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Understanding developmental progress in young children: Exploring demographic and dietary influences through a cross-sectional study

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ABSTRACT

Background: Developmental surveillance is a crucial task aimed at monitoring and ensuring children's age-appropriate progression. However, demographics and dietary factors can significantly influence the developmental progress of young children.
Methods: We employed a cross-sectional study design, enrolling children aged 2–5 years from early childhood education settings. Their age-appropriate development was assessed using the Ages and Stages Questionnaires.
Results: Our study revealed that children demonstrated adequate development across all assessed domains. Notably, communication skills exhibited the highest mean score (Mean: 53.09, SD: 7.34) compared to other domains. Sex-based analysis revealed substantial disparities between young boys and girls, particularly in regard to fine motor and social-emotional skills, with differences exceeding 20 %. Additionally, fathers' education and socio-economic status were found to influence developmental outcomes. Fruit and vegetable consumption positively correlated with development, while dairy intake demonstrated a negative association.
Conclusion: This research underscores the significance of addressing developmental disparities related to sex and emphasises the necessity of investigating the role of the modern diet in child development, with specific attention to milk and dairy consumption.

1. Background

Surveillance of developmental milestones incorporates monitoring of child's growth according to their age and it assists in early identification of developmental problems [1]. The American Academy of Pediatrics (AAP) endorses developmental and behavioural screening of children at 9, 18, and 30 months by trained early childhood educators, healthcare or other providers, recognising that children at developmental risk may not always be identified by doctors, parents, or childcare workers [2]. Additionally, the United Nations (UN) has prioritised early childhood development, reflected in one of the Sustainable Development Goals (SDGs), which assesses the percentage of children under 5 years who are developmentally on track in learning, health, and psychosocial well-being, categorised by sex [3].

The Australian Early Development Census (AEDC) is an Australia wide assessment conducted every three years to assess the development of children by the time schooling is initiated [4]. The AEDC is conducted in the first year of school (approximately 5 years of age) and was started in 2009. The initiative assesses the development of across a number of domains, which include physical health and wellbeing, social competence, emotional maturity, language and cognitive skills (school-based), communication skills and general knowledge [4]. However, no similar formal assessment of this kind is available for children younger than 5 years of age in Australia.

There are developmental assessment tools available which may assist parents and early education providers to conduct early age developmental assessment. This enables the introduction of strategies to support children who may be at risk while promoting inclusive developmental opportunities [5]. Bayley Scales of Infant and Toddler Development and Age and Stages questionnaires are some of the validated and credible tools which may be used for the assessment of children under the age of five years [5,6]. Age and Stages Questionnaires assess development against elements which include gross and fine motor skills, communication, problem-solving, personal-social and social-emotional

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development [7,8].

In addition to the assessment of developmental measures, there are a range of demographic factors such as sex (biological sex at birth), number of siblings, socio-economic status, parental education that have been suggested to influence the developmental outcomes of children aged under five years of age [9–12]. Despite this, there is a paucity of research among this age group in Australia. Similarly, the role of diet is another substantial component that requires research especially in the time of increasing inflation and inorganic food. Previous research has demonstrated the beneficial influence of fatty fish consumption (in a clinical trial comparing it with meat consumption) on children's cognition [13]. Additionally, a systematic review of 12 trials concluded that dietary interventions positively affected the cognitive development of undernourished preschool children [14]. An Australian study involving 4253 children also revealed a positive association between a healthy diet at ages 2–3 years and improved behavioural functioning, pro-social skills, and nonverbal and verbal cognitive abilities at ages 4–5 years [15]. However, this study did not assess the individual contributions of specific dietary components to cognitive development, and the dietary, behavioural, and cognitive assessments were not conducted concurrently [15].

Considering the above factors the aim of this study is to examine the development of young children enrolled in early childhood education settings and to explore to role of diet and sociodemographic factors on the developmental outcomes.

2. Materials and methods

This study constituted a component of a double-blinded randomised controlled trial, registered with the Australian New Zealand Clinical Trials Registry (ACTRN12622000153718). The data utilised in this paper were collected at baseline and analysed as a cross-sectional study.

2.1. Population sample

The study participants were selected according to the specific criteria of the randomised controlled trial. Children aged 2 to 5, enrolled in early childhood education settings (ECESs) in Victoria, Australia, were included. Key inclusion criteria comprised the specified age range, enrolment in ECE, overall good health (without serious chronic health conditions), and residing and attending ECE within Victoria. Recruitment occurred onsite at ECE settings and via targeted social media marketing. A total of 118 children were enrolled from various regions across Victoria, including north, south, east, and west. The sample size calculation was conducted for the parent study, a double-blinded randomised controlled trial. The trial included a control group (and the active group), thus accounting for a proposed 20 % difference between the groups and using 80 % power, an alpha level of 0.05, and incorporating a 15 % dropout rate. Consequently, a total sample size of 120 was calculated. Since this cross-sectional analysis was conducted at baseline, all 118 children recruited were included in the analysis regardless of their study group allocation.

2.2. Questionnaire administration

All questionnaires were administered digitally, aligning the child's age with the relevant questionnaire thresholds. Parents received detailed instructions and ample time to complete the questionnaire, with researcher assistance provided as needed. Pictorial cues and explanations were offered to mitigate procedural bias and ensure uniform execution.

2.3. Data collection tools

Demographic data related to sex, number of siblings, socio-economic status and parental education were collected using standardised demographic questions. Similarly, Age and Stage Questionnaire, 3rd edition (ASQ-3), and the Age and Stage Social-Emotional Questionnaire, 2nd edition (ASQ:SE-2), were employed for developmental assessment [7,8]. ASQ-3 assesses five developmental domains (gross and fine motor skills, communication, problem-solving, and personal-social development), while ASQ:SE-2 focuses specifically on social-emotional development [7,8]. Both questionnaires feature age-appropriate intervals to minimise bias. ASQ-3 comprises six questions for each domain, scored on a scale of 0, 5, or 10, with a maximum total score of 60 per domain. Higher scores indicate better performance. Conversely, ASQ:SE-2 measures social-emotional development with approximately 25 questions, also scored on a scale of 0, 5, or 10, where higher scores reflect lower social-emotional development [7,8]. Each globally recognised questionnaire offers high reliability and validity; ASQ-3 reliability: $\alpha = 0.92$, validity: 86 % and ASQ:SE-2 reliability: $\alpha = 0.82$, validity: 84 % [7,8,16]. Moreover, dietary intake was collected in accordance with the Australian dietary guidelines for serving sizes. Parents were provided with information on the serving sizes of different types of nutrients and were asked to report the number of servings. Similarly, information related to dairy and yogurt consumption was collected separately using two different questions—one asking about all sources of dairy (excluding yogurt) and the other specifically about yogurt consumption.

2.4. Data analysis

Each questionnaire item was coded according to the ASQ-3 and ASQ:SE-2 assessment guide on a scale of 0, 5, or 10. Complete data sets were obtained as all questions were mandatory. Mean (SD) values were presented for domains with approximately normal distribution or minimal skewness impact on the mean. Student's *t*-test was used to establish statistical significance for mean (SD) measures. Domains with substantially skewed distributions were presented using median (IQR), ranks, and analysed using the Mann-Whitney *U* test.

Statistical significance in subgroup analyses involving more than two groups was determined using ANOVA and Kruskal-Wallis tests. Additionally, Spearman correlation test was employed to establish correlations between variables and developmental domains. A significance level of 0.05 was applied, with clinically significant findings emphasised even if their statistical significance exceeded 0.05.

2.5. Ethics and informed consent

The study received approval from the Federation University Human Ethics Committee (approval number: A21–163) and the Victorian Department of Education (approval number: 2022_004555). Additionally, it was prospectively registered with ANZCTR (registration number: ACTRN12622000153718). Similarly, prior to any study procedure, all participants provided informed consent to participate in the study.

3. Results

Within the group, 61 % were females, with an average age of 43 months (range: 24–70 months). The average age of the male children was 42 months (range: 24–70 months), while the average age of female children was 45 months (range: 28–66 months). Additionally, 98 % of the children were born in Australia, with 82 % speaking English at home. The average number of siblings was 1, with a maximum of 4. Similarly, 96 % of the children came from homes with two-parent households. The majority of mothers held a bachelor's degree (38 %), while the majority of fathers had a certificate or diploma (43 %). In terms of household income, the majority (36 %) earned between $1920 and $2879 per week. Across the spectrum of ASQ-3 developmental domains, children enrolled in ECESs and participating in the study demonstrated notably higher proficiency in communication skills compared to other domains. Notably, fine motor skills exhibited the lowest mean (Table 1). Whereas ASQ:SE-2 median rank of 32.50 (IQR

Table 1
Overall, sex and sibling-count based ASQ-3 and ASQ:SE-2 findings.

Developmental domains	Test statistic	Overall (n = 118) Mean (SD)	Sex			Siblings		
			Boys (n = 46) Mean (SD)	Girls (n = 72) Mean (SD)	p-value	0 (n = 23) Mean (SD)	1 or more (n = 95) Mean (SD)	p-value
Communication	t-test	53.09 (7.34)	52.28 (8.04)	53.61 (6.83)	0.339	52.83 (7.81)	53.16 (7.26)	0.847
Gross motor	t-test	49.15 (11.23)	49.24 (10.43)	49.10 (11.79)	0.947	50.00 (10.98)	48.95 (11.34)	0.689
Fine motor	t-test	42.88 (13.67)	37.07 (14.13)	46.60 (12.07)	<0.001**	42.61 (13.47)	42.95 (13.79)	O.916
Problem solving	t-test	51.86 (9.33)	49.13 (10.13)	53.61 (8.40)	0.010*	50.65 (8.96)	52.16 (9.44)	0.490
Personal-social	t-test	50.00 (9.04)	45.87 (9.39)	52.64 (7.78)	<0.001**	49.35 (10.56)	50.16 (8.67)	0.701
ASQ:SE-2 Median	Mann-Whitney U test	Median (IQR) 32.50 (20.00–55.00)	68.23	53.92	0.026*	64.54	58.28	0.429

* $p < 0.05$.
** $p < 0.01$.

22–55) indicates satisfactory social and emotional regulation and skills among the children.

However, when examining development domains among sex the data revealed substantial disparities between young boys and girls (Table 1). Young boys exhibited significantly lower performance in fine motor, problem-solving, personal-social, and social-emotional skills, with fine motor and social-emotional skills showing significant differences exceeding 20 %. Conversely, the number of siblings did not exert any discernible influence on developmental domains. Children with no siblings and those with one or more siblings demonstrated similar means (or ranks in the case of ASQ:SE-2) across all domains (Table 1).

Similar to sex, children aged above and below 4 years showed substantial differences in development across ASQ-3 and ASQ domains (Table 2). In particular, children older than 4 years demonstrated better development in communication, fine motor skills, problem-solving, and personal-social domains.

In addition, it was demonstrated that a mother's education status did not exert a significant influence on any of the developmental domains measured. Conversely, the education status of the father showed some notable impact. For example, children with fathers completing education at or below year 10 exhibited the lowest mean across developmental domains, with social-emotional (ASQ:SE-2) scores indicating substantial differences (Table 3).

Children with fathers with education completed at or below year 10 had a mean ASQ:SE-2 rank score of 91.05, in contrast to 51.63 for those with fathers holding post-graduate education (Table 3). Generally, children with fathers having post-graduate education displayed higher scores (compared to year 10 or below) across most domains, except in gross motor skills. It is essential to highlight that the father's post-graduate section included five Ph.D. holders, while this number was two for the mother.

When examining socio-economic disparities and their implications for developmental domains it was noted that gross motor ($p = 0.002$) skills exhibited a significant difference with economic class. Children from households earning between $2400–$3839 a week demonstrated significantly higher mean compared to their counterparts from lower income ($1529 or less) households. Furthermore, these economically advantaged children consistently displayed the lowest means across all developmental domains (Table 4).

The correlations among developmental domains alongside breastfeeding duration and it was noted breastfeeding duration exhibits a significant, albeit weak, positive correlation with communication and problem-solving skills (Table 5). All other domain except gross motor and social-emotional showed significant correlations with each other. Conversely, fine motor skills and problem-solving abilities exhibit the strongest correlation with the personal-social domain. Moreover, the personal-social domain demonstrates the most pronounced correlation with the social-emotional domain.

Table 6 demonstrated the association between dietary intake, BMI, and ASQ-3 and ASQ:SE-2 domains. Notably, among all dietary components, fruits and vegetables demonstrated significant positive correlations with multiple developmental domains. Fruit consumption revealed a weak positive correlation with communication and ASQ:SE-2 domains (appearing negative, signifying a positive influence). In contrast, vegetable consumption exhibited weak positive correlations with more domains, including communication, gross motor, personal-social, and ASQ:SE-2 domains, although these correlations were slightly weaker than those observed for fruit consumption (Table 6). BMI demonstrated a weak negative correlation with gross motor ($p < 0.05$). Furthermore, even though non-significant, dairy intake displayed negative correlations (statistically significant with social-emotional) with almost all developmental domains, suggesting an opposing effect compared to other food components.

Table 2
ASQ-3 and ASQ:SE-2 findings by age group.

Developmental domains	Test statistic	Age group		
		Children aged 4 years and below (n = 78) Mean (SD)	Children aged above 4 years (n = 40) Mean (SD)	p-value
Communication	t-test	51.92 (7.91)	55.38 (5.48)	0.007**
Gross motor	t-test	48.85 (11.42)	49.75 (10.98)	0.681
Fine motor	t-test	39.55 (13.46)	49.38 (11.72)	<0.001**
Problem solving	t-test	50.13 (10.19)	55.25 (6.20)	<0.001**
Personal-social	t-test	48.14 (9.30)	53.63 (7.34)	0.002**
ASQ:SE-2	Mann-Whitney U test- ranks	60.56	57.43	0.636

*$p < 0.05$.
** $p < 0.01$.

4. Discussion

This study was conducted to assess the developmental progress of children enrolled in ECESs and to highlight the sociodemographic and dietary factors influencing these outcomes. Overall, the study results highlighted children are on track for their age-appropriate developmental progress. The mean developmental scores exceeded the minimum threshold for all ASQ-3 and ASQ-SE:2 domains [7,8]. These findings are aligned with a Japanese study where 434 children aged 6 to 60 months were assessed using the Japanese translation of the ASQ-3 questionnaire [17]. Comparing results with children aged 24 to 60 months (from the Japanese study) showed that the mean scores were above the cut-off value, suggesting adequate development [17]. However, another study from Canada involving 334 children aged 12 to 60 months highlighted some contrasting findings [18]. The study found that 10 % of the children had developmental delays, with male children from lower-income households being at a higher risk of developmental delay compared to others in the sample. However, the sample was recruited from primary care rather than education settings, which could potentially explain the difference in findings [18].

Table 3
ASQ-3 and ASQ:SE-2 findings based on parental education.

Developmental domains	Test statistic	Education - mother			p-value	Education - father				p-value
		Diploma or certificate (n = 33) Mean (SD)	Undergraduate (n = 45) Mean (SD)	Post-graduate (n = 40) Mean (SD)		Year 10 or below (n = 11) Mean (SD)	Diploma or certificate (n = 51) Mean (SD)	Undergraduate (n = 30) Mean (SD)	Post-graduate (n = 26) Mean (SD)	
Communication	ANOVA	52.73 (8.03)	52.33 (7.12)	54.25 (7.03)	0.462	50.91 (7.01)	53.04 (7.62)	51.33 (8.19)	56.15 (4.76)	0.063
Gross motor	ANOVA	50.91 (9.31)	49.56 (11.02)	47.25 (12.81)	0.369	47.73 (9.84)	49.80 (10.99)	50.50 (9.50)	46.92 (14.01)	0.619
Fine motor	ANOVA	42.73 (14.48)	40.78 (12.88)	45.38 (13.79)	0.304	37.73 (16.94)	46.08 (13.54)	40.83 (12.25)	41.15 (13.37)	0.142
Problem solving	ANOVA	52.12 (7.91)	51.67 (9.23)	51.88 (10.66)	0.978	50.91 (9.17)	51.57 (10.32)	51.00 (9.32)	53.85 (7.39)	0.666
Personal-social	ANOVA	50.30 (9.01)	49.89 (8.29)	49.88 (10.03)	0.975	45.45 (9.62)	51.18 (9.09)	50.33 (7.30)	49.23 (10.27)	0.277
ASQ:SE-2	Kruskal-Wallis	66.48	60.63	53.46	0.208	91.05[a]	54.35[b]	63.50[ab]	51.63[b]	0.006**

*$p < 0.05$.
** $p < 0.01$.
ab Values which are significantly different to each other.

Table 4
ASQ-3 and ASQ:SE-2 findings and household income.

Developmental domains	Test statistic	Household income				p-value
		High (≥$3840) (n = 17) Mean (SD)	Upper moderate ($2400–$3839) (n = 40)	Lower moderate ($1530–$2399) (n = 38)	Low (≤$1529) (n = 23)	
Communication	ANOVA	54.12 (6.43)	54.00 (6.91)	53.95 (6.79)	49.35 (8.70)	0.057
Gross motor	ANOVA	43.53[a] (10.86)	53.63[b] (10.50)	49.74[ab] (9.29)	44.57[a] (12.69)	0.002**
Fine motor	ANOVA	45.29 (11.92)	43.13 (15.18)	42.89 (12.93)	40.65 (13.84)	0.769
Problem solving	ANOVA	53.24 (6.60)	53.25 (10.10)	51.18 (9.55)	49.57 (9.28)	0.420
Personal-social	ANOVA	50.29 (10.8)	51.13 (8.13)	50.66 (7.90)	46.74 (10.62)	0.282
ASQ:SE-2	Kruskal-Wallis	44.91	60.89	59.17	68.41	0.191

*$p < 0.05$.
** $p < 0.01$.
ab Values which are significantly different to each other.

Table 5
Spearman correlations between developmental domains and breast-feeding time.

		Breast-feeding time	Communication	Gross motor	Fine motor	Problem solving	Personal-social
Communication	rho	0.21*	–	–	–	–	–
	Sig	0.026					
	n	118					
Gross motor	rho	0.07	0.27**	–	–	–	–
	Sig	0.480	0.003				
	n	118	118				
Fine motor	rho	0.07	0.33**	0.21*	–	–	–
	Sig	0.474	<0.001	0.026			
	n	118	118	118			
Problem solving	rho	0.22*	0.32**	0.19*	0.30**	–	–
	Sig	0.017	<0.001	0.045	<0.001		
	n	118	118	118	118		
Personal-social	rho	0.07	0.21*	0.24**	0.45**	0.46**	–
	Sig	0.423	0.021	0.008	<0.001	<0.001	
	n	118	118	118	118	118	
ASQ:SE-2 (mean ranks)	rho	−0.14	−0.36**	−0.18	0.27**	−0.21*	−0.53**
	Sig	0.129	<0.001	0.050	0.003	0.020	<0.001
	n	118	118	118	118	118	118

* $p < 0.05$.
** $p < 0.01$.

The current study results are also supported by the economic status of Australia, which is ranked among the top 20 economies (GDP per capita) in the world [19]. Moreover, the study sample included children enrolled in ECE settings in Victoria. The Victorian ECE settings follow The Early Years Learning Framework (EYLF), which not only focus on the physical development of children but also put special emphasis on emotional development, including identity, a strong sense of wellbeing, and communication [20].

The significance of EYLF and ECE attendance is supported by the Australian development research which showed that children who attended ECE settings were less likely to show developmental risk on 1 or more domain compared to those who did not attend ECE settings (19.9 % vs 38.5 %, respectively) [21]. The positive impact of ECE attendance on children's development is supported by subgroup analysis of siblings, which showed no significant influence in the present study. In contrast, previous research conducted locally [22] and globally [11] has highlighted the substantial influence of siblings on development. This suggests that in the current study sample, ECE attendance

Table 6
Spearman correlations between developmental domains, dietary intake and BMI.

		Communication	Gross motor	Fine motor	Problem solving	Personal-social	ASQ:SE-2
Fruits	rho	0.31**	0.16	0.07	0.13	0.14	−0.36**
	Sig	<0.001	0.080	0.424	0.176	0.129	<0.001
	n	118	118	118	118	118	118
Vegetable	rho	0.23*	0.20*	0.15	0.09	0.26**	−0.31**
	Sig	0.012	0.030	0.112	0.358	0.005	<0.001
	n	118	118	118	118	118	118
Yogurt	rho	0.03	0.04	−0.03	0.08	0.04	−0.04
	Sig	0.748	0.686	0.780	0.397	0.708	0.681
	n	118	118	118	118	118	118
Dairy	rho	−0.06	−0.15	−0.11	−0.10	−0.17	0.20*
	Sig	0.511	0.113	0.224	0.282	0.059	0.034
	n	118	118	118	118	118	118
Protein	rho	0.08	−0.04	0.004	−0.07	0.03	−0.05
	Sig	0.409	0.653	0.969	0.426	0.726	0.602
	n	118	118	118	118	118	118
Cereals	rho	0.16	0.05	0.00	0.07	−0.03	−0.16
	Sig	0.091	0.577	0.968	0.471	0.753	0.081
	n	118	118	118	118	118	118
BMI	rho	−0.16	−0.23*	−0.17	−0.08	−0.03	−0.04
	Sig	0.088	0.015	0.073	0.383	0.773	0.663
	n	118	118	118	118	118	118

** $p < 0.01$.
* $p < 0.05$.

outweighs the influence of siblings, if any, on young children's development. However, the study revealed significant developmental disparities attributable to demographic differences.

Sex-based differences are the most prominent among all. Young boys compared to girls exhibited significantly lower performance in 4 out of 6 domains including fine motor, problem-solving, personal-social, and social-emotional skills. In addition, the fine motor and social-emotional skills showed a substantial difference of exceeding 20 %. This highlights disparities both in physical domain as well as cognitive, however; in comparison, cognitive is more at risk. Biological theorists posit that prenatal differences, such as genetic variations, between girls and boys influence their behaviour [23]. These disparities originate in gene expression, particularly between the Y and X chromosomes, and are further shaped by hormonal stimuli like testosterone during gestation, contributing to distinct body and brain developments in males and females [24]. For example, genetic predispositions result in boys typically exhibiting lower language abilities and inhibitory control compared to girls [23]. This divergence may result in challenges for boys in regulating their emotions, necessitating additional support during their early developmental stages to promote not only equality but also equity (which EYLF may have been missing) [25].

The above findings are also consistent with the 3-yearly developmental assessment conducted in the first year of school across Australia and with the Canadian study, which suggested that male children from low-income households at higher risk of developmental delay [18,26]. The findings from the AEDC 2018 reports showed that young boys compared with girls were 3.4 times more likely to be at developmental risk in emotional maturity, while twice as likely as to at risk in the social competence domain [26]. Children doing not well in these domains experiences challenges such as anger management, prone to inattention and impulsive behaviour [26]. Also, children at risk of development in 1 or more domain (compared with children not at risk at age 5) are more likely to be in the bottom 20 % of The National Assessment Program – Literacy and Numeracy (NAPLAN) assessments in years 3, 5 and 7 [21].

Age group distribution also showed substantial variation across developmental domains. Children older than 4 years demonstrated significantly better development in communication, fine motor skills, problem-solving, and personal-social domains. However, this disparity does not indicate an issue of equity, as unlike sex, each child is expected to grow and achieve development in the next age group. Additionally, it may highlight that the ASQ-3 questionnaires might not be sensitive enough to accurately capture the developmental growth of children aged 4 and above. Moreover, the difference in development due to sex cannot be attributed to differences in age, as both male and female children had similar mean ages and age ranges.

Conversely, the parental education status had limited influence on the children's developmental outcomes. The most apparent different was seen again in the social-emotional domain where children with fathers having post-graduate education showed almost two times improvement in development compared to children with fathers who have achieved year 10 education or below. This difference was not as significant in the mother's education section, suggesting the role model influence or active involvement of fathers with their children, which may be associated with their education status [12]. A meta-analysis by McWayne et al. [27] found out that the direct involvement of fathers had profound influence on cognitive abilities and social skills but is most strongly associated with children's self-regulation abilities [27]. The social-emotional domain was assessed on a comprehensive tool (ASQ-SE:2), including >20 questions directly assessing this area. Thus, despite the fact the sample size was small due to education status stratification, these findings hold substantial value and provide fertile ground for future research.

Similar to the education status, the household income influenced two of the six developmental domains. Communication development showed an increasing trend with increasing household income, while gross motor skills showed an increasing trend from low to upper moderate socio-economic class. Among highest earning households, children showed the lowest gross motor development suggesting restrictive opportunities for children in terms of activities that induce gross motor development such as outdoor play. The possible basis for this may be time allocation to activities not associated with gross motor skills. For example, a recent study by Olds et al. [28] found out that children from highest socioeconomic group were spending 30 min/day more on school related activities compared to children in the lowest socioeconomic group in Australia. This was also noted in a US study of children aged 2–5 years and which indicated the trend of gross motor skills vulnerability among children from higher income households [29]. However, apart from the gross motor function, children from the highest earing households showed better development in other domains. Household income supports children's development not only by providing the facilities of life but also support children through healthy relationships in the household [30]. The relationships improved among partners and with children with increasing income, since financial independence reduce stress and increase happiness among parents [30].

With respect of breast-feeding time and developmental outcomes, this study suggested weak positive relationship with 2 domains – communication and problem-solving, both of which can be classified under the cognitive development domain. This may be explained by the fact that the long-chain fatty acids, especially docosahexaenoic acid (DHA), present in breast milk have a positive influence on brain development. [31]. Further, these findings extend upon previous literate [32] and highlight the long-term positive effects of breast-feeding duration on the psychological developmental aspects of children. However, it also shows that at least in the long term other social (e.g. ECE attendance) and demographic (e.g. sex) factors and are more important for children's development than the duration of breast-feeding time in the current study cohort.

The current study also examined the inter-relationship between six developmental domains. As expected, personal-social and social-emotional indicated the strongest relationship. This finding not only supports the robustness of the instruments but also increase confidence in the current study findings in terms of accuracy of assessments conducted by the parents. Moreover, almost all other domains showed a significant relationship between each other. However, the personal-social/social-emotional domain emerged as a strong foundation for majority of them and in particular showed a substantial association with fine motor and problem-solving skills indicating substantial cognitive-motor relationship. These findings align with previous research and support the concept of "Mind–body monism", that individuals are a unity, supporting the use of motor skills to improve cognitive efficiency [33].

With regards to dietary intake, BMI and development, the current study unwinds some significant findings. Consumption of fruits and vegetable was significantly associated with cognitive development particularly the personal-social and social-emotional regulation. These findings are coherent with the systematic review findings by Guzek et al. [34], which suggests the protective function of fruits and vegetable consumption for mental health conditions [34]. On the other hand, dairy consumption (excluding yogurt) emerged as a risk factor for the development especially for the emotional development.

There are multiple pathways through which these associations can be understood. Milk consumption of >500 mL per day is substantially associated with childhood obesity, which is mediated through insulin-like growth factor-1 that is a risk for diabetes, cardiovascular disease and cognitive decline [35–37]. Moreover, although Australian Dairy industry is strictly regulated, and artificial hormone injections are illegal as a mechanism to increase milk production [38]. However, hormones are typically used all over Australia to synchronise oestrus [39]. Also, antibiotic use is permitted to treat milk producing animals such as cows to treat infections [39]. All of the above discussed factors suggest the potential pathways through milk consumption or particularly high milk consumption among children can be detrimental, but warrant further closer examination.

Similarly, BMI is another risk factor found to be associated with gross motor development. Increasing BMI was associated with decreased gross motor development, which made visible sense as increasing weight can make substantial difficulty for children to participate in the physical play due to difficulty in movement or due to discrimination [40,41]. Overweight related teasing and discrimination is not uncommon, and it can substantially influence the emotional well-being of children, however; this study did not show any direct relationship between BMI and emotional domain, possibly due to very young age of children [41].

5. Limitations

The study incorporated a cross-sectional design; thus, causal relationships were not established. Although the sample was recruited from a diverse range of venues, the sample size was small, especially in the subgroup analysis, and should be considered during the interpretation of the findings. Similarly, the developmental assessment was conducted by parents, which could introduce some bias into the findings. Additionally, as the study is conducted in a high socioeconomic country, the findings may not be applicable to developing nations.

6. Conclusion

Young children enrolled in Victorian ECE settings were demonstrated to perform well in terms of their development. However, substantial disparities have been found due to various demographic factors. The Victorian EYLF is not inclusive enough to accommodate the developmental needs of both young boys and girls and boys are notably lagging behind. The education status of fathers, socio-economic status, and breastfeeding duration have all been found to influence children's development. Moreover, the personal-social domain has emerged as a strong foundational area that supports the bilateral cognitive-motor relationship. Similarly, the consumption of fruits and vegetables has been positively associated with the majority of developmental domains. However, dairy consumption (excluding yogurt), along with increasing BMI, has been identified as a risk factor for development. This research highlights several avenues for future research, especially in addressing the weaknesses of the EYLF regarding sex inclusion, exploring the dynamics of fathers' education and its impact on children's development, investigating the role of diet in development with a particular focus on milk and dairy consumption, and utilising large longitudinal studies to better understand the causal links between these factors.

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CRediT authorship contribution statement

Hafiz Haris Ahmad: Writing – original draft, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Blake Peck:** Writing – review & editing, Supervision, Methodology, Conceptualization. **Daniel Terry:** Writing – review & editing, Supervision, Methodology, Conceptualization.

Declaration of competing interest

The authors have no conflict of interest to declare.

Data availability

The data generated in this research cannot be shared due to confidentiality reasons.

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