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MILK CONSUMPTION IN CHILDHOOD AND ADULTHOOD AND ITS EFFECT ON BODY COMPOSITION

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ABSTRACT

Throughout their life, people are exposed to many different types of milk. First, it is breast milk if infants are breastfed or special formula based on cow milk with modified composition if they are not breastfed. Later in life, it is recommended that humans consume the milk of other mammals as a source of highly valuable protein, calcium, and phosphorus. This work aimed to evaluate the effects of methods and duration of feeding in infancy and consumption of milk or milk alternatives in adulthood on body composition. We used a questionnaire of 21 specific questions to obtain information on breastfeeding and milk consumption. All 84 participants (18 men, 66 women; age 23.26 ±1.36) underwent measurement of body composition, using BIA methods (InBody 720). A comparison of the information from the questionnaire with the information from the body composition measurement was made. Significant differences were observed in visceral fat area (p = 0.048) and waist-to-hip ratio (p = 0.022) according to duration of breastfeeding. Participants who were fed formula for a shorter time than 1 year (until 12 months of age) showed a higher percentage of body fat (p = 0.047). The fat percentage of milk was a significant factor for the waist-to-hip ratio (p = 0.026). Participants consuming plant-based milk alternatives showed significant differences in waist-to-hip ratio (p = 0.031) and body mass index (p = 0.015) and highly significant differences in weight (p <0.001) and fat-free mass (p <0.001). In conclusion, results show that the duration of breastfeeding may prevent the development of overweight and eventually obesity. Usage of infant formulas as an alternative to breast milk should be limited to those who are unable to breastfeed. The current consumption of milk indicates the benefits of whole milk in the diet but also shows increasing interest in the advantages of plant-based milk.

Keywords: milk; breastfeeding; plant-based milk; body composition; milk fat percentage

INTRODUCTION

From the very first day of their life, humans are introduced to milk. They are exposed to breast milk or formula as the only sustenance until 6 months of age. Breastfeeding should then continue up to 2 years of age and beyond, but children should also begin to eat adequate complementary foods as recommended by the WHO **(WHO, 2011)**. Human milk composition is dynamic and varies daily, during a feeding, based on the lactation stage, between mothers and populations. The mean macronutrient composition of mature milk is estimated to be approximately 0.9 to 1.5 g of protein, 3.2 to 3.6 g of fat, and 6.7 to 7.8 g of carbohydrates, mainly lactose (6.5g) in 100 ml. Energy is estimated to range from 65 to 70 kcal (270 to 295 kJ) in 100 ml and is highly correlated with the fat content of human milk. Macronutrient composition differs; preterm milk tending to be higher in protein and fat **(Ballard and Morrow, 2013)**. Mineral content is approximately 0.2g, represented by calcium, phosphorus, sodium, potassium, magnesium, and iron. Vitamins present in the milk include A, D, E, C, and B vitamins, but human milk is deficient in vitamin K **(Bernier, Adrian, and Vidon, 1988)**. Breastfeeding provides many positives for both infants and mothers: decreased postpartum bleeding and faster uterine involution caused by increased concentrations of oxytocin, decreased menstrual blood loss and increased child spacing attributable to lactational amenorrhea, earlier return to pre-pregnancy weight, decreased risk of breast cancer, decreased risk of ovarian cancer, and possible decreased risk of hip fractures and osteoporosis in the postmenopausal period **(American Academy of Pediatrics, 2005)**. Known effects in infants include a decrease in child morbidity and mortality; protection against diarrhea, respiratory infections, and otitis media; and a possible 68% reduction of malocclusion in children **(Victora et al., 2016)**. There are also positive effects on cognitive skills, which determine educational outcomes, and on knowledge and skill accumulation during both childhood and adult life. Longer breastfeeding duration is also associated with decreased autistic traits and decreases the risk of overweight and obesity in adulthood **(Victora et al., 2016; Boucher et al., 2017)**. However, breastfeeding for longer than 12 months or during the night increases the risk of dental caries in

deciduous teeth **(Tham et al., 2015)**. Despite all the positive effects, many infants and children do not receive optimal feeding. WHO reports that only about 44% of infants aged 0 – 6 months worldwide were exclusively breastfed throughout 2015 – 2020 **(WHO, 2020)**. Unfortunately, some mothers are not able to breastfeed. Known alternatives include human milk provided by milk banks or infant formulas. The main ingredient of an infant formula is usually cow milk, which must be modified because of its different composition than human milk **(Blanchard, Zhu and Schuck, 2013)**. The composition of infant formula is defined by The European Union Commission Directive (2006) concerning infant formula that applies to all member states **(European Commission, 2006)**. Nevertheless, formula-fed infants face a higher risk of diseases due to a lack of specific and innate immune factors present in human milk **(Stuebe, 2009)**. Later in life, it is recommended that people continue to have milk intake, most frequently cow milk, because it contains several essential nutrients **(Haas et al., 2019)**. Cow milk is proposed as a useful eatable, mainly during childhood and adolescence, when its content of calcium (125 mg per 100 ml), the protein of high biological value (3.5 g per 100 ml), phosphorus (100 mg per 100 ml), and other micronutrients promotes skeletal, muscular, and neurological development **(Blanchard, Zhu and Schuck, 2013; Visioli and Strata, 2014)**. However, its relatively high-fat content (approximately 70% SFAs; myristic and palmitic acids combined account for ~50%, the remainder are mostly short- and medium-chain FAs and oleic acid) has marked it as potentially detrimental food, especially in connection to cardiovascular health **(Visioli and Strata, 2014; Juráček et al., 2020)**. Furthermore, due to widespread health issues linked to milk consumption, such as lactose intolerance or milk allergies, and lifestyle changes, an alternative market for plant-based milk is emerging **(Chalupa-Krebzdak, Long and Bohrer, 2018)**. Plant-based milk alternatives are fluids made from ground plant matter (cereals, pseudo-cereals, legumes, oilseeds, nuts) extracted in water. Further homogenization is necessary and results in particle size distribution in the range of 5–20 μm, which imitates cow milk appearance and consistency **(Sethi, Tyagi and Anurag, 2016)**.

Scientific hypothesis

Many studies confirm and highlight the beneficial effects of breastfeeding on health in later life. This study aimed to determine whether breastfeeding in childhood affects the development of body composition and to observe differences between breastfed and formula-fed participants. We also try to refute the stigma that consuming whole milk is not suitable for maintaining optimal body weight and body fat.

MATERIAL AND METHODOLOGY

We examined the relationship between breastfeeding in childhood, milk and milk alternatives consumption, and body composition in adulthood. A questionnaire method was used to obtain information on breastfeeding in infancy and the current consumption of milk and milk alternatives. Each participant completed the questionnaire alone and anonymously. The survey involved 84 participants, 18 men (21%), and 66 women (79%). The average age of the participants was 23.26 ±1.36. The questionnaire consisted of questions on gender, age, educational level, health status, and certain anthropometric parameters, and 21 specific questions on milk consumption. Body composition data were obtained using InBody 720 (Biospace Co. Ltd., Seoul, Republic of Korea), a multi-frequency bioelectrical impedance analyzer (BIA). Measured parameters included body weight (kg), FM (fat mass, kg), FFM (fat-free mass, kg), percentage of body fat (%), VFA (visceral fat area, cm^2), WHR (waist-to-hip ratio), and BMI (body mass index). We compared the information from the questionnaire with the information from the body composition measurements. Participants undergoing measurements using BIA were healthy, without a pacemaker. None of the women were pregnant. All participants provided written consent to the bioelectrical impedance measurement.

Statistical analysis

Statistical analysis was carried out using MS Excel 2010 (Los Angeles, CA, USA) and STATISTICA Cz version 10 (**TIBCO Software Inc., Palo Alto, California, USA**). Data were expressed in **Figure 1** and **Figure 2** as a mean ± standard deviation (SD), minimum, maximum, median, and mode were calculated. Statistical comparisons between groups were made utilizing a one-way analysis of variance (ANOVA) followed by Tukey's post hoc test. Significance levels were determined as p <0.05 (*), p <0.01 (**), and p <0.001 (***).

Table 1 Mean values of selected anthropometric parameters according to the duration of breastfeeding

Duration of breastfeeding	Anthropometric parameter						
	Weight [kg]	FFM [kg]	FM [kg]	Percentage of body fat [%]	VFA [cm^2]	WHR -	BMI [kg/m^2]
<4 months	70.66	49.94	20.72	27.46	78.60[1]	0.87[1]	24.35
4 – 6 months	65.34	49.85	18.49	23.86	62.80	0.85	22.80
6 – 12 months	67.40	50.82	16.58	24.56	67.26	0.85	23.13
>12 months	59.75	46.52	13.23	21.92	52.12[1]	0.82[1]	20.99

Note: [1]p <0.05 was considered statistically significant.

RESULTS AND DISCUSSION

Breastfeeding

We compared the participants who were breastfed as infants with those not breastfed and investigated the potential effect of breastfeeding on body composition. The differences were not significant, which could be due to the uneven distribution of participants, breastfed (n = 80), and non-breastfed (n = 4). However, breastfeeding may have a small but consistent protective effect on obesity prevention, as indicated by a meta-analysis of 9 studies with more than 69,000 subjects, concluding that breastfeeding significantly reduces the risk of developing obesity in adult humans (Arenz et al., 2004). Some studies suggest that breastfed infants tend to have lower FM when compared with formula-fed infants. When we examined the FM to weight and FM to lean body mass ratio, breastfed infants showed lower values. Formula-fed infants tend to have a lower lean body mass to body weight ratio (Pludowski et al., 2009). Breastfeeding directly from the breast appears to be the safest way for children to receive breast milk. It protects against obesity, as these children have the least chance of being overfed. In infants fed breast milk from a bottle, the risk is higher but still low, as breast milk helps to create an intestinal microbiome that is likely to help prevent obesity **(Azad et al., 2018)**. Breastfeeding protects against overweight and obesity in children by inducing lower plasma insulin levels, thereby reducing fat storage and preventing excessive early adipocyte development **(Oddy, 2012)**. Significant differences in body composition depending on the duration of breastfeeding in childhood were observed for VFA (p = 0.048; **Figure 1**) and WHR (p = 0.022). In both cases, there was a significant difference between participants breastfed for less than 4 months and those breastfed for more than 12 months. Higher mean values of VFA and WHR were present in participants breastfed for less than 4 months **(Table 1)** and therefore did not meet the WHO recommendations of min. 6 months of breastfeeding **(WHO, 2011)**. This finding agrees with the claim that infants breastfed longer (6 months or longer) have a reduced risk of developing overweight and obesity **(Victora et al., 2016)**. Long-term breastfeeding is directly related to a decreased risk of obesity **(Yan et al., 2014)**. The recorded changes in other measured parameters were not significant, but they were visible in the graphic display. Participants who were not breastfed were fed formula, which replaced breast milk. The use of infant formula increases the risk of childhood obesity due to overfeeding, and childhood obesity is often carried into adulthood **(Azad et al., 2018)**. We observed significant differences in the percentage of body fat in the group of formula-fed participants. Participants fed for only 1 year (until 12 months of age) showed higher values when compared to participants fed for 1.5 years (until 18 months of age) (26.02% to 19.16 %, respectively; p = 0.47). Exclusive breastfeeding prevents improper dietary practices, such as the early introduction of complementary foods, which could lead to unhealthy weight gain. Protein and total energy intake are higher in formula-fed infants compared to breastfed infants, which is positively associated with the development of obesity later in childhood **(WHO, 2014)**, leading to an increase in total cholesterol in adulthood **(Owen et al., 2008)**. Unfortunately, infant formula, which should be considered a specialized food that is vital for children who cannot be breastfed, is becoming a regular meal for children due to promotion and marketing **(McFadden et al., 2016)**.

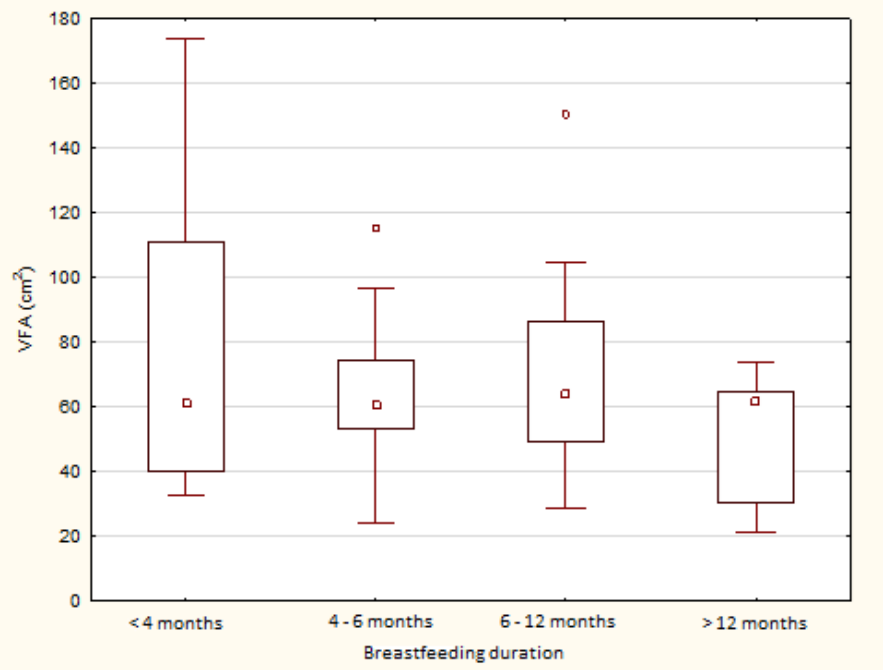

Figure 1 Differences in VFA according to duration of breastfeeding in infancy.

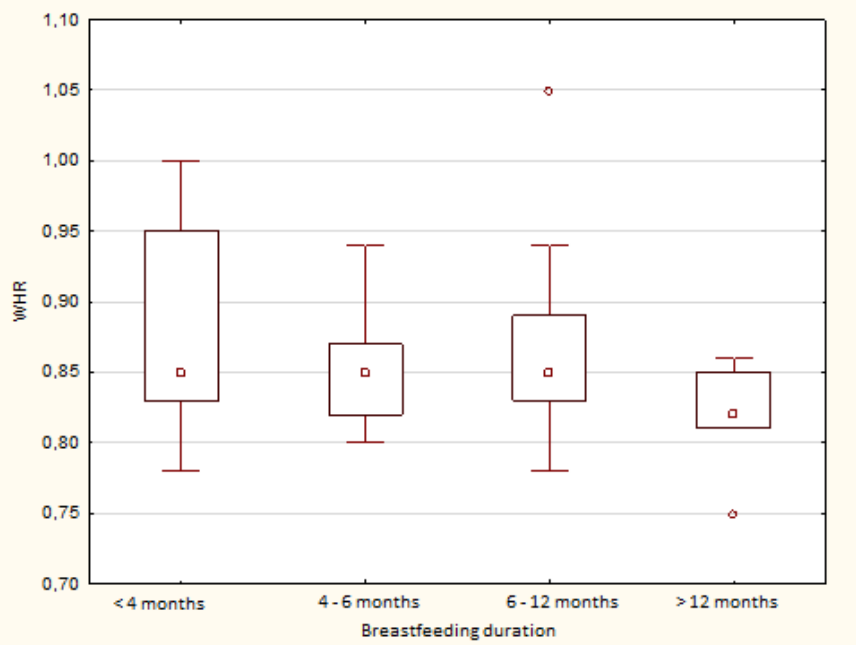

Figure 2 Differences in WHR according to duration of breastfeeding in infancy.

Current milk consumption

We investigated the effects of current milk consumption in participants on body composition. Participants were divided into 2 groups, consumers, and non-consumers of milk. We did not find any significant differences; in fact, the values of anthropometric parameters were very similar **(Table 2)**. Available scientific evidence suggests that consumption of milk and dairy products does not adversely affect body weight or body composition **(Spence, Cifelli and Miller 2011; Schwingshackl et al., 2016)**. Most of the cross-sectional and prospective studies suggest a favorable relationship between milk consumption, body weight, and body composition in children and adolescents. Also, milk is an important source of calcium, vitamin D, phosphorus, and potassium in the diet of children aged 2 to 18 **(Spence, Cifelli, and Miller 2011)**. Following the milk consumption analysis, we paid separate attention to the fat percentage in milk, according to the possibilities available on the market (fat content 0.5%; 1.5%; 3.5%). We observed a significant difference in WHR between the groups consuming milk with a fat content of 1.5% and 3.5% (0.86 and 0.83, respectively; $p = 0.026$; **Figure 2**). A higher percentage of fat in milk is inversely related to weight gain and thus is not a factor for the development of overweight and obesity **(Rautiainen et al., 2016)**. Today, many people succumb to the phenomenon of plant-based milk because of health or other reasons. Therefore, we also monitored the effect of these beverages on body composition and its parameters. The mean values of anthropometric parameters according to the consumption of plant-based milk are shown in **Table 3**. We observed statistically significant differences in the parameters of

Table 2 Mean values of selected anthropometric parameters according to current consumption of milk.

Participants	Anthropometric parameters						
	Weight [kg]	**FFM [kg]**	**FM [kg]**	**Percentage of body fat [%]**	**VFA [cm^2]**	**WHR -**	**BMI [kg/m^2]**
Consumers	67.15	50.26	16.90	24.62	67.01	0.86	23.11
Non-consumers	64.37	48.83	15.54	24.3	62.71	0.85	22.79

Table 3 Mean values of selected anthropometric parameters according to current consumption of plant-based milk.

Participants	Anthropometric parameters						
	Weight [kg]	**FFM [kg]**	**FM [kg]**	**Percentage of body fat [%]**	**VFA [cm^2]**	**WHR -**	**BMI [kg/m^2]**
Consumers	59.51[2]	44.49[2]	15.2	24.74	60.55	0.84[1]	21.86[1]
Non-consumers	77.98[2]	61.00[2]	16.98	22.3	68.75	0.89[1]	25.38[1]

Note: [1]differences at $p < 0.05$ were considered significant, [2]differences at $p < 0.001$ were considered highly significant.

weight and FFM. Mean body weight in participants consuming plant-based milk alternatives was 59.5 kg and those who did not consume plant-based milk 77.98 kg (p <0.001). Similarly, the mean FFM of consumers was 44.49 kg and of non-consumers 61.00 kg (p <0.001). Significant differences were also noted for WHR (0.84 to 0.89 respectively; p = 0.031) and BMI (21.86 vs. 25.38, respectively; p = 0.015). These differences may be due to the different nutritional composition of plant alternatives to milk, in particular their lower energy content. It is not recommended to use these beverages as substitutes for cow milk **(Singhal, Baker and Baker, 2017; Vanga and Raghavan, 2018)**, even though calcium-fortified soy beverage is comparable to cow milk in its macronutrient content **(Silva, Silva and Ribeiro, 2020)**.

CONCLUSION

We did not observe significant differences between breastfed and non-breastfed participants, but in those who were breastfed as infants, the duration of this period played a significant role. Significant differences were detected in VFA (p = 0.048) and WHR (p = 0.022) between participants breastfed for less than 4 months and breastfed for more than 12 months. This finding is consistent with the WHO recommendations and the benefits of breastfeeding. Participants that were formula-fed as infants showed a higher percentage of body fat (p = 0.047) when fed for less than 1 year (12 months). Consumption of milk did not cause significant differences in body composition. However, the fat percentage of milk was a significant factor for WHR (p = 0.026), refuting claims that whole milk is a detrimental food. Participants consuming plant-based milk alternatives showed significant differences in WHR (p = 0.031) and BMI (p = 0.015) and highly significant differences in weight (p <0.001) and FFM (p <0.001). Those differences are most likely due to the lower energy content of these beverages and various protein and fat compositions based on the raw materials used for production.

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