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Baby-led weaning in Italy and potential implications for infant development

Elsa Addressi^{a,*}, Amy T. Galloway^b, Twila Wingrove^b, Hadley Brochu^b, Arianna Pierantozzi^a, Francesca Bellagamba^c, Claire V. Farrow^d

^a CNR, Istituto di Scienze e Tecnologie della Cognizione, Via Ulisse Aldrovandi, 16/b, Rome, Italy

^b Department of Psychology, Appalachian State University, Boone, NC, USA

^c Dipartimento di Psicologia Dinamica, Clinica e Salute, Sapienza Università di Roma, Via degli Apuli 1, 00185, Rome, Italy

^d Department of Psychology, College of Health and Life Sciences, Aston University, Aston Triangle, B4 7ET Birmingham, UK

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ABSTRACT

Baby-led weaning is an approach to complementary feeding that emphasizes an infant's ability to self-feed rather than being spoon fed, and to eat minimally-processed foods rather than puréed foods. This study aimed to investigate the variability in infant feeding practices and the possible association with developmental milestones in an Italian population. A sample of 1245 mothers of 6–12 month-old infants completed an online survey about complementary feeding and their infant's attainment of developmental milestones. Infants' eating of family food was positively related to self-feeding and to a lower consumption of puréed foods. As in previous studies in the UK and New Zealand, a baby-led weaning style was positively associated with breastfeeding, exposure to complementary foods around six months of age, earlier exposure to both finger and family foods, and higher interest in family food and shared family meals. Infants who were introduced to solid foods using a baby-led weaning approach were more likely to have met important developmental milestones; when controlling for covariates, percentage of family feeding was positively associated with sitting unsupported at an earlier age and a low spoon-feeding style was associated with crawling at an earlier age. These data suggest that baby-led weaning should be defined more comprehensively. Moreover, its potential influence on developmental domains beyond diet and eating behavior warrants future targeted exploration.

1. Introduction

The complementary feeding period (i.e., when infants are introduced to foods and liquids different from milk) has lifelong consequences for physical, cognitive, and socio-emotional well-being (Rose, Birch, & Savage, 2017; Seach, Dharmage, Lowe, & Dixon, 2010). In many industrialized societies, the first solids that mothers offer to infants are puréed foods on a spoon, with a gradual transition to purées with a coarser texture, finger foods (i.e., food that can be eaten with the hands), and eventually family foods (Agostoni et al., 2008; Seaman, D'Alessandro & Swannie, 1996). This approach is known using a range of different names, including “standard weaning” (Brown & Lee, 2011), “traditional weaning” (Brown, 2016), “traditional spoon feeding” (Fu et al., 2018), or “parent-led weaning” (PLW) (Cameron, Taylor, & Heath, 2013). In the last 15 years, there has been a rise in an approach to

feeding solid foods which has been termed “baby-led weaning” (BLW); this alternative approach to introducing solids is based on the infant independently eating finger foods rather than being fed puréed foods on a spoon, setting the pace and amount eaten at the meal, and participating in family meals (e.g., Brown, Jones, & Rowan, 2017; Brown & Lee, 2011; Cameron, Heath, & Taylor, 2012).

It appears that BLW is associated with many positive outcomes. For example, from questionnaire data obtained from convenience samples it has emerged that, compared to PLW mothers, BLW mothers are more likely to exclusively breastfeed until 6 months of age (Cameron et al., 2013; Fu et al., 2018), and to delay the introduction of complementary foods (Brown & Lee, 2011; Cameron et al., 2013). The above findings are confirmed also by questionnaire data obtained in a randomized clinical trial examining outcomes from PLW compared to a modified BLW approach: The Baby-Led Introduction to Solids – BLISS (Taylor et al.,

* Corresponding author. CNR, Istituto di Scienze e Tecnologie della Cognizione, Via Ulisse Aldrovandi, 16/b, 00197, Rome, Italy.

E-mail addresses: elsa.addressi@istc.cnr.it (E. Addressi), gallowayat@appstate.edu (A.T. Galloway), wingrovetta@appstate.edu (T. Wingrove), hadleybrochu@gmail.com (H. Brochu), ottoeary@icloud.com (A. Pierantozzi), francesca.bellagamba@uniroma1.it (F. Bellagamba), c.farrow@aston.ac.uk (C.V. Farrow).

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2017). In comparison to PLW children, both BLW and BLISS children are reported by parents to participate more frequently in family meals (Brown & Lee, 2011; Cameron et al., 2013; Morison et al., 2016), and to show lower levels of food fussiness (between 6 and 36 months: Fu et al., 2018; at 12 months: Taylor et al., 2017 [see Townsend and Pitchford (2012) and Brown and Lee (2015) for data showing no significant differences]). BLW children have also been reported to show greater satiety-responsiveness at 18–24 months of age (Brown & Lee, 2015), although in 24-month-old BLISS infants the opposite was found (Taylor et al., 2017). Finally, BLW and BLISS approaches have been shown to result in a diet that is approximately as nutritionally adequate as PLW (e.g., Daniels et al., 2018; Doğan et al., 2018; Williams Erickson et al., 2018) and do not imply an increased choking hazard for infants (e.g., Brown, 2018; Doğan et al., 2018; Fangupo et al., 2016).

There is however still a lack of agreement upon a formal operational definition of what constitutes BLW (D'Auria et al., 2018). Some authors (e.g. Brown & Lee, 2011) consider infants to be exposed to BLW if their mothers report spoon feeding and purée food feeding in $\leq 10\%$ of feeding occasions, whereas others (e.g. Cameron et al., 2013; Pérez-Ríos et al., 2020) only consider infants as following BLW if they feed autonomously all or most of the time. Around the same time that the BLW approach first emerged in the UK, a similar approach known as “on-demand complementary feeding” (“*alimentazione complementare a richiesta*”) also arose in Italy. This approach focuses on the importance of the infant signaling an interest in food and eating family foods with the rest of the family, with less emphasis on the form of the foods or the modality of feeding (Buglioni et al., 2017; Piermarini, 2002, 2006, 2020). The limited research that has been conducted about this approach in Italy suggests that around 7% of pediatricians recommended on-demand complementary feeding to new parents and about 8% of families followed this approach (Lacorte et al., 2018). To date there is no data comparing BLW and on-demand complementary feeding approaches, therefore for simplicity we refer to the “BLW approach” in the present paper to indicate all alternative approaches to PLW.

In addition to the impact of BLW on eating behavior, there is an emerging interest in the potential impact that different approaches to weaning may have for other developmental domains. Supporters of the BLW approach have hypothesized that it may promote motor and language development (Rapley, 2005) and a recent study with 8–24 month old infants suggests that an approach to complementary feeding which promotes eating unaided, rather than being fed puréed foods, is related to more advanced child language production and comprehension and that this relationship is mediated by the prevalence of family meals (Webber et al., in press). In terms of an association between a BLW approach and motor development, there is no published data available. The age at which children reach for food has been associated with other developmental milestones, such as walking (Wright, Cameron, Tsiaka, & Parkinson, 2011), suggesting that developmental readiness in one domain is associated with readiness in other areas. However whether the nature of the approach to weaning may relate to developmental outcomes is still unclear.

The present study aimed to (i) assess the frequency of a BLW approach in an Italian sample; considering low spoon and purée feeding but also considering the additional criterion of being often fed family food, (ii) explore the association between a BLW approach and variables known to be related to BLW in other countries (e.g., several demographic variables and breastfeeding), (iii) evaluate the association between a BLW approach and infant's first experiences with complementary foods (e.g., age of introduction of first foods, finger foods, and family foods), and (iv) appraise whether a BLW approach is associated with three developmental milestones (e.g., sitting unsupported, crawling, and utterance of the first words).

It was hypothesized that, as observed in other countries (i) a BLW approach would be scarcely adopted by Italian families, compared to PLW, (ii) Italian infants exposed to a BLW approach would show longer breastfeeding, and (iii) delayed introduction to first complementary

foods accompanied by an earlier exposure to finger foods and family foods, and (iv) a BLW approach including low spoon- and purée-feeding and a frequent consumption of family foods would be associated with an earlier age of sitting unsupported, crawling and utterance of first words.

2. Methods

2.1. Participants

In 2017, mothers from Italy ($n = 3021$) with their youngest or only child aged between 6 and 12 months participated in an online survey, hosted in Qualtrics. Responses were sought from mothers employing a variety of weaning practices by advertising via social media, parenting sites, message boards, posters in pediatrician offices and maternity centers, and through the newsletter of the magazine for parents “*UPPA Magazine*”. In the invitation letter, mothers were informed that they would participate in a survey on infant eating development and they gave informed consent to participate. Baby-led weaning was not mentioned on study materials. From the initial pool of $N = 3021$ questionnaires, we excluded $N = 1389$ participants who did not achieve 80% completion, $N = 58$ participants who took less than 10 min to complete the questionnaire, $N = 188$ participants with children younger than 6 months or older than 12 months of age (or who did not report their children's age), $N = 5$ participants who reported an unrealistic birth weight and $N = 16$ participants with twins, for a final sample of $N = 1365$ (11% Southern Italy and Islands, 21.4% Central Italy, 57.4% Northern Italy, 2.6% Italians living abroad, 7.6% missing information). Participants with infants who had low birth weight (< 2500 g) or were born prematurely (before 37 weeks) were excluded from the analysis. The final sample included 1245 mothers. The study was approved by the Ethics Committee of the Institute of Cognitive Sciences and Technologies of CNR (n. 0000811, March 8, 2017).

2.2. Measures

The survey was partly based on two previous surveys (Brown & Lee, 2011; Cameron et al., 2013) and asked about demographic information, approach to the introduction of complementary foods, breastfeeding, and infant's developmental milestones. The survey also asked for sources of information and support about complementary feeding, mother's feelings about complementary feeding and mother's and infant's dietary habits; however, these data will be reported in future publications.

2.2.1. Demographic information

Mothers provided information on their age, highest level of education (high school or below, vocational or bachelor's, master's or doctoral qualification), employment status (employed, unemployed; regardless of whether they were currently on maternity leave), marital status (married/partnered, not married/partnered), return to work (how many months after birth they returned to work, if at all), and income level (Table 1). They also provided information about their infant, including age, gender, birth order, number of siblings in the household, gestational age at birth, and birth weight.

2.2.2. Approach to the introduction of complementary foods

Mothers were asked to approximate the percentage of time that spoon feeding and puréed foods were each employed as a means of feeding their infant and the percentage of family food eaten by the infant (regardless of whether the infant was spoon fed or ate autonomously, alone or within the context of the family meal). Response options were 100%, 90%, 75%, 50%, 25%, 10% and 0% in all cases.

Mothers also provided information about the infant's age when complementary foods were first introduced, the age when finger foods and family foods were introduced, the percentage of time children showed interest in family food, i.e., in the food eaten by their family members when sharing family meals (response options were 100%,

Table 1
Demographic characteristics of the sample.

Variable	Group	Spoon feeding criterion		Student t/ Chi square	Purée feeding criterion		Student t/ Chi square	Family-food feeding criterion		Student t/ Chi square
		Parent-led weaning	Baby-led weaning		Parent-led weaning	Baby-led weaning		Parent-led weaning	Baby-led weaning	
Infant age (months, mean ± SD)		8.96 ± 1.91	9.65 ± 2.05	t₁₂₃₄ = -3.81***	8.67 ± 1.87	9.72 ± 1.89	t₁₂₄₃ = -9.27***	8.55 ± 1.86	9.74 ± 1.84	t₁₂₄₃ = -11.15***
Infant gender (n and %)	Males	598 (53.8)	59 (47.2)	$\chi^2_1 = 1.98$	452 (54.5)	213 (51.3)	$\chi^2_1 = 1.09$	403 (53.5)	262 (53.3)	$\chi^2_1 = .009$
	Females	513 (46.2)	66 (52.8)		378 (45.5)	202 (48.7)		350 (46.5)	230 (46.7)	
Birth order (n and %)	Only child	828 (74.6)	81 (64.8)	$\chi^2_4 = 8.40$	629 (75.9)	287 (69.2)	$\chi^2_4 = 7.93$	569 (75.7)	347 (70.5)	$\chi^2_4 = 4.23$
	First child	9 (.8)	3 (2.4)		6 (.7)	6 (1.4)		6 (.8)	6 (1.2)	
	Second child	233 (21.0)	35 (28.0)		164 (19.8)	106 (25.5)		151 (20.1)	119 (24.2)	
	Third child	33 (3.0)	4 (3.2)		25 (3.0)	12 (2.9)		21 (2.8)	16 (3.3)	
	Fourth or fifth child	7 (.6)	2 (1.6)		5 (.6)	4 (1.0)		5 (.6)	4 (.8)	
Infant birth weight (grams, mean and SD)		3373.3 ± 407.5	3410.4 ± 441.1	t ₁₂₃₄ = -.96	3358.2 ± 408.2	3413.5 ± 415.9	t₁₂₄₃ = -2.24*	3368.9 ± 409.1	3388.6 ± 415.1	t ₁₂₄₃ = -.83
Maternal age (years, mean and SD)		34.3 ± 4.1	33.7 ± 4.0	t ₁₂₂₁ = 1.32	34.3 ± 4.1	34.0 ± 4.1	t ₁₂₂₈ = 1.13	34.3 ± 4.1	34.0 ± 4.2	t ₁₂₂₈ = 1.51
Maternal education (n and %)	High school or below	262 (23.9)	32 (26.2)	$\chi^2_3 = 3.17$	205 (25.1)	90 (21.9)	$\chi^2_3 = 2.76$	172 (23.2)	123 (25.5)	$\chi^2_3 = 7.33$
	Vocational or Bachelor's	225 (20.5)	25 (20.5)		168 (20.6)	82 (19.9)		137 (18.4)	113 (23.4)	
	Master's	527 (48.0)	61 (50.0)		382 (46.9)	212 (51.6)		376 (50.6)	218 (45.1)	
	PhD	83 (7.6)	4 (3.3)		60 (7.4)	27 (6.6)		58 (7.8)	29 (6.0)	
Marital status (n and %)	Married/Partnered	1001 (93.6)	107 (91.5)	$\chi^2_1 = .748$	744 (93.5)	371 (93.2)	$\chi^2_1 = .027$	681 (93.7)	434 (92.9)	$\chi^2_1 = .251$
	Not married/Partnered	69 (6.4)	10 (8.5)		52 (6.5)	27 (6.8)		46 (6.3)	33 (7.1)	
Currently employed (n and %)	Yes	898 (81.6)	90 (73.8)	$\chi^2_1 = 4.39*$	662 (81.0)	331 (80.3)	$\chi^2_1 = .084$	609 (81.9)	384 (79.2)	$\chi^2_1 = 1.36$
	No	202 (18.4)	32 (26.2)		155 (19.0)	81 (19.7)		135 (18.1)	101 (20.8)	
Return to work - months after birth (mean and SD)		6.46 ± 2.80	7.04 ± 2.72	t ₇₅₄ = -1.59	6.32 ± 2.79	6.89 ± 2.78	t₇₅₆ = -2.67**	6.28 ± 2.79	6.87 ± 2.80	t₇₅₆ = -2.88**
Income (Euro) (n and %)	<20,000	146 (15.5)	22 (20.2)	$\chi^2_3 = 3.30$	108 (15.4)	61 (17.2)	$\chi^2_3 = 1.35$	91 (14.4)	78 (18.2)	$\chi^2_3 = 12.97**$
	20-34999	380 (40.4)	43 (39.4)		280 (39.9)	146 (41.1)		235 (37.6)	191 (44.6)	
	35-50000	259 (27.6)	23 (21.1)		195 (27.8)	88 (24.8)		189 (30.0)	94 (22.0)	
	>50,000	155 (16.5)	21 (19.3)		118 (16.8)	60 (16.9)		113 (18.0)	65 (15.2)	

Note. All percentages in each category add up to 100% because missing data were excluded from the calculation. Some participants did not answer all of the demographic questions. Significant p values are highlighted in bold (*p < .05, **p < .01, ***p < .001).

90%, 75%, 50%, 25%, 10% and 0%) and the frequency of shared family meals on a 4-point Likert scale (regardless of whether the infant ate the same food eaten by the other family members or specially prepared baby food).

2.2.3. Breastfeeding

Mothers provided information regarding whether the infant was breastfed (including pumped milk) since birth, the duration of time the infant was breastfed, and whether the infant was still breastfed at the time of the questionnaire was completed.

2.2.4. Developmental milestones

Mothers were asked whether their infant has already achieved three developmental milestones (i.e., sitting unsupported, crawling, and utterance of first words). In case the infant had achieved the milestone, we have further asked the number of months at which this occurred, if the mother was able to recall (if not, the mother could flag the option “don’t remember”). If the infant had not achieved a specific developmental milestone yet, the mother could flag the option “not yet”.

2.3. Data analysis

Data were analyzed using SPSS version 25. To assess the frequency of a BLW approach and the relationships between the style of weaning and (i) demographics, (ii) breastfeeding, and (iii) infant’s first experiences with complementary foods, we categorized participants as belonging to BLW and non-BLW groups, separately following three criteria: (i) percentage of occasions in which infants were spoon fed, (ii) percentage of occasions in which they were fed purée food, and (iii) percentage of occasions in which they were offered the same food eaten by the rest of the family. The first two criteria (percentage of spoon feeding and percentage of purée feeding) were based on the two definitions of BLW provided by Brown and Lee (2011). Mothers who reported spoon feeding their infant $\leq 10\%$ of the time were categorized in the “low spoon-feeding group” (as opposed to the “high spoon-feeding group”, including all the other participants). Mothers who reported feeding puréed food to their infant $\leq 10\%$ of the time were categorized in the “low purée-feeding group” (as opposed to the “high purée-feeding group”). The third criterion was based on time spent feeding the infant with food eaten by the rest of the family (Piermarini, 2002, 2006, 2020). Mothers who reported their infant feeding on family food $\geq 90\%$ of the time were categorized in the “high family-food-feeding group” (as opposed to the “low family-food-feeding group”). We controlled for income when analyzing the relationship between style of weaning and breastfeeding (since the latter has been shown to be related to socioeconomic status: Heck, Braveman, Cubbin, Chavez, & Kiely, 2006), and for the infant’s age when analyzing the relationship between style of weaning and the infant’s first experiences with complementary foods.

We also completed hierarchical regression analyses to evaluate the association between the age at which infants achieved each of the three developmental milestones (sitting unsupported, crawling, and utterance of first words) and the three feeding variables (percentage of spoon feeding, purée feeding, and family-food feeding). We preliminarily checked whether any of these three developmental measures correlated with several variables which are possibly related to early child development: infant’s gender, birth order (Day & Heckman, 2013), infant’s birth weight (Gill, May-Benson, Teasdale, & Munsell, 2013), number of months infants have been breastfed (Choi, Kang, & Chung, 2018), mother’s age (Brooks-Gunn & Furstenberg, 1986), months after birth mother returned to work (Baker & Milligan, 2010), marital status, yearly income (Votruba-Drzal, 2003), maternal education (Jeong, McCoy, & Fink, 2017) (Supplementary Table 1). In the hierarchical regressions, we controlled for infant’s age and for the variables which were significantly related to the developmental outcomes. Data are available from the authors upon request.

Table 2

Distribution of reported frequencies of Spoon-, Purée- and Family-Food-Feeding. Participants engaging in a baby-led weaning approach are highlighted in bold (for definitions, please see main text).

Variable	n (%)	
Spoon feeding (Percentage of Time)	100	332 (26.7)
	90	306 (24.6)
	75	200 (16.1)
	50	190 (15.3)
	25	83 (6.7)
	10	94 (7.6)
	0	31 (2.5)
	Missing	9 (0.7)
Purée feeding (Percentage of Food)	100	163 (13.1)
	90	194 (15.6)
	75	137 (11.0)
	50	170 (13.7)
	25	166 (13.3)
	10	233 (18.7)
	0	182 (14.6)
	Missing	0
Family-food feeding (Percentage of Food)	100	187 (15.0)
	90	305 (24.5)
	75	204 (16.4)
	50	183 (14.7)
	25	141 (11.3)
	10	147 (11.8)
	0	78 (6.3)
	Missing	0

3. Results

3.1. Frequency of BLW

Table 1 reports the demographic characteristics of the sample. Table 2 reports the percentage of spoon feeding, puréed foods, and family food eaten by the infants. Overall, mothers reported spoon feeding very frequently (mode: 100%) and their infants eating family food very often (mode: 90%), whereas they reported feeding puréed foods quite rarely (mode: 10%). These three measures were correlated: percentage of time spent spoon feeding with percentage of puréed food ($r = 0.556, p < .001, N = 1236$), spoon feeding with percentage of family-food feeding ($r = -0.464, p < .001, N = 1236$), and purée feeding with family-food feeding ($r = -0.491, p < .001, N = 1245$).

The “low spoon-feeding group” included 10% ($n = 125$) of the sample. The “low purée-feeding group” included 33.3% ($n = 415$) of the sample. The “high family-food-feeding group” included 39.5% ($n = 492$) of the sample. A smaller percentage of participants simultaneously adhered to all the three aspects of BLW, using low levels of spoon feeding, low levels of purée feeding and high levels of family-food-feeding (6.91%, $n = 86$).

3.2. Style of weaning and demographics

As reported in Table 1, infants belonging to all the BLW groups were slightly older than those belonging to the non-BLW groups. Infants belonging to the low purée-feeding group had a slightly higher birth weight than infants belonging to the high purée-feeding group. A greater proportion of mothers in the low spoon-feeding group were employed compared to mothers in the corresponding high spoon-feeding group. Mothers belonging to the low purée-feeding and high family-food-feeding groups returned to work significantly later than mothers belonging to the corresponding non-BLW groups. Finally, mothers belonging to the high family-food-feeding group had a lower income than mothers belonging to the low family-food-feeding group. All the other demographic variables did not significantly differ between groups.

3.3. Style of weaning and breastfeeding

The mean duration of breastfeeding was, on average, 5.84 months ($SD = 2.29$). After controlling for income, mothers belonging to all BLW groups breastfed significantly longer than mothers belonging to the corresponding non-BLW groups (length of breastfeeding in months: Estimated Marginal Means, EMM, and Standard Deviations, SD: spoon feeding: $EMM_{BLW} = 6.59, SD_{BLW} = 0.221$; $EMM_{non-BLW} = 5.77, SD_{non-BLW} = 0.077$; $F(1, 982) = 12.6, p < .001$; purée feeding: $EMM_{BLW} = 6.46, SD_{BLW} = 0.121$; $EMM_{non-BLW} = 5.53, SD_{non-BLW} = 0.088$; $F(1, 989) = 38.2, p < .001$; family-food feeding: $EMM_{BLW} = 6.44, SD_{BLW} = 0.111$; $EMM_{non-BLW} = 5.45, SD_{non-BLW} = 0.092$; $F(1, 989) = 46.6, p < .001$).

Most of the sample ($n = 968, 77.8\%$) was still breastfeeding at the time of the survey. Mothers who were still breastfeeding engaged in less spoon feeding, $t(480.922) = -8.29, p < .001$, less purée feeding, $t(376.566) = -4.55, p < .001$, and more family-food feeding, $t(1201) = 4.53, p < .001$ than the mothers who were no longer breastfeeding.

3.4. Style of weaning and infant's first experiences with complementary foods

The average age at which infants consumed their first solid food was 5.73 months ($SD = 0.795$). The majority of participants ($n = 805, 65.1\%$) reported waiting until the infant was at least six months old. Mothers belonging to all BLW groups reported significantly later introduction of complementary foods, compared to mothers belonging to the corresponding non-BLW group (age of introduction of complementary foods in months: Means, M, and Standard Deviations, SD: spoon feeding: $M_{BLW} = 6.00, SD = 0.835$; $M_{non-BLW} = 5.70, SD = 0.786$; $t(149.917) = -3.94, p < .001$; purée feeding: $M_{BLW} = 5.92, SD = 0.722$; $M_{non-BLW} = 5.64, SD = 0.812$; $t(909.641) = -6.23, p < .001$; family-food feeding: $M_{BLW} = 5.91, SD = 0.756$; $M_{non-BLW} = 5.62, SD = 0.799$; $t(1078.551) = 6.40, p < .001$).

Infants belonging to all the BLW groups started eating food with their fingers significantly earlier than infants belonging to the corresponding non-BLW groups (age of introduction of finger foods in months: Means, M, and Standard Deviations, SD: spoon feeding: $M_{BLW} = 6.65, SD = 1.13$; $M_{non-BLW} = 7.38, SD = 1.55$; $t(206.317) = 6.19, p < .001$; purée feeding: $M_{BLW} = 7.03, SD = 1.34$; $M_{non-BLW} = 7.46, SD = 1.61$; $t(818.428) = 4.16, p < .001$; family-food feeding: $M_{BLW} = 7.11, SD = 1.44$; $M_{non-BLW} = 7.45, SD = 1.57$; $t(805.195) = 3.18, p = .002$).

Similarly, infants belonging to all the BLW groups started eating family food significantly earlier than infants belonging to the corresponding non-BLW groups (age of introduction of family foods in months: Means, M, and Standard Deviations, SD: spoon feeding: $M_{BLW} = 6.64, SD = 1.30$; $M_{non-BLW} = 7.46, SD = 1.86$; $t(219.113) = 5.85, p < .001$; purée feeding: $M_{BLW} = 7.07, SD = 1.65$; $M_{non-BLW} = 7.57, SD = 1.91$; $t(766.926) = 3.87, p < .001$; family-food feeding: $M_{BLW} = 7.12, SD = 1.74$; $M_{non-BLW} = 7.64, SD = 1.86$; $t(640.017) = 3.93, p < .001$).

We found significant negative associations between the degree of spoon feeding and purée feeding and the frequency of (i) infant's interest for family food (spoon feeding: $r = -0.212, p < .001$; purée feeding: $r = -0.204, p < .001$), and (ii) sharing family meals (spoon feeding: $r =$

$-0.363, p < .001$; purée feeding: $r = -0.354, p < .001$). In contrast, we found significant positive associations between degrees of family-food feeding and the frequency of (i) infant's interest for family food ($r = 0.437, p < .001$), and (ii) sharing family meals ($r = 0.479, p < .001$). In all the above analyses we controlled for infant's age ($df = 1220$).

3.5. Style of weaning and achievement of developmental milestones

Table 3 shows the means and standard deviations of the reported age (months) at which infants met each developmental milestone for parent-led and baby-led weaning groups, and Supplementary Tables 2, 3 and 4 show the distribution of reported frequencies of the achievement of the three developmental milestones for parent-led and baby-led weaning groups.

We performed hierarchical multiple regressions to examine the association between the age at which infants achieved each of the three developmental milestones (sitting unsupported, crawling, and utterance of first words) and the three feeding variables (percentage of spoon feeding, purée feeding, and family-food feeding). In each regression, in the first step we entered the variables which were related to developmental outcomes (i.e., infant's age, birth weight, and mother's age for sitting unsupported; infant's age and number of months infants have been breastfed for crawling; infant's age and mother's education for utterance of first words). The feeding variables were entered in the second step. Percentage of family-food feeding was significantly associated with sitting unsupported at an earlier age (Table 4) and a lower percentage of spoon feeding was significantly associated with crawling at an earlier age (Table 5), indicating that aspects of the BLW approach were related to advanced motor milestones. However, none of the feeding variables were associated with the age at which infants uttered their first words (Table 6).

4. Discussion

A sample of 1245 mothers of 6–12 month-old infants completed an online survey about complementary feeding and infant's attainment of developmental milestones. Overall, a low percentage of participants simultaneously adhered to all the three criteria employed to define BLW ($\leq 10\%$ spoon feeding or purée feeding, $\geq 90\%$ family-food feeding), but 10, 33, and 40% of participants, respectively, were categorized as low-spoon feeding, low-purée feeding, and high family-food feeding. Moreover, a BLW approach was positively associated with breastfeeding, exposure to complementary foods around six months of age, earlier exposure to both finger and family foods, higher interest in family food and shared family meals. Furthermore, this study provided preliminary evidence that percentage of family-food feeding may be positively associated with sitting unsupported at an earlier age and a low spoon-feeding style may be positively associated with crawling at an earlier age, although these relationships were small.

There is currently no formally agreed definition of BLW (Brown & Lee, 2011; Cameron et al., 2013; D'Auria et al., 2018; Piermarini, 2002, 2006) and clearer definitions of both BLW and PLW are needed in order to investigate these approaches more thoroughly (Rapley, 2018a). In the

Table 3

Means and standard deviations of the reported age (months) at which infants met each developmental milestone for each of the three parent-led and baby-led weaning groups.

Developmental milestone	Spoon feeding criterion		Puree feeding criterion		Family-food feeding criterion	
	Parent-led weaning	Baby-led weaning	Parent-led weaning	Baby-led weaning	Parent-led weaning	Baby-led weaning
Sitting Unsupported	5.88 ± .957	5.82 ± 1.04	5.89 ± .961	5.84 ± .970	5.92 ± .934	5.80 ± 1.0
Crawling	7.91 ± 1.42	7.79 ± 1.64	7.82 ± 1.41	8.0 ± 1.51	7.84 ± 1.45	7.96 ± 1.46
Utterance of first words	7.62 ± 1.80	8.25 ± 1.85	7.50 ± 1.75	8.01 ± 1.86	7.42 ± 1.71	8.01 ± 1.88

Table 4
Hierarchical Regression Analysis of predictors of infant's first Sitting Unsupported (months).

Variable	B	SE B	Beta	t	p	VIF	R ²	Adj R ²	SE	Δ R ²	Δ F	df1	df2	p
Step 1														
Infant age (months)	.039	.016	.075	2.43	.015	1.00	.020	.018	.959	.020	7.26	3	1042	< .001
Infant birth weight (grams)	.000	.000	-.074	-2.42	.016	1.00								
Maternal age (years)	.022	.007	.093	3.03	.003	1.00								
Step 2														
Infant age (months)	.063	.017	.122	3.63	< .001	1.20	.032	.026	.955	.011	4.01	3	1039	.008
Infant birth weight (grams)	.000	.000	-.066	-2.14	.033	1.01								
Maternal age (years)	.018	.007	.078	2.53	.012	1.02								
% family-food feeding§	-.003	.001	-.089	-2.35	.019	1.55								
% purée feeding§	.001	.001	.037	.954	.340	1.65								
% spoon feeding§	.000	.001	.006	.167	.868	1.56								

§ Response options were 100%, 90%, 75%, 50%, 25%, 10% and 0%.

Table 5
Hierarchical Regression Analysis of predictors of infant's first Crawling (months).

Variable	B	SE B	Beta	t	VIF	P	R ²	Adj R ²	SE	Δ R ²	Δ F	df1	df2	p
Step 1														
Infant age (months)	.488	.029	.545	16.6	1.03	< .001	.290	.288	1.23	.290	138.7	2	679	< .001
Breastfeeding (months)	-.028	.020	-.046	-1.40	1.03	.161								
Step 2														
Infant age (months)	.508	.031	.567	16.4	1.15	< .001	.300	.295	1.23	.010	3.10	3	676	.026
Breastfeeding (months)	-.020	.020	-.032	-.98	1.06	.328								
% family-food-feeding§	-.003	.002	-.065	-1.69	1.51	.108								
% purée-feeding§	-.002	.002	-.043	-1.08	1.63	.150								
% spoon-feeding§	.004	.002	.088	2.25	1.56	.037								

§ Response options were 100%, 90%, 75%, 50%, 25%, 10% and 0%.

Table 6
Hierarchical Regression Analysis of predictors of infant's Utterance of First Words (months).

Variable	B	SE B	Beta	t	p	VIF	R ²	Adj R ²	SE	Δ R ²	Δ F	df1	df2	p
Step 1														
Infant age (months)	.567	.041	.514	13.7	< .001	1.0	.275	.272	1.54	.275	98.4	2	520	< .001
Maternal education#	.181	.072	.093	2.50	.013	1.0								
Step 2														
Infant age (months)	.542	.045	.491	12.1	< .001	1.18	.280	.273	1.54	.005	1.28	3	517	.279
Maternal education#	.201	.073	.104	2.74	.006	1.02								
% family-food-feeding§	.003	.003	.053	1.17	.240	1.47								
% purée-feeding§	.002	.003	.033	.680	.497	1.67								
% spoon-feeding§	-.003	.003	-.056	-1.19	.233	1.60								

High school or below, Vocational or Bachelor's, Master's, PhD.

§ Response options were 100%, 90%, 75%, 50%, 25%, 10% and 0%.

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present study, we defined participants as following a BLW approach if they spoon fed or offered puréed foods ≤10% of the time (as reported by [Brown & Lee, 2011](#)), or offered the same food eaten by the rest of the family ≥90% of the time (to account for the importance of sharing family meals highlighted by the Italian version of BLW, labeled “on-demand complementary feeding”; [Piermarini, 2002, 2006, 2020](#)). The inverse correlations between the frequency of family-food feeding and both spoon feeding and purée feeding suggest that a BLW approach may be accounted for by all three components. Thus, a third definition of BLW based on percentage of family-food feeding may well represent the variability and complexity of feeding practices potentially affecting infants' health and development. Not surprisingly, only about 7% of the participants simultaneously adhered to all the above three possible criteria of defining a BLW approach. This is a similar percentage to that reported in another study using an Italian sample, in which parents were asked to report the feeding practices employed with their infants ([Lacorte et al., 2018](#)), and is similar to that reported by [Cameron et al. \(2013\)](#) in a New Zealand sample, in which BLW was defined only as

infant self-feeding.

In a previous study in which the frequency of BLW was assessed in a UK sample ([Brown & Lee, 2011](#)), the low spoon-feeding group and the low purée-feeding group included 52% and 57% of the participants respectively. In contrast, our Italian sample largely relied on spoon feeding (only about 10% of the participants were defined as using a BLW approach based on low reliance on spoon feeding) and, to a lesser extent, on purée feeding (33% of the participants). The latter findings may be explained by cultural differences between Italian and UK populations, with Italian mothers possibly feeling more personally responsible for actively feeding their infants. In a cross-cultural study on parenting in Italian and U.S. populations, Italian mothers displayed greater affective behavior and physical contact during feeding than American mothers ([Hsu & Lavelli, 2005](#)). Despite the overall large reliance of Italian participants on spoon feeding, in Italy eating is a largely social activity ([Ochs & Shohet, 2006](#)) and Italian mothers show higher level of co-eating with their children compared to British mothers ([Costantini, Akehurst, Reddy, & Fasulo, 2018](#)). All these factors may explain why the

Italian version of BLW (“on-demand complementary feeding”) is mainly focused on the importance of the infant signaling to the adults his/her interest in food and eating family food (i.e., the same food eaten by the other family members) in the context of the family meal (Piermarini, 2002, 2006, 2020). Indeed, in our sample about 40% of the children were fed family food at least 90% of the time, which seems to indicate that this aspect of infant feeding is prevalent when considering the BLW approach in Italy. However, the evidence is still scant and future studies should investigate whether infant feeding on family foods and sharing family meals are aspects that vary cross-culturally.

Children belonging to the high purée-feeding group had a slightly lower birth weight than children belonging to the low purée-feeding group. Thus, perhaps mothers perceived their children as more in need of being fed, as they were born with a lower birth weight, and they were more inclined to use purée feeding to ensure that their infants consumed enough food. Similarly, other studies have reported that mothers of infants with lighter birth weights introduced solid foods earlier than mothers with heavier born infants, probably because the former perceived their infants as hungrier than the latter (Caton, Ahern, & Hetherington, 2011; Costantini, Harris, Reddy, Akehurst, & Fasulo, 2019; Hodges, Hughes, Hopkinson, & Fisher, 2008).

Mothers belonging to the low spoon-feeding group were less likely to be employed than mothers belonging to the high spoon-feeding group. Similarly, mothers belonging to the low purée-feeding group and to the high family-food-feeding group returned to work later than mothers belonging to the corresponding non-BLW groups (as previously observed by Brown & Lee, 2011 in the UK). It appears that maternal employment and timing of return to work after birth are important factors associated to weaning, with the BLW approach possibly being perceived as taking longer or being more demanding (for instance in terms of cleaning up after the infant has eaten) than the PLW approach, thus leading working mothers to prefer spoon feeding and purée feeding. Moreover, mothers belonging to the high family-food-feeding group had a lower income than mothers belonging to the low family-food-feeding group. The fact that mothers with a lower income are more inclined to offer their infants the food eaten by the rest of the family suggests that parents may perceive BLW as yielding a potential economic advantage, as recently reported in a sample from New Zealand (Bacchus et al., 2020).

As in previous research (Brown & Lee, 2011; Cameron et al., 2013; Fu et al., 2018; Morison et al., 2016), breastfeeding and a BLW approach were significantly related. BLW mothers breastfed significantly longer and were more likely to be still breastfeeding compared to non-BLW mothers. Moreover, the majority of participants (65%) reported waiting until the infant was at least six months old before introducing complementary foods. This is a higher percentage compared to previous data from both a cohort of 400 infants from Northern Italy (Carletti, Pani, Monasta, Knowles, & Cattaneo, 2017) and a cohort of 655 UK infants (Brown & Lee, 2011), where only 14% and 34% of participants, respectively, were introduced complementary foods after six months of age. This probably indicates that, over the years, there is a progressive shift towards complying with the WHO recommendations of waiting until six months of age (World Health Organization, 2014). However, we cannot exclude that our self-selected sample may be somewhat biased towards more informed and compliant mothers. As reported in previous studies (Brown et al., 2017; Cameron et al., 2013; Morison et al., 2016), mothers following a BLW approach generally introduced complementary foods later than non-BLW mothers. Thus, the current data confirm that there is a positive association between a BLW approach and a delayed introduction of solid foods up to around six months of age.

Moreover, as reported by Brown and Lee (2011), BLW infants started to eat finger foods earlier than non-BLW infants. These findings suggest an earlier autonomy in self-feeding by BLW infants, that may result in a higher nutrient intake (Carruth, Ziegler, Gordon, & Hendricks, 2004), help to prevent later feeding issues (Northstone, Emmett, & Nethersole, 2001) and difficulties in food acceptance (Coulthard, Harris, & Emmett, 2009), and even lead to an advantage in development (as suggested by

Rapley, 2005).

As for the latter, one of the main goals of the current study was to assess whether BLW is associated with motor and language development (Rapley, 2005), which may provide information to further explore the potential implications of a BLW approach for developmental domains beyond infant eating behavior. It emerged that both family-food feeding and spoon feeding were associated with an earlier motor development: percentage of family-food feeding was significantly related to sitting unsupported at an earlier age and a low spoon-feeding style was significantly related to crawling at an earlier age. Of course, from our data it is not possible to establish a causal relationship between complementary feeding style and infant development. However, the negative relationships between family-food feeding and the age of first sitting unsupported, which is considered a prerequisite to begin the introduction of complementary foods, may suggest that infants’ developmental readiness may lead parents to opt for a BLW approach, rather than a BLW approach positively influencing infants’ motor development. Nonetheless, given the relationship between spoon-feeding and the age of first crawling, it cannot be excluded that the interactions infants have with food several weeks before they actually ingest it, which is typical of a BLW approach, may provide them with experiences that could affect their cognitive and motor development (Rapley, 2018a).

It has also been hypothesized that a BLW approach may promote language development (Rapley, 2005) through two not necessarily mutually exclusive patterns. Firstly, the early experience of manipulating and chewing food (Rapley, 2018b) leads children to using oral-motor and fine-motor skills which are related to language development (Alcock, 2006; Gernsbacher, Sauer, Geye, Scheigert, & Goldsmith, 2008; LeBarton & Iverson, 2016). Secondly, eating together with other family members in a positive context (Brown & Lee, 2011) may provide important opportunities for exposure and modeling of language and vocabulary (Weizman & Snow, 2001; Zimmerman, Connaghan, Hoover, Alu, & Peters, 2019). Indeed, a very recent study found that an approach to complementary feeding which promotes eating unaided, rather than being fed puréed foods, is related to more advanced child language production and comprehension at 8–24 months of age (Webber et al., in press). In contrast, despite the positive relationship between a BLW approach and the frequencies of infant’s interest in family food and shared family meals, the current study did not observe a positive relationship between a BLW approach and the age at which infants uttered their first words, probably because our sample included 6-12-month-olds, thus comprising many participants who were not yet developmentally ready to speak. Future studies should examine language development in greater depth, by directly recording children’s speech, possibly in a longitudinal sample extending up to toddlerhood and beyond.

Strengths of this study include that it is one of the first Italian investigations on the use of a BLW approach. Additionally, it contributes to the lively debate about the need to reach a comprehensive definition of BLW, and it provides preliminary data on the association between the complementary feeding approach and some developmental milestones. However, our study has also several limitations. Firstly, we employed a cross-sectional, web survey and relied on maternal recall and self-report, using novel and unvalidated instruments, to assess infants’ motor and language development. Secondly, we had to exclude from the analyses about 46% of participants who did not achieve 80% completion. Although this percentage is comparable to other similar surveys (e.g., Alpers, Blackwell, & Clegg, 2019), we cannot be sure whether the sample of participants who completed at least 80% of the survey had different characteristics (e.g., education level, income, etc.) from the sample of participants who did not do so, potentially influencing our findings. Finally, the effects we found were small for the comparisons between infants exposed to different complementary feeding approaches and the relationships between a BLW approach and developmental milestones.

Nonetheless, the information gained in this study may be useful for

developing specific hypotheses on the relationships between complementary feeding approaches and infant development, which will be specifically tested in future, more comprehensive, experimental studies. If a positive, meaningful relationship between a BLW approach and the achievement of developmental milestones (controlling for potential extraneous variables) is confirmed, this information may promote the diffusion of BLW among parents and professionals. A complementary feeding approach that encourages the early involvement of the infant within the context of the family meals and an early exposure to the food eaten by the rest of the family may lead to a more positive relationship with food and eating activities well beyond the complementary feeding period.

In conclusion, we evaluated the variability in infant feeding practices and the possible associations with developmental milestones in an Italian population. Our data suggest that BLW may be a multifaceted approach simultaneously defined by low spoon and purée feeding and high family-food feeding, although not all these three components may be present at the same time. As in previous studies, the frequency of a BLW approach was positively related with breastfeeding, later exposure to complementary foods, earlier exposure to both finger and family foods, and higher interest in family food and shared family meals. Finally, family-food feeding was associated with sitting unsupported and a low spoon-feeding style was associated with crawling at an earlier age, but none of the feeding measures were associated with the age at which infants uttered their first words. These findings suggest the need to know more about whether infant feeding practices have the potential to influence not only diet quality and eating behavior, but also cognitive and motor development, which is an aspect that future longitudinal studies should specifically target.

Declaration of competing interest

The Authors declare no conflict of interests.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.appet.2021.105286>.

Author contributions

EA and AG conceived the study and developed the survey. FB and CF provided advice about the research design and survey. EA, AP and HB collected the data. EA and TW analyzed the data. EA and AG drafted the manuscript. All authors provided feedback on the manuscript and approved the published version.

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