Evaluation of the Movement and Play Opportunities and Constraints Associated with Containers for Infants

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Declaration of Interest

None

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Abstract

Purpose:

Containers (e.g., strollers, bouncers) are an important part of infants' environment but may negatively impact infant development and health. This study evaluated movement and play opportunities, constraints, and manufacturers' developmental claims for infant containers.

Methods:

Containers were identified through Amazon.com. A content analysis of identified products was conducted to identify movement and visual-manual play opportunities, constraints, and developmental claims.

Results:

Content was analyzed for 460 containers. Containers varied in their movement and play opportunities; however, most did not incorporate toys and restricted trunk movement, self-directed locomotion, and independent head and trunk control. Containers, especially those with built-in toys, often had claims related to gross motor, sensory, and fine motor development.

Conclusion:

These findings demonstrate the variability of movement and play opportunities observed across and within categories of infant containers. Global recommendations about container use may be less effective than more specific education to parents about selecting and implementing containers.

Keywords: infant containers; infant development; physical environment; opportunities; company labeling; play

WHAT THIS EVIDENCE ADDS
Current evidence: Infant containers such as strollers, jumpers, and floor seats are commonly used by caregivers in home and daycare settings.[1,2] Caregivers' reports of container use indicate that infants spend hours in containers each day.[1,3] Although containers are a significant component of infants' physical environment, their prolonged use has been discouraged by some professional organizations to prevent the negative developmental and health outcomes associated with Container Baby Syndrome (CBS).[4] On the other hand, manufacturers often make claims about the developmental benefits of their products. These claims, which may or may not align with current literature, can influence parents' beliefs and purchasing decisions.[5]
Gap in the evidence: Containers may negatively impact infant development and health by limiting movement and environmental exploration opportunities, however, the opportunities and constraints provided by commercially available containers have not been evaluated. Additionally, the developmental claims made by manufacturers have not been examined.
How does this study fill this evidence gap? In this study, we performed a systematic content analysis of the movement and play opportunities, constraints, and developmental claims made by manufacturers of a large sample of commercially available containers.
Implication of all the evidence: Most containers place young infants in supine or reclined, restrict trunk movement, limit independent support of the head, do not allow self-locomotion, and lack built-in toys. These findings provide insight into potential mechanisms by which containers may result in CBS. Varying levels of movement and play opportunities for containers were observed. The results can inform clinicians and others when supporting parents selecting containers and suggest recommendations for use should depend upon the container rather than being global. Manufacturers of many containers made claims related to motor, cognitive, sensory, and physical development. Clinicians' awareness of these claims may support education efforts with parents since claims influence parents' beliefs and purchasing decisions.

Version of Record at: https://doi.org/10.1097/PEP.0000000000001125

Introduction

Infant containers are "any commonly used piece of baby equipment that resembles a container", such as strollers, car seats, and walkers.[4] These devices may be used for purposes such as infant safety, soothing, entertainment, transportation, positioning, developmental promotion, and feeding.[6–8] Infant containers are highly utilized by parents and caregivers at home and in daycare settings,[1,2] and many infants spend hours in them each day.[3,9,10] Infants with reflux, respiratory congestion, or colic may spend considerably more of their day (up to 24 hours) in containers.[11]

Container Baby Syndrome (CBS) is a relatively recent term used to describe a collection of symptoms (e.g., developmental delay, head shape deformity, and obesity) seen in babies who spend significant time in containers; the term does not represent an official diagnosis and has only just begun to be discussed in scientific literature.[4,12] Pediatric healthcare professionals recommend limiting container use to prevent CBS.[13] Cross-sectional studies have identified that higher container use was negatively associated with motor development in typically developing infants but not in infants born prematurely.[9,14] One longitudinal study identified that greater time using containers from 2-6 months of age was associated with later acquisition of supported walking.[3] There is a lack of causal evidence on the effects of containers, likely due to the challenges associated with limiting use of products that are ubiquitous and useful for parents and childcare providers. Moreover, the mechanisms by which prolonged container use may contribute to the symptoms associated with CBS have not yet been evaluated. A systematic evaluation of the movement and play opportunities and constraints of different containers may provide insight into these mechanisms. The purpose of this study was to identify and evaluate: 1) the types of commercially available containers; 2) when parents are advised to first use these containers; and 3) the motor and visual-manual opportunities and constraints of these products.

Version of Record at: https://doi.org/10.1097/PEP.0000000000001125

An additional purpose of this study was to evaluate the developmental claims made by manufacturers. Manufacturers of infant toys and equipment may include claims about the developmental benefits of the products that may or may not align with recommendations from healthcare professionals. For example, electronic media and toys are marketed to have developmental benefits for children despite research demonstrating that they are associated with decreased motor, cognitive, and language activity.[15–17] Manufacturers' claims may have a powerful influence on parents' purchasing decisions of toys and other infant products. Parents' preference for selecting traditional toys (e.g., rattles and blocks) over electronic toys (e.g., battery-operated musical toys) was reversed after they read manufacturers' claims about the developmental benefits of electronic toys.[5] Parents value the educational and developmental benefits of infant products and consider these important factors when purchasing products.[18] To date, the claims made by manufacturers regarding containers have not been evaluated. Examining these claims can inform professionals working with infants and their families about the nature and accuracy of the claims and their potential impact on parents' beliefs about containers.

Methods

Product Selection

We defined "infant containers" as commercially available equipment that surrounds, supports, and/or creates boundaries for infants. We aimed to select products across all of the common categories of infant containers available. Categories of containers were identified based on content on the American Physical Therapy Association's (APTA) webpage about infant containers,[4] in blogs by physical and occupational therapists,[13] and known to our research team members with extensive experience working with infants and caregivers. This process yielded a list of 12 categories of

containers: carriers, car seats, exersaucers, floor gyms, floor seats, highchairs, jumpers, playpens, positional pillows, rockers (i.e., bouncers, swings, and rockers), strollers, and walkers (Table 1).

Products in each container category were primarily identified using Amazon.com, Inc. (Bellevue, WA) where nearly 50% of online transactions in the USA take place.[19] Each category was entered as a search term in the browser. A list of the resultant products in the first 1-2 pages on Amazon.com for each search was created. The first 1-2 pages were reviewed because they included the most relevant and popular products that parents were more likely to encounter.[20] Moreover, only 30% of Amazon consumers scroll past the first page of search results.[20] In addition, products encountered through advertisements (from THE TOT®, Crate and Barrel®, and Maisonette®) during the search process were also considered. The information for each product (i.e., images and descriptive text about the product, links to product information and videos) was then archived for screening and potential evaluation.

Each product was screened for inclusion by the first author. To be included, a product had to meet the aforementioned definition of an infant container and had to be recommended for use with infants 12 months of age or younger. Exclusion criteria were: 1) products recalled for any reason including safety concerns as indicated in the product information on Amazon.com; 2) duplicate products that matched an already included product but varied only in color or seller; 3) products that did not provide any recommended age for use; and 4) products that appeared to be illegitimate, for example, a product without reviews or a description and with a significantly different price than similar products. The initial product search was conducted between February and September 2021.

To ensure the products represented the current products available, we conducted an updated search in May 2023. To make certain this search was comprehensive, we repeated the searches in Amazon.com and screened the products on all of the resultant pages (i.e., beyond the first 1-2 pages)

Version of Record at: https://doi.org/10.1097/PEP.0000000000001125

using the aforementioned inclusion and exclusion criteria. To guarantee a sufficiently large sample size in each category, we added all new products meeting the study criteria in cases where a category had fewer than 30 products after the initial search. To ensure the containers evaluated in the remaining categories accurately represented the containers currently available, we added any new products meeting the study criteria that also offered movement and play opportunities that differed from those offered by containers included from the initial search.

Variables

Product data were coded in a spreadsheet application by the primary coder (i.e., first author) and trained research assistants from the archived product information using a standardized coding scheme developed by our team of experts in child development (Supplemental Digital Content 1 - Code Book). Inter-rater and intra-rater agreement on 25% of the products was calculated as the percentage of number of agreements among coders divided by the total number of possible agreements for each product. In cases of coding disagreements, the primary coder reviewed the archived information to ensure accuracy of the final dataset.

It is important to note that the codes for all variables were not determined through direct measurement with infants, rather they were determined by viewing each product's description. This included written descriptions about the features of the products and images and/or videos of the products and infants using the products.

Earliest Recommended Age for Use

For each product, the earliest recommended age for use was coded from the manufacturer's product description. If the earliest age for use was not specified but a minimum height or weight for

container use was provided, this was used to calculate age using growth data for males published by the Centers for Disease Control that represented the 50th percentile for height or weight.[21] If neither age nor weight/height was specified but manufacturers recommended product use only after attainment of a developmental milestone (e.g., good head control, sitting unassisted), the earliest recommended age of product use was determined based on the age at which 50 % of infants attain that skill as described by the CDC.[22,23] When this information was not present for containers in which infants could assume multiple positions (i.e., playpens and floor gyms), earliest recommended age was coded based on the position(s) of the baby as seen in the product's pictures and videos: 0 months for supine and prone, 6 months for sitting, and 10 months for standing. For analyses, the earliest recommended age data were grouped into the age categories 0-3, 4-6, 7-9, or 10-12 months.

Infant Position

The infant's position(s) in each product was coded as being: 1) supine- lying flat on the back; 2) reclined- lying on the back propped up at an angle between approximately 20 and 80 degrees; 3) prone- lying on the stomach regardless of the angle of inclination; 4) sitting- sitting upright with about 90 degrees of hip flexion; or 5) standing- bearing weight on the feet with or without support from objects or people. Multiple selections were possible. Infant position(s) was coded strictly from the manufacturer's recommended positioning in order to capture the methods in which parents were advised to implement products. This may not reflect all of the positions allowed by a container.

Opportunities for Body Movement

We coded whether movement of the infant's head, trunk, arms, or legs was *restricted*, *encouraged, or possible* through any range of motion. A product *restricted* movement when the

Version of Record at: https://doi.org/10.1097/PEP.0000000000001125

body part was significantly or completely limited in any plane due to the presence of a constraining safety system (e.g., harness) or tray or due to the structure of the container (e.g., carrier that surrounds and constrains a body part). A product *encouraged* movement when there was potential for movement of the body part in all planes, and the product's design or built-in toys encouraged infants to move. For example, head movement was encouraged when built-in toys were placed at different locations in the container, encouraging the infant to move their head in a variety of directions. Arm movement was encouraged when there were built-in toys located within the infant's potential arm reach in the container. Leg movement was encouraged when there were built-in toys located within the infant's potential foot reach or if the product bounced in response to the infant's leg movement. Movement was *possible* within a product when there was potential for movement of the body part in all planes and the criteria for coding the movement as *restricted* or *encouraged* were not met.

Level of Support

The highest level of physical support provided to the infant by the product was coded as being through the infant's *head*, *upper trunk*, or *lower trunk*; alternatively, the container might provide *no head or trunk support*. For example, an infant reclined in a swing would be supported through the *head*, while an infant standing in a playpen or sitting unsupported in a floor gym would be coded as having *no trunk or head support.* The level of support for products that positioned infants in supine or prone was coded as through the *head.*

Locomotion

We coded whether each product provided opportunities for *no locomotion* (i.e., translation through space not naturally possible based on the product design), *passive locomotion* (i.e., being

Version of Record at: https://doi.org/10.1097/PEP.0000000000001125

carried or pushed through space by a caregiver), or *active locomotion* (i.e., infants could independently translate their bodies in space in the products; for example, walking in a walker or rolling in a floor gym or playpen).

Visual-Manual Opportunities

Opportunities for interaction with toys in a product were coded. We coded whether toys were *present* in the product, and, when present, whether the toys were *within reach* (i.e., allowing visual-manual interaction) or *beyond reach* (i.e., allowing only visual observation) for the infant.

Manufacturers' Developmental Claims

We coded the content of the claims made by manufacturers about the advantages of their products for infant development. The content was reviewed independently by the first and second authors and categorized into themes using an inductive coding process; a sample of the data was reviewed, codes were identified and applied across a broader sample of the data, new codes were created as needed based on the broader sample, and this process continued until the data were coded in their entirety. Coders discussed differences in coding to reach a consensus.

Analysis

Some products were static and only offered one method of use. Other products could be modified and used in a different manner to accommodate infants' growth and changing developmental abilities; in these cases, the product was evaluated separately for each modification only for variables that were altered by the modifications. Manufacturers' developmental claims were independent of the modifications for the products, so they were evaluated only once for each product.

Version of Record at: https://doi.org/10.1097/PEP.0000000000001125

Data were analyzed using descriptive statistics including frequencies and percentages. Statistical analyses were conducted using SPSS version 28.0.1.1 (Armonk, NY, USAA), Chi-Square Goodness of Fit Tests were performed for tests with one variable. Pearson's Chi-Square Test of Independence was conducted for tests with two categorical variables. The significance level was set to alpha = .05. Post-hoc analyses were conducted using standardized adjusted residuals and Bonferroni adjustments to test for individual cell significance for tests that were significant.[24]

Results

The initial search resulted in 369 products (45 car seats; 37 carriers; 23 exersaucers; 48 floor gyms; 23 floor seats; 36 highchairs; 6 jumpers; 43 playpens; 11 positional pillows; 37 rockers; 50 strollers; and 10 walkers). The updated search led to the addition of new products (16 exersaucers; 19 floor seats; 18 jumpers; 9 positional pillows; and 31 walkers) for categories with fewer than 30 products. For the remaining categories, no product from the updated search was identified to have different opportunities, highlighting the stability of these products across time. The total number of products included after the updated search was 460 (Table 2; Supplemental Digital Content 2 contains the complete dataset), with > 99 % (n = 457) identified through Amazon.com and < 1 % (n = 3) from product advertisements encountered during the search process. Inter-rater (M = 93.71 %, SD = 0.06) and intra-rater (M = 95.07 %, SD = 0.06) agreement among coders was high.

Earliest Recommended Age for Use and Infant Position

The proportion of products and their modifications recommended for earliest use differed in relation to age [$\chi^2_1 = 319.9$, $P < .001$]. Products were more likely to be recommended for earliest use at 0-3 or 4-6 months old ($z = 7.64$, $p < .001$; $z = 10.09$, $P < .001$, respectively) and were less likely

Version of Record at: https://doi.org/10.1097/PEP.0000000000001125

to be recommended for earliest use at 7-9 or 10-12 months old (z = -7.86, p < .001; z = -9.89, p < .001, respectively).

There were differences in the positions recommended for infants in the containers within each of the age groups analyzed [0-3 months: χ^2_4 = 94.9, p < .001; 4-6 months: χ^2_4, = 249.1, p < .001; 7-9 months: χ^2_4 = 32.9, p < .001; 10-12 months: χ^2_1 = 22.5, p < .001; Table 3]. Products marketed for earliest use from 0-3 months were more likely to position infants in supine (z = 3.06, p = .002) or reclined (z = 5.92, p < .001). Products marketed for earliest use from 4-6 months were more likely to position infants in sitting (z = 11.32, p < .001) or standing (z = 4.97, p < .001). Products marketed for earliest use from 7-9 months (z = 3.37, p < .001) or 10-12 months (z = 3.36, p < .001) were more likely to position infants in sitting. Prone positioning was rarely recommended within any age group (Figure 1).

Opportunities for Body Movement

There was a difference among the body parts (i.e., head, trunk, arms, and legs) in terms of whether movement was *restricted* [χ^2_3 = 323.4, p < .001] or *encouraged* [χ^2_3 = 23.8, p < .001] by the products and their modifications. Movement of the trunk was more likely to be *restricted* (z = 15.46, p < .001), while movement of the arms was more likely to be *encouraged* (z = 2.74, p < .006).

Restriction of trunk movement varied among the categories of containers [χ^2_9 = 122.5, p < .001]. Trunk movement was more likely to be *restricted* in car seats, carriers, and strollers than in other types of containers [z = 4.14, p < .001; z = 2.95, p = .003; z = 4.74, p < .001, respectively]. Encouragement of arm movement also varied among the categories of containers [χ^2_5 = 58.8, p < .001]. Arm movement was more likely to be *encouraged* in floor gyms than in other types of containers (z = 4.31, p < .001).

Version of Record at: https://doi.org/10.1097/PEP.0000000000001125

Level of Support

The proportion of products and their modifications was not equally distributed among the level of support categories [$\chi^2_3 = 289.8$, $p < .001$]. Products were more likely to provide support through the *head* ($z = 11.36$, $p < .001$) or *upper trunk* ($z = 4.83$, $p < .001$) rather than at the *lower trunk* or *no head or trunk support*. There were only 56 (11 %) products and their modifications that provided *no head or trunk support*. These were playpens (e.g., standing independently) or floor gyms (e.g., sitting independently).

Locomotion

The proportion of products and their modifications was not equally distributed among the locomotion categories [$\chi^2_2 = 61.0$, $p < .001$]. Products were more likely not to provide opportunities for locomotion ($z = 5.64$, $p < .001$) and less likely to allow for passive locomotion ($z = -5.40$, $p < .001$). Floor gyms, some floor seats, playpens, positional pillows, and one exersaucer allowed for active locomotion, while carriers and strollers allowed for passive locomotion. Car seats, highchairs, rockers, jumpers, and most floor seats did not provide opportunities for locomotion.

Visual-Manual Opportunities

Most of the products and their modifications did not incorporate toys (n = 266, 57 %). When present, built-in toys were more often, but not always, within reach for infants. Built-in toys were found in most exersaucers, floor gyms, and walkers. On the other hand, built-in toys were not found in any car seats, carriers, or strollers.

Version of Record at: https://doi.org/10.1097/PEP.0000000000001125

Manufacturers' Claims About the Developmental Benefits of Containers

Of the 460 products, 171 (37 %) made claims about how their products would benefit infants' development. The 10 themes that emerged, in order from most to fewest claims, were *gross motor development*, *sensory development*, *fine motor development*, *cognitive development*, *physical activity*, *coordination and balance, other* (e.g., security; interaction with the environment), *correct positioning* (e.g., hip placement), *language development*, and *prevention of deformities* (Table 4). The number of claims differed among the identified themes [$\chi^2_9 = 263.9$ $p < .001$]. Developmental claims were more often related to *gross motor development* ($z = 4.25$, $p < .001$), *sensory development* ($z = 10.49$, $p < .001$), and *fine motor development* ($z = 4.71$, $p < .001$).

There was a significant relation between the presence of developmental claims and container category [$\chi^2_{11} = 225.878$, $p < .001$]. Exersaucers ($z = 5.90$, $p < .001$), floor gyms ($z = 7.00$, $p < .001$), jumpers ($z = 5.10$, $p < .001$), and walkers ($z = 5.20$, $p < .001$) were more likely to have developmental claims, while car seats ($z = -5.40$, $p < .001$), carriers ($z = -4.50$, $p < .001$), highchairs ($z = -4.80$, $p < .001$), and strollers ($z = -5.50$, $p < .001$) were less likely to have developmental claims. There was also a significant relation between the presence of developmental claims and the incorporation of toys in containers [$\chi^2_1 = 145.0$, $p < .001$]. Products with built-in toys were more likely to have developmental claims ($z = 12.00$, $p < .001$). There was a significant relation between the type of developmental theme and container category [$\chi^2_{81} = 271.9$, $p < .001$], but post hoc testing did not reach significance after Bonferroni corrections for the large number of comparisons. Supplemental Digital Content 3 shares examples of manufacturers' developmental claims.

Discussion

Version of Record at: https://doi.org/10.1097/PEP.0000000000001125

Infant containers are a significant part of an infant's physical environment; however, they are linked to negative health and developmental outcomes for infants.[1,3,4,14] In this paper, we evaluated the movement and play opportunities and constraints associated with common infant containers. We also evaluated manufacturers' developmental claims about containers. The results can improve our understanding of the potential mechanisms through which containers may affect infants' health and development and can inform recommendations related to the use of containers.

Our analysis revealed a total of 460 different infant containers across twelve categories. The large number and variety of containers available to parents aligns with current literature that describes high utilization of containers both at home and in childcare settings.[1,2] Furthermore, containers are likely integrated in infants' environments at very early ages, as our results found that most containers are marketed to parents of infants younger than 7 months old. This matches existing research that showed container use was higher for infants from 2- to 6-months-old than for older infants.[3]

The products most often allowed for and recommended that infants 0 to 3 months old be positioned supine or reclined with older infants (> 4 months old) sitting or standing. Developmental literature highlights that young infants spend more time in supine or reclined, while older infants spend more time sitting or standing; these data may be compounded by the use of containers.[25] Play and movement experiences across different body positions are important for infant health and development.[26,27] Container use in the first months of life in particular may limit play and movement experiences in positions outside of supine or reclined, especially limiting tummy time as most containers do not support prone positioning by design or explicit recommendations. Prolonged supine positioning is associated with the development of head shape deformities and delayed motor development,[3,28,29] while prone experiences are positively associated with early attainment of motor

skills such as rolling, sitting, and crawling and with increased physical activity.[30] Therefore, containers that position infants in supine or reclined may increase infants' risk for developing head shape deformities when used for extended periods.[11]

Most of the containers evaluated restricted trunk movement mainly due to safety features (e.g., 5-point harnesses) and provided physical support through the head or upper trunk. Infants develop motor control through variable action performance under different contexts.[31] For example, before infants become expert sitters, they demonstrate varied and complex postural control strategies when learning to sit, and these strategies decrease and become more stable as infants develop independent sitting ability.[32] Containers that restrict trunk movement and/or fully support the head and trunk may hinder infants' ability to engage in the complex motor practice that facilitates gross motor development.

Self-directed locomotion through crawling and walking has been shown to advance infants' cognitive, social, and language development.[33] For instance, infants' ability to adapt their locomotor decisions when navigating challenging environmental contexts (e.g., slopes) is dependent on their locomotor experience.[31] Passive locomotion (e.g., being pushed in a stroller) does not demand the same attention from infants, so strollers and carriers which offer passive locomotion may not provide infants with similarly rich learning experiences. Self-directed locomotion is not an experience that most containers allow.[33] Restricting self-directed locomotion for prolonged periods of time may negatively impact learning for infants with developing or established independent mobility, especially since most containers for older infants did not allow for self-directed locomotion (e.g., exersaucers) primarily due to safety concerns.

Version of Record at: https://doi.org/10.1097/PEP.0000000000001125

Most products lacked built-in toys and, therefore, did not offer visual-manual opportunities. Object manipulation facilitates infants' motor, language, and cognitive development.[34–36] It is unknown how infants interact with objects when placed in containers. Object exploration is embedded within a real time postural context; infants may exhibit more object exploration when sitting compared to lying supine or prone.[27] Therefore, containers that place infants upright, such as floor seats and exersaucers, may facilitate greater object exploration than those placing infants in supine. Future studies examining how infants explore built-in or supplemented toys when placed in containers is needed.

The movement and play opportunities varied among the different categories of containers. The categories with limited movement and play opportunities tended to be ones used for transportation likely due to safety features (e.g., 5-point harnesses) and a lack of built-in toys (e.g., car seats, carriers, strollers, and highchairs). In contrast, categories with greater movement and play opportunities tended to be ones designed for play with built-in toys (e.g., floor gyms, walkers, and exersaucers). Within each container category, opportunities for movement and play varied among the products; for instance, one floor seat might incorporate toys and allow more movement, while another floor seat might lack these features. Overall, these are important findings to consider when developing recommendations about container use. For example, rather than a global recommendation such as a suggested time limit for container use, it may be more appropriate to encourage parents to use the transport- and feeding-related containers with low movement and play opportunities only for those purposes, minimizing or avoiding time in these containers for other purposes (i.e., entertainment). Parents could also be educated about how to safely incorporate toys and prone positioning, when possible, in containers and about how to select containers that provide

Version of Record at: https://doi.org/10.1097/PEP.0000000000001125

infants greater movement and play opportunities. This could complement current practices of globally discouraging prolonged container use and encouraging free play on the floor.[4]

The most common developmental claims made by manufacturers related to gross motor, sensory, and fine motor development. Developmental claims were more common for containers with built-in toys (e.g., exersaucers, floor gyms, walkers). There is a mismatch between the current evidence about containers and the content of some claims made about containers. For example, exersaucer and walker use has been shown to negatively correlate with motor milestone achievement despite the large number of developmental claims made about motor development for these containers.[1] It is also important to note the American Academy of Pediatrics has expressed concerns about the safety of walker use for infants, reporting that walker accidents (i.e., rolling down stairs, tipping over) send thousands of infants to the hospital with injuries each year.[37] It is important to consider this safety information alongside the developmental claims made by those manufacturing walkers and the increased movement and play opportunities documents for walkers devices in this study. Awareness of the developmental claims made about containers is necessary to evaluate their accuracy in relation to existing research. Additionally, research examining parents' beliefs about the developmental benefits or harms associated with using containers is needed as these beliefs may impact the effectiveness of parent education efforts.

Limitations

There are several limitations that need to be considered when interpreting the results of this research. First, the products we evaluated were located from the US online store of Amazon.com. Products sold at retail stores or in other parts of the world were not considered in this evaluation. Despite this limitation, our sample contained a comprehensive list of a variety of products across a comprehensive list of container categories. Second, we relied on each product's description, images,

Version of Record at: https://doi.org/10.1097/PEP.0000000000001125

and videos as presented on Amazon.com to analyze the potential movement and play opportunities. We did not conduct direct measurements of infants' movements in the containers. Therefore, the results highlight potential opportunities to move or interact with toys built within containers; they cannot demonstrate whether infants utilize these opportunities. These data do not demonstrate whether infants take advantage of these potential opportunities when placed in the containers. Future research should aim to evaluate this topic.

Version of Record at: https://doi.org/10.1097/PEP.0000000000001125

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Figure Legends

Figure 1. Manufacturers' recommended positions for infants in containers in relation to the earliest recommended age for use. Data were normalized based on the percent of products within each age range. Asterisks indicate positions recommended significantly more often within each age range.

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