of physical health have established strong linkages between physical activity and numerous acute and chronic physical health conditions such as obesity, cardiovascular disease, and diabetes (e.g., Burke et al., 2015). Despite the importance of promoting the physical well-being of ECE educators, literature on this topic is scarcer than studies on other dimensions of well-being, and the field needs more attention to this important area.

1.4. Health behaviors

The fourth domain is *Health Behaviors*, which encompasses a range of behaviors and actions taken by educators that either support or hinder the maintenance and improvement of their mental and physical health. In this context, health is best understood as a state of well-being. The behaviors and actions include physical activity/exercise, nutrition/eating, sleep, alcohol consumption, smoking, substance abuse, self-care/preventive practices, awareness of health behaviors and concepts, leisure activities, and hygiene. In addition to associations between physical activity and well-being-related outcomes within the ECE workforce described above, healthy dietary behaviors in the workplace may similarly reduce educators' absenteeism and enhance productivity (Fitzgerald et al., 2016). Sleep is a predictor of turnover intention in high demand, helping professions (An et al., 2022). Among the few studies investigating sleep among ECE educators, only 43% to 57% reported getting seven or more hours of sleep per night (Lessard, 2020). Self-care and preventative practices (e.g., relaxation, restoration, and rejuvenation activities) are associated with reducing burnout and turnover, suggesting that self-care interventions may be a professional imperative in ECE workplaces (Penning, 2018). Given the significant relations of health behaviors to other well-being domains, it is critical to include health behaviors as a distinctive aspect of ECE workforce holistic well-being.

1.5. Relational well-being

In our model, the dimension of *Relational Well-Being* is conceptualized as a distinct yet interconnected domain that surrounds the four core well-being domains. This reflects the reciprocal and dynamic nature of relational well-being—both influencing and being influenced by other

domains of educator well-being. Including relational well-being enables a holistic, process-oriented understanding of well-being, recognizing that individuals exist within—and are shaped by—their interpersonal environments over time.

Indicators of relational well-being include the quality of the relationships ECE educators have with those in the workplace, such as co-workers, supervisors, children, and families, as well as the quality of their relationships. For example, positive collegial relationships can buffer stress and enhance job satisfaction, while ongoing conflicts with families or coworkers may increase emotional exhaustion (Baum & Schnake, 2024). Notably, educators who experience relational challenges at work are more susceptible to burnout and decreased job performance, whereas those with higher relational support tend to use more adaptive coping strategies (Jeon & Ardeleanu, 2020). Although relational well-being is often associated with workplace relationships, importantly, relational well-being extends beyond the workplace. Personal relationships—such as those with partners, close friends, or family members—play a significant role in educator well-being by offering emotional support, promoting work-life integration, reducing stress, and supporting mental health and professional identity (Baum & Schnake, 2024).

When relational well-being is poor, it has implications for the other dimensions of well-being and vice versa. In a systemic review of the determinants of burnout among ECE educators, results suggested that poor relationships, such as perceiving conflict with co-workers, supporting children with challenging behaviors, and managing unresolved conflicts with parents, were associated with burnout (e.g., Ng et al., 2023). In sum, supporting the relational lives of educators—across professional, personal, and community contexts—is essential for sustaining a thriving and resilient ECE workforce.

1.6. Importance of contexts

1.6.1. Work environment

Work Environment, which may directly influence educators' holistic well-being, includes four domains. The first domain is *Physical Environment*, such as facilities, furniture, and physical safety. Despite its recognized importance for employee's well-being (Colenberg et al., 2021; Kwon, Ford, et al., 2021), ECE settings often overlook adult-specific needs, such as adult-sized furniture and separate personal/social spaces (Cumming et al., 2021; Kwon et al., 2022). Evidence linking the quality of the physical environment to ECE educators' well-being is emerging (Kwon, Ford et al., 2021), yet research remains scarce. The second domain is *Professional/Practice-Related Environments* including child-to-educator ratio, child behavioral issues, parent engagement, professional development, and program vision. These factors are well-documented significant predictors of educator well-being, especially in the professional and psychological domains (e.g., Jones et al., 2020; Kwon, Jeon, et al., 2021).

The third domain is *Workplace Culture and Climate* linked to educator well-being, including the emotional/social atmosphere of workplace—often described as a sense of community and collaborative climate (e.g., Jones et al., 2020); workplace conditions, particularly regarding job demands and compensation (e.g., Jones et al., 2020); and practices that support respectful and responsive approaches to varied cultural and language backgrounds (e.g., Cheruvu et al., 2015). The last domain is *Instrumental, Structural, and Policy Regulations*, including compensations/benefits, QRIS and certification requirements, and safety-related provisions, which are also related to educator well-being and retention (e.g., Otten et al., 2019).

While these work environment factors are widely recognized for their importance, research regarding how they predict well-being is mixed. For instance, wages/benefits and professional development show no significant link to well-being indicators in some recent studies (e.g., Lipscomb et al., 2022). Some of the inconsistencies may stem from the prevalent use of correlational designs and cross-sectional data without

sufficient controls for confounders. Additionally, studies in this field often aggregate various work environment factors into single measures based on the job demands-resources model (Bakker & Demerouti, 2007). Our model addresses the importance of different work environment aspects across a broader range of well-being indicators.

1.6.2. Contextual factors

ECE educators' well-being is influenced by multiple nested systems that impact their well-being and professional functioning. To that end, the surrounding *political, economic, and social climate* as well as *education system and policies* in which teachers reside both directly and indirectly influence their educational context (Price & McCallum, 2014). At a policy level, decisions related to education funding, resources, curriculum, and workplace rights directly contribute to the well-being of educators (Halfon et al., 2009). Parallel to the policy landscape, an unstable economic climate can have a profound effect on educators' wellness (Kraft & Bleiberg, 2022), such as reduced compensation, lack of resources, lower access to health insurance, and heightened workload. Each of these consequences has been strongly linked to heightened levels of stress, depressive symptoms, poor well-being and burnout in educators (Farewell et al., 2023, 2024).

The decline in teacher well-being documented during the COVID-19 pandemic illustrates the importance of institutional and political support for ECE (Edie et al., 2021). As a result of the pandemic, many ECE educators experienced increased workloads and responsibilities coupled with financial strain due to reduced hours, layoffs, or changes in enrollment patterns resulting from the economic impact of the pandemic. Additionally, teachers serving in schools with higher levels of economic and social needs are more likely to be affected by staffing reductions and during funding shortfalls (Kraft & Bleiberg, 2022). Considerable evidence shows that Black, Asian, and Hispanic/Latino teachers are constantly earning lower hourly wages than others (Lee et al., 2022; Phillips et al., 2016). Moreover, robust evidence shows that Black teachers are disproportionately more likely to be placed in under-resourced schools than others, a concept called "workforce segregation" (D'Amico et al., 2017). These trends underscore the need for continued attention to fair staffing and compensation practices across the ECE workforce. In addition, it highlights the importance of situating educators' experiences within the broader *community and demographic landscape*.

1.7. Personal factors

Many *Personal Factors* may be related to ECE educators' holistic well-being, and they interact with contextual factors. Personal factors are represented in our model with indicators. These include (a) individual characteristics such as demographics (e.g., age, self-identified gender) and perceived financial security, (b) personal backgrounds such as one's relational history (e.g., adverse childhood experiences, benevolent or positive childhood relational experiences), (c) professional background and beliefs such as one's teaching role, career stage, educational background, teaching experience, and (d) individual resources such as personality characteristics.

Regarding financial security, perceiving higher financial stress is associated with lower psychological well-being (Vesely et al., 2024). Teachers' demographic characteristics, such as age and race/ethnicity, are other salient factors to consider when examining the well-being of ECE educators. For example, one study found that early childhood educators from minority backgrounds reported higher levels of stress, emotional strain, and sleep-related concerns (Souto-Manning & Melvin, 2022). When examining individual background characteristics, adverse childhood experiences (ACEs) may be associated with psychological and relational well-being among ECE educators. In recent studies of ECE educators, having more ACEs was moderately associated with higher levels of workplace exhaustion (Grist & Caudle, 2021). Professional background characteristics (i.e., educational levels) are also associated

with some aspects of ECE educators' well-being (Jeon et al., 2018; Kwon, Ford, et al., 2022), but the findings are mixed. For example, Jeon et al. (2018) found that teachers with an associate degree reported lower workplace exhaustion than teachers without an associate degree. However, Kwon, Ford, et al. (2022) found that while teachers with higher educational levels provided a higher quality of care, they reported lower professional and physical well-being as compared to teachers with lower educational levels. Due to a wide range of individual characteristics and mixed findings, more studies are needed to advance our understanding of their associations with ECE holistic well-being.

1.7.1. The present study

Although previous studies have proposed and tested various conceptual models of educators' well-being, a comprehensive model addressing multiple aspects of ECE educators' well-being along with work environments, contextual and personal factors, and potential outcomes is still lacking. In addition, despite growing research on ECE educators' well-being, the field's current state remains unclear. To summarize the current state of ECE workforce well-being research and to inform future research, we developed a comprehensive conceptual framework for ECE educators' well-being, its indicators, predictors, and outcomes. We used Artificial Intelligence (AI), an advanced analytic method, to conduct a systematic review for refining and validating the model. This is the first study, to our knowledge, to incorporate an extensive systematic review in creating a conceptual model of ECE well-being. Our research questions were: (a) What is the current state of literature focused on ECE workforce well-being?; (b) To what extent have the four core domains of well-being (i.e., physical, psychological, and professional well-being and health behaviors), and their indicators, in the new model been studied in the literature? Are there any gaps in the literature and missing indicators in the model?; and (c) To what extent have relational well-being and work environments been studied as predictors and outcomes of the four core domains of educators' well-being?

2. Methods

2.1. Development of a conceptual framework

The conceptual framework presented in Fig. 1 was developed through an iterative process. The initial draft of the model was co-developed by representatives from each of the six universities participating in the consortium. The draft was modified continuously until we reached a consensus on the model layout and the terms used in the model. After the conceptual model draft was completed, we collected potential indicators within each model domain. The consortium members used previous research on ECE educators' well-being to identify potential indicators. We also included frequently studied well-being indicators in other disciplines (e.g., K-12 education, nursing, social work, public health, medicine). To maximize the benefit of having a large team of interdisciplinary scholars, we did not limit the scope of indicators during this initial stage. After the potential indicators were gathered, the team collectively reviewed the indicators and discussed any disagreements until we had a consensus on the placement of each indicator under each domain. After identifying the indicators, we conducted a systematic review of the literature to validate the indicators. The goals of this process were (a) to ensure that we did not miss any indicators of well-being studied in the literature and (b) to identify indicators studied widely versus rarely in the literature to inform future research. The study was pre-registered at the Open Science Foundation (osf.io/awcyn).

2.2. Study identification and eligibility criteria

The full review process is visually presented in Fig. 2. We included studies published from January 1, 1990, through January 31, 2023, for

the systematic review. We included “apply related words” and “apply equivalent subjects” as expanders. We used the Academic Search Ultimate, APA PsychINFO, Education Source, and ERIC databases for the systematic search. All truncations of the search terms were used in the Boolean string by searching abstracts of documents. We used four layers in our search terms: population, context, well-being domains, and conceptual terms. First, we included search terms related to our population of interest: educator OR teacher OR “childcare provider” OR “child-care provider” OR staff OR workforce. Second, we included terms for the context describing ECE settings: “early childhood education” OR “early childhood care and education” OR “early care” OR “early education” OR child*care OR “Head Start” OR preschool OR Pre-K OR kindergarten OR nursery OR day*care OR “center-based care.” Third, we used the four core domains of holistic educator well-being as our conceptual search terms: psychological OR physical OR professional OR “health behavior” OR social-emotional OR “mental health” OR psychosocial OR well-being. In this stage, we included social-emotional, psychosocial, and mental health as additional search terms because the previous literature on ECE educator well-being often uses these terms (e.g., [Kwon, Ford, et al., 2021](#)). We also included well-being to capture studies on well-being without specifying the domains. Finally, the conceptual terms related to well-being were included: well-being OR health OR wellness OR self-care OR challenge OR difficulties OR distress OR

competen*. Using these search terms, we identified a total of 17,144 studies in the search results.

In this review, we used the following eligibility criteria: (a) Studies needed to be published in or after 1990; (b) Studies could take place anywhere in the world, but the report had to have been available in English. Studies in other languages were also included if they provided an English abstract with sufficient information for coding; (c) Studies had to include early childhood educators in teaching positions who work with children from birth through 5 years old. Educators must have worked in full-time equivalent teaching positions in non-residential, center-based early childhood settings (e.g., Head Start, childcare centers, public or private preschools). Studies only focusing on the well-being of non-teaching staff (e.g., administrators, social workers, family service coordinators, etc.), family child care providers, individual therapy and service providers (e.g., speech and language pathologists, board-certified behavior analysts, and special education specialist) and staff working in all other types of public/private early childhood services (e.g., Home Visiting, Early Intervention, etc.) were excluded; (d) Studies had to investigate at least one of the four core domains of early childhood educators’ well-being (i.e., physical well-being, psychological well-being, professional well-being, and health behaviors) or indicators that fall under these domains. Indicators not currently listed in the framework but relevant to any of the four well-being domains could be

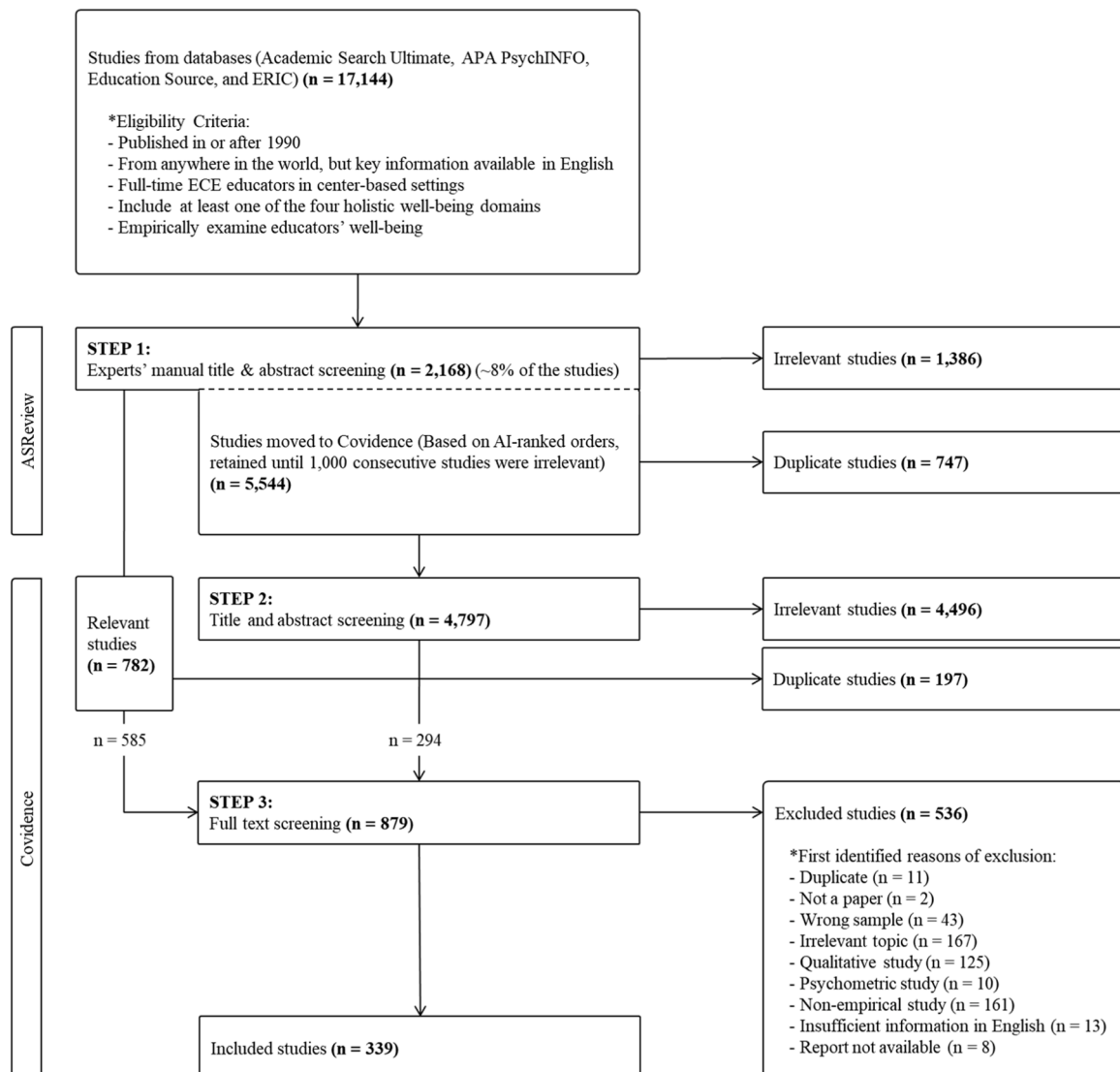


Fig. 2. AI-assisted systematic review procedures.

included, and (e) Studies needed to examine educators' well-being empirically. Qualitative studies or non-empirical studies such as literature reviews or theoretical frameworks were excluded.

2.3. AI-assisted screening procedures

Using the eligibility criteria, we used a three-step approach to screen all search results. Fig. 2 describes the screening procedures. In the first step, to increase the efficiency and reliability of screening, we used an open-source AI-aided screening tool: Active Learning for Systematic Reviews (ASReview; Van De Schoot et al., 2021) designed to support screening of materials. The primary goal of ASReview screening was to rank all search results by the order of relevance and to determine the most relevant studies for title and abstract screening. Previous simulation studies using ASReview have found that it identifies 95% of relevant publications after screening about 8% to 33% of all records (e.g., van de Schoot et al., 2021).

Three lead authors of the study, who have extensive knowledge and expertise in the topic area, screened titles and abstracts of approximately 8% of the search results ($n = 1,386$). The three members reviewed and made decisions about each record based on 100% consensus. This process generated the ranked order of all search results using the machine learning algorithm. Next, we identified the top 33% of the ranked list as the most relevant studies and included them in the title and abstract screening process. To ensure all relevant studies were included, we reviewed the titles of the studies beyond the 33% cut-off point. We predetermined the secondary cut-off point at 1,000 consecutive irrelevant studies. Previous studies using ASReview have used varying thresholds, stopping the review process after observing 20 to 500 irrelevant studies (Bourke et al., 2023; Guan et al., 2023). We chose 1,000 as a threshold to be conservative, given the large search results. We found that 1,000 consecutive studies were irrelevant after the 6,326th record. Among the 6,326 records, we included the first 782 studies for the full-text review. The remaining 5,544 records went through the secondary title and abstract screening.

In the second step, seven research assistants conducted the title and abstract screening of 5,544 records using Covidence software. Two authors who participated in the ASReview screening supervised the procedure. All studies were double-screened by two reviewers. All conflicts were resolved by a group discussion involving one of the three lead authors. The reviewers in the title and abstract screening phase demonstrated 89% agreement.

In the third step, full-text screening was administered by eight other research assistants under the two authors' supervision. A total of 879 studies were included in the full-text screening after removing the duplicates (67% from ASReview; 33% from Covidence). The most frequent reasons for exclusion were having an irrelevant topic and being a non-empirical study. All studies were double-screened by two reviewers. A group discussion resolved any disagreements between the initial two reviewers. The reviewers demonstrated 86% agreement in the full-text screening. At the end of the full-text screening, we included 339 studies. Fig. 2 describes the number of studies excluded for each reason.

2.4. Coding procedures

All studies were double-coded by at least two research team members coming from at least two different universities. One of the three lead authors trained the coding team, which comprised 12 researchers. Coding was completed by one member of the coding team, then reviewed by a second coder. The second-round coding was closely monitored and supervised by senior-level researchers at each university. All coders had weekly meetings with at least one of the three lead authors and participating senior-level researchers. Any questions or conflicts were resolved by group discussion. Any unresolved questions from the weekly meetings were addressed in monthly discussions involving all authors from the six universities. We found that eight studies

included separate data on educator well-being from different countries. Acknowledging differences in the ECE system across different countries, we coded these as separate studies. Thus, the final data analysis comprised 345 data rows, each treated individually from 339 unique studies. All included studies are listed in Appendix A.

2.5. Analytic strategy

First, to understand the current literature on ECE workforce well-being, we analyzed descriptive statistics of study characteristics, including authors, publication years, first authors' disciplines, availability of full texts in English, and whether the study was peer-reviewed. Because some studies included ECE educator well-being as a secondary variable (e.g., as a control) in examining other key variables, we also analyzed whether the primary focus of the study was ECE educator well-being. Acknowledging growing attention to ECE workforce well-being since the COVID-19 pandemic, we examined whether the study primarily focused on COVID-19-related well-being. We also analyzed sample characteristics, including sampling locations (countries), sample size, whether the study solely focused on ECE educators (versus other professionals), sampling of Head Start educators and ages of children served, and the study's methodologies.

Second, we analyzed variables studied in each study as indicators of educator well-being and examined the frequencies of these indicators in the literature under each domain of holistic educator well-being. In addition, to validate the conceptual model developed by the authors, we identified missing indicators from the initial draft of the model. Finally, we counted the number of studies that examined relational well-being and work environments as predictors and outcomes of educators' well-being.

3. Results

3.1. Current state of ECE workforce well-being literature

Table 2 shows key characteristics of the studies. The analysis of 345 studies revealed 289 unique lead authors representing multiple disciplines. The lead authors' disciplines included early childhood education ($n = 10$, 2.9%), education (excluding early childhood education; $n = 170$, 49.3%), psychology ($n = 65$, 18.9%), public health ($n = 51$, 14.8%), medicine ($n = 19$, 5.5%), and other disciplines (e.g., human science, sociology, statistics, etc.; $n = 61$, 17.7%). The studies were published from 1993 to 2023, with about 53% published after 2019 (9.0% in 2019, 13.6% in 2020, 11.0% in 2021, 16.2% in 2022, and 3.2% in January 2023; full data available in Appendix B). There were 295 peer-reviewed studies (85.5%), and 315 studies had full-text available in English (91.3%). Most studies ($n = 304$, 87.8%) examined ECE educators' well-being as the primary focus while 12.2% examined it as a secondary variable. About 6.4% of the studies focused primarily on COVID-19-related well-being.

Regarding sample characteristics, 45.2% of the studies ($n = 156$) included data from the U.S. The remaining studies analyzed data from 42 different countries (complete data available in Appendix C). Examples of these countries included China ($n = 33$), Canada ($n = 12$), Italy ($n = 12$), Germany ($n = 11$), Ghana ($n = 11$), Turkey ($n = 11$), and Australia ($n = 10$). The sample size varied from 3 to 135,488, with an average sample size of 1,103 ($SD = 8,626$). The total sample size across the 345 studies reviewed was 379,547. Although 10.0% of the studies had a large sample size exceeding 1,000 (with three studies having a sample size greater than 10,000), half of the studies had a sample size of <200, with 28% having a sample size of <100. About 32.5% of the studies had ECE educators as the sole sample of the study (other studies had other professionals, including ECE administrators, mixed in the sample). A total of 93 studies had Head Start teachers as their sole sample or in combination with other ECE educators. Most studies (80.6%) included educators working with preschool-aged children,

Table 2
Characteristics of included studies.

Study Characteristics	Study n	Percentage (%)
Lead author's discipline		
Education	170	49.3
Psychology	65	18.8
Public health	51	14.8
Medicine	19	5.5
Early childhood education	10	2.9
Others	61	17.7
Peer reviewed	295	85.5
Full text available in English	315	91.3
Primary focus of the study is teacher well-being	303	87.8
COVID-19 related study	22	6.4
Sample only included ECE teachers	112	32.5
Head Start status		
Head Start	43	12.5
Non-Head Start ^a	213	61.7
Both Head Start and non-Head Start	50	14.5
Head Start status unknown	39	11.3
Age of children		
General ECE (unspecified)	47	13.6
Infant (0-18 months)	76	22.0
Toddler (19-36 months)	96	27.8
Preschool (3-5 years)	278	80.6
Kindergarten (6 years+) ^b	99	28.7
Study methods		
Descriptive	39	11.3
Correlational	248	71.9
Quasi-experimental	28	8.1
Randomized controlled trials	26	7.5
Single case/other	3	0.9

Notes. ^aIncluding studies conducted outside of the US. ^bIncluding studies having samples mixed with ECE settings.

followed by toddlers and infants. Most studies were either descriptive (11.3%) or correlational (71.9%). Only 54 studies employed a quasi-experimental design ($n = 28$, 8.1%) or randomized controlled trials ($n = 26$, 7.5%). Three studies employed other designs.

3.2. Analyses of well-being domains and indicators

In the analysis of each domain of holistic well-being in the framework, we found that professional well-being ($n = 235$, 68.1%) was the most frequently studied domain, followed by psychological well-being ($n = 220$, 63.8%), physical well-being ($n = 96$, 27.8%), and health behaviors ($n = 73$, 21.2%). Table 3 shows the frequency of target indicators from our analysis. Table 3 also shows the indicators that were originally included in the initial draft of the model and added indicators (with an asterisk) following validation through the systematic review. The most frequently studied indicators in the psychological well-being domain were depressive symptoms, personal stress, general mental health, anxiety, and emotion/self-regulation; in the physical well-being domain were general health, body index, general pain/fatigue, ergonomic/musculoskeletal functioning, and work-related health issues; in the professional well-being domain job-related stress, job satisfaction, job-related emotional exhaustion, general work-related efficacy, and burnout; and in the health behavior domain were physical activity/exercise, nutrition/eating, sleep, drinking/smoking/substance abuse, and self-care/preventive practices. Newly identified indicators include life satisfaction/quality of life, self-esteem, gastrointestinal issues, vocal symptoms, enjoyment of leisure and recreation, and hygiene practices.

Finally, we examined how frequently relational well-being and work environment in the conceptual framework were studied as predictors or outcomes of the well-being indicators. Our analysis revealed that 100 studies (29.0%) investigated relational well-being as part of their study on the four domains of well-being. We found that 17.4% of the studies ($n = 60$) examined relational well-being as a predictor of well-being, and 10.4% ($n = 36$) examined relational well-being as an outcome of well-being. Furthermore, about 40% of the studies examined work

Table 3
Frequency of studied indicators in the literature.

Well-being Domain	Indicator	n	%
Psychological Well-being	Depressive symptoms	80	23.9
	Personal stress	56	16.7
	General mental health	37	11.0
	Anxiety	36	10.8
	Emotion/Self-regulation	29	8.7
	Mindfulness	20	6.0
	Coping skills	17	5.1
	Life Satisfaction/Quality of Life*	17	5.1
	Positive/negative affect	17	5.1
	Resilience	15	4.5
	Self-efficacy	13	3.9
	Self-esteem*	13	3.9
	Hostility/anger/fear/tension*	11	3.3
	Emotional intelligence	9	2.7
	Spirituality	8	2.4
	Psychiatric symptoms*	8	2.4
	Optimism	7	2.1
	Thriving/growth	7	2.1
	Emotion recognition	6	1.8
	Self-compassion	6	1.8
	Perspective taking/empathy*	5	1.5
	Hope	4	1.2
	Gratitude*	2	0.6
	Covid-19 anxiety/fatigue	2	0.6
	Perseverance/persistence*	2	0.6
	Personal autonomy	2	0.6
	Personal competence	2	0.6
	Psychological capital	1	0.3
	Physiological responses	1	0.3
	Self-acceptance*	1	0.3
Physical Well-being	General health	48	14.2
	Body index (BMI/weight/height)	26	7.8
	General pain/fatigue	24	7.1
	Ergonomic/musculoskeletal functioning	20	6.0
	Work-related health issues	12	3.6
	Cardiovascular	11	3.3
	Gastrointestinal (GI) issues*	10	3.0
	Headache/migraine*	9	2.7
	Respiratory (issues) issues	9	2.7
	Vocal symptoms*	9	2.7
	Infection*	4	1.2
	Diabetes*	4	1.2
	Cortisol*	4	1.2
	Women's health issues*	3	0.9
	Urinary Tract Infection (UTI)*	2	0.6
	Dental issues*	1	0.3
	Hearing issues*	1	0.3
Professional Well-being	Vision issues*	1	0.3
	Job-related stress	77	22.9
	Job satisfaction	77	22.8
	Job-related emotional exhaustion	69	20.5
	General work-related efficacy	62	18.5
	Burnout	59	17.6
	Sense of meaning/mission/motivation	40	11.9
	Accomplishment	39	11.6
	Perceived job autonomy/control	37	11.0
	Depersonalization	32	9.5
	Turnover intention/Intent to leave	31	9.2
	Work engagement	20	6.0
	Job/Professional commitment	19	5.7
	Job-related competence	16	4.8
	Work-life balance/conflict	10	3.0
	Perceived job security	7	2.1
	Positive feelings about work*	7	2.1
	Secondary traumatic stress	5	1.5
	Compassion satisfaction/fatigue	4	1.2
	Recognition*	4	1.2
	Happiness at work*	3	0.9
	Career aspiration	2	0.6
	Thriving at work*	1	0.3
	Anger at work*	1	0.3
	Mindfulness in teaching*	1	0.3
	Professional identity	0	0

(continued on next page)

Table 3 (continued)

Well-being Domain	Indicator	n	%
Health Behavior	Physical activity/Exercise	37	11.0
	Nutrition/eating	22	6.6
	Sleep	20	5.9
	Drinking, smoking, substance abuse*	19	5.7
	Self-care/preventive practices	11	3.3
	Awareness of health behaviors and concepts*	6	1.8
	Leisure and recreation*	2	0.6
	Hygiene*	1	0.3

* Notes indicators that were newly found after the systematic review.

environments as part of their well-being study ($n = 137$). The results show that 34.8% of the studies examined work environments as predictors of well-being ($n = 120$), and only two studies explored work environments as outcomes of well-being.

3.3. Examination of holistic well-being

We found that 130 studies (37.7%) examined one domain of holistic well-being, 152 studies (44.1%) examined two domains, and 50 studies (14.5%) examined three domains. Only ten studies (2.9%) examined all four well-being domains holistically. Analyzing the studies that addressed all four well-being domains, we found that ECE educators consistently report challenges with all four domains of well-being (e.g., Kwon, Ford, et al., 2021; Kwon et al., 2022), and these four domains are significantly correlated with one another (Kwon, Ford, et al., 2021). For example, Sjödin et al. (2012) demonstrated that teachers' experience of burnout was associated with reduced sleep quality and morning sleepiness.

Furthermore, we found that the studies examining all four domains of well-being consistently report the importance of the work environment. Johnsen et al. (2018) found that directive and nondirective social support in the workplaces, indicators of the Workplace Culture/Climate domain in our conceptual model, were significantly related to holistic well-being, including job satisfaction and musculoskeletal complaints. This finding was aligned with Reffett's (2009) study reporting that the work environment, as measured by job demands, was more closely related to their experience of vocational, psychological, interpersonal, and physical strains representing holistic well-being than individual factors, such as education, length of employment, and difficulty with using teaching techniques. Aligned with the conceptual model emphasizing the role of the physical environment as part of the work environment, Kwon, Ford, et al. (2021) and Sjödin et al. (2012) provided evidence that teacher-perceived noise at the workplace predicts their holistic well-being. In one study, although the objective level of noise was not related to teachers' health characteristics, the subjective noise (e.g., sudden sound change in the environment) was significantly associated with preschool teachers' suboptimal well-being, including lack of energy and motivation, physical discomfort, and sleepiness (Sjödin et al., 2012).

Lastly, studies examining holistic well-being generally did not address the role of contextual factors outlined in the conceptual model, such as the broader social, economic, and political climate. Uniquely, Barajas-Gonzalez (2021) reported that teachers' psychological distress and sleep problems were associated with immigration-related stressors, which could be related to political and social climate. However, most studies primarily focused on work environment factors that are more directly associated with ECE educators.

4. Discussion

The present study aimed to develop and validate the Ecological Model of Holistic ECE Workforce Well-Being as a novel conceptual framework that encompasses four core domains of well-being informed

by an interdisciplinary group of scholars and an AI-assisted systematic review. In the model, we demonstrate how individual ECE educators' well-being is embedded within the context of their relational well-being and working environments, as well as larger educational systems, policies, and societal environments. Similar to the bioecological model (Bronfenbrenner, 1994), our framework also captures understanding and support of holistic well-being within systems at multiple levels that are varied and complex within ECE center-based settings. Although the model integrated and was built upon existing theories and models of well-being that are widely used (Bakker & Demerouti, 2007; Chari et al., 2018; Gallagher & Roberts, 2022; Kwon, Ford, et al., 2021; Kwon et al., 2022; Jennings & Greenberg, 2009), our study extends these ideas in more comprehensive and integrated ways. First, the present model offers a clear definition of holistic ECE well-being with a comprehensive set of related indicators supported by a systematic review. Although ECE educators' well-being has received increased attention recently, the holistic nature of well-being has not been captured and conceptualized with a well-defined set of indicators, which has been brought up across multiple studies (e.g., Kwon, Ford, et al., 2022). We included positive and negative aspects of well-being indicators and added new indicators through the systematic review that have not been well-addressed in prior literature.

Second, our model extends from proximal and immediate working conditions that have been the focus of existing models (e.g., Bakker & Demerouti, 2007; Kwon, Ford, et al., 2021; Kwon et al., 2022; Jennings & Greenberg, 2009) to include individual characteristics, larger contexts, and the bidirectional associations among them. In addition, our systematic review identified the extent to which contextual factors have been explored in previous literature for providing suggestions for future research. Third, our team members comprise scholars from six universities across diverse disciplines (e.g., education, psychology, public health, mental health), providing a rich, diverse approach to the development and validation of this conceptual framework. Our study further showcases how interdisciplinary scholars effectively collaborated to strengthen the comprehensive conceptual framework.

Lastly, we validated the model by systematically reviewing a large body of literature on ECE well-being (345 studies) using AI. Although there have been a few scoping or review studies on ECE educator well-being, most have only focused on one aspect of well-being (e.g., Wilson et al., 2023), were not exclusive to ECE educators (e.g., Berger, 2022) or had limited scope in as defined by their search terms. For example, Cumming and Wong (2019) conceptualized ECE educators' work-related well-being holistically. However, their systematic review was limited to 77 studies. In a scoping literature review of Head Start teachers' psychological well-being, Wilson et al. (2022) reviewed 32 articles from 1,107 studies screened. Our state-of-the-art methodological approach helped us screen 17,144 studies efficiently, making the collaboration process across six universities easier, more efficient, and more impactful.

4.1. Recent trends in the study of ECE well-being

We analyzed overall trends and characteristics of studies conducted across 42 countries over the past 30 years, identifying gaps and limitations in the current literature on ECE workforce well-being. To explore future directions for ECE workforce well-being research and practice, it is necessary to evaluate the field's current standing and where it has yet to go. We sought to do so by identifying trends and, consequently, persistent gaps in literature that, if addressed, could further support efforts to professionalize the ECE workforce and, ultimately, the quality of care and learning for young children.

One notable trend is the rapid increase in attention to ECE workforce well-being in literature since 2019. Undoubtedly, widely-shared health and educational challenges of COVID-19 have shed light on this often-neglected subsector of the educator workforce—a similar conclusion to that of other systematic reviews (e.g., Yu et al., 2022). Indeed,

recognizing the importance of ECE teachers' working conditions in their ability to both perform their jobs effectively and derive meaning and purpose in their work is essential for improving their overall workplace satisfaction and well-being. Such burgeoning attention has had the added benefit of attracting researchers from a wide range of fields to study educational workforce issues. Our analysis indicates that, based on lead author's departmental affiliation, about half of all included studies were led by researchers outside of the education field.

Despite the marked increase in studies examining ECE workforce well-being, many studies remain descriptive or correlational, leaving unanswered questions about the directionality of associations and the potential role of interventions in supporting ECE educator well-being. In particular, intervention studies targeting ECE educators with a quasi-experimental design or randomized controlled trial were scarce. Intervention studies with more rigorous designs are needed to better understand and support ECE educators' well-being. Another gap in the literature was relatively small sample sizes in most studies. Only 10% had large samples (>1,000 participants), highlighting the need for more studies with larger sample sizes, especially in developing countries that have received little attention. Additionally, studies on infant and toddler teachers are limited, underscoring the necessity for increased attention to this specific population of educators. This heightened focus is essential to better support the unique needs of those working with the youngest children in ECE settings.

Furthermore, most studies have focused on one or two aspects of well-being rather than examining well-being holistically. Only 17.5% of studies take a more holistic approach, including three or four aspects of well-being. The indicators of holistic well-being represented in the included studies were largely consistent with those identified in our conceptual model. Still, a few more unique indicators were uncovered in our review (e.g., enjoyment of leisure and recreation and hygiene practices). Our ecological conceptual framework and suggestions of specific indicators would help better operationalize ECE workforce well-being in future research. These indicators encompass both positive and negative aspects of holistic well-being, offering an opportunity to examine diverse factors, including the strengths of educators, in future research.

Finally, by reviewing the findings of studies that examined all four domains of well-being, we found that indicators of these four domains are correlated, and ECE educators' work environments play a significant role in supporting their holistic well-being. However, studies addressing key contextual factors, such as workplace fairness and access to opportunity, the broader community and demographic landscape, and the political, economic, and social climate, were largely lacking. This gap highlights the need for a more holistic examination of the contextual factors outlined in our conceptual model. Taken together, our findings support the need for more interdisciplinary, collaborative, complex, and dynamic approaches using diverse research methods and more advanced and innovative analytic methods.

4.2. Limitations

This study was designed to reflect on the well-being of educators serving children aged 0-5 in center-based settings. Therefore, it cannot be generalized to other ECE contexts, such as family child care homes. However, it is sufficiently flexible and comprehensive to apply to other ECE contexts considering the uniqueness of each setting. In addition, our systematic review extensively focused on reviewing the studies examining four core domains of well-being. Although we examined relational well-being and work environments as predictors and outcomes, it was simply descriptive. The information on larger contextual factors or personal factors is also limited. Future studies need to incorporate various factors across different levels and examine their interconnectedness and their relation to overall well-being. We also acknowledge some gray areas or conceptual overlaps across indicators of well-being, personal resources, and working conditions. Based on our

initial attempt, further investigation is necessary for a clearer definition of each construct and indicator. Of the studies from 42 countries, we found that most were conducted in developed countries (including the U.S. and countries in Europe and Asia). It may be because our search is limited to the studies indexed in English through an accessible database.

5. Conclusions

In our systematic review, it is striking that ECE well-being is rarely viewed or studied holistically. There needs to be more heterogeneity in how well-being is currently defined. Our study findings demand a call for more studies on holistic and balanced approaches, including multiple aspects of well-being. There is currently a dearth of literature examining physical well-being, health behaviors, aspects of ECE educator well-being intersect with relational well-being, and there is a need to focus on both positive and negative aspects of well-being, as well as multilevel factors and processes. Such an approach may advance our understanding for uplifting, supporting, and enhancing the well-being of the ECE workforce in a mutually beneficial way to themselves and the children in their care.

Our holistic model situates an individual ECE educator's well-being within their relational well-being, working environments, and larger educational system, policy, and societal environments. This holistic approach provides a starting point for future research and intervention practices. It provides ways to nurture the well-being of early childhood educators by considering the contextual challenges they face, and by identifying and addressing barriers to access and opportunities for educators from various demographic backgrounds. It informs the needed support and resources for every ECE educator to have their well-being supported.

Finally, our conceptual model, supported by existing research, uplifts the critical importance of holistically attending ECE educators' well-being. Well-being is a critical foundation for educators; it is a direct result of the work as well as the working conditions they experience. Achieving a high degree of well-being is key to ECE educators living satisfying lives, working in safe spaces, and providing a learning environment conducive to individual and organizational learning and development; all of which foster ECE environments where both educators and children thrive.

CRedit authorship contribution statement

Liemy Jeon: Writing – original draft, Writing – review & editing, Validation, Supervision, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Kyong-Ah Kwon:** Writing – original draft, Writing – review & editing, Validation, Supervision, Project administration, Methodology, Investigation, Funding acquisition, Conceptualization. **Sooyeon Byun:** Writing – original draft, Writing – review & editing, Visualization, Validation, Supervision, Project administration, Methodology, Investigation, Data curation, Conceptualization. **Dominique Charlot-Swiley:** Writing – original draft, Writing – review & editing, Supervision, Methodology, Investigation, Funding acquisition, Conceptualization. **Celene E. Domitrovich:** Writing – original draft, Writing – review & editing, Supervision, Methodology, Investigation, Funding acquisition, Conceptualization. **Charlotte V. Farewell:** Writing – original draft, Writing – review & editing, Validation, Supervision, Methodology, Investigation, Funding acquisition, Conceptualization. **Timothy G. Ford:** Writing – original draft, Writing – review & editing, Funding acquisition. **Holly Hatton:** Writing – original draft, Writing – review & editing, Supervision, Methodology, Investigation, Funding acquisition, Conceptualization. **Yoonkyung Oh:** Writing – original draft, Writing – review & editing, Supervision, Methodology, Investigation, Funding acquisition, Conceptualization. **Jini E. Puma:** Writing – original draft, Writing – review & editing, Validation, Supervision, Methodology, Investigation, Funding acquisition, Conceptualization.

Declaration of competing interest

We have no known conflict of interest to disclose.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at [doi:10.1016/j.ecresq.2025.09.007](https://doi.org/10.1016/j.ecresq.2025.09.007).

Data availability

We have shared the list of included studies which served as our data in Appendix A in the supplementary materials.

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