Growth of infants in relation to type of feeding in Jahrom, Islamic Republic of Iran

F. Emamghorashi[1] and S.T. Heydari[2]

نموّ الرضَّع تبعاً لنمط التغذية في مدينة جهرم الإيرانية

فاطمة إمام قرشي، سيد تقي حيدري

الخلاصة: قام الباحثان بتقييم نمو 597 من الرضَّع الذين تقلُّ أعمارهم عن 24 شهراً، ممَّن يراجعون المراكز الصحية في مدينة جهرم، في ضوء نمط تغذيتهم. كما قارنا بين منحنيات النمو المستخدَمة من قبلهما وبين منحنيات المركز الوطني للإحصاءات الصحية. وقد قُسِّم الرضَّع إلى ثلاث مجموعات: مجموعة تقتصر على الرضاعة من الثدي، ومجموعة تقتصر على التغذية من الزجاجة، ومجموعة تستخدم كلا النمطَيْن، وتم تقييم المجموعات الثلاث كل شهر خلال السنة الأولى، وكل شهرَيْن في السنة الثانية. ولم تُلاحَظ فروق يُعْتدُّ بها إحصائياً بين المجموعات من حيث الطول والوزن في الأشهر القليلة الأولى بعد الولادة؛ ولكن تبيَّن بعد ذلك زيادة وزن وطول الرضَّع الذين يرضعون من الثدي زيادةً يُعتدُّ بها إحصائياً. وكانت متوسطات أوزان وأطوال الرضَّع المدروسين أقلَّ من متوسطات الوزن والطول في المركز الوطني للإحصاءات الصحية.

ABSTRACT We evaluated the growth of 597 infants < 24 months attending health centres in Jahrom according to type of infant feeding. We also compared our growth curves with those of the National Center for Health Statistics (NCHS). The infants were divided to 3 groups: exclusively breastfed, exclusively bottle-fed and both breast- and bottle-fed and were assessed monthly for the first year and every 2 months in the second year. There were no significant differences between the groups in height and weight in the first few months of birth; later, breastfed infants were significantly heavier and taller. The mean heights and weights of our infants were lower that those for NCHS.

Croissance du nourrisson en fonction du type d'alimentation à Jahrom en République islamique d'Iran

RÉSUME En fonction du type d'alimentation du nourrisson, nous avons évalué la croissance de 597 enfants âgés de moins de 24 mois consultant les centres de santé de Jahrom. Nous avons en outre comparé nos courbes de croissance à celles du *National Center for Health Statistics* (NCHS, Centre national des statistiques de santé). Les nourrissons ont été répartis en trois groupes : allaitement au sein exclusif, allaitement exclusivement au biberon, allaitement mixte au sein et au biberon. Ces nourrissons ont fait l'objet d'une évaluation mensuelle au cours de leur première année de vie et tous les 2 mois au cours de la deuxième année. Les groupes n'ont laissé apparaître aucune différence en termes de taille et de poids pendant les tout premiers mois suivant la naissance. Par la suite, les enfants nourris au sein ont affiché une taille et un poids supérieurs. La taille et le poids moyens des nourrissons participant à notre étude se sont avérés inférieurs à ceux enregistrés par le NCHS.

[1]*Department of Paediatrics, Jahrom School of Medical Science, Jahrom, Islamic Republic of Iran (Correspondence to F. Emamghorashi: ghoraishy@yahoo.com).*
[2]*Gastro-Entero-Hepathology Research Centre, Shiraz University of Medical Sciences, Shiraz, Islamic Republic of Iran.*
Received: 26/07/05; accepted: 31/10/05

Introduction

Normal growth needs appropriate nutrition. In the first months of birth, breastfeeding is without doubt the most important feeding method which has value both immunologically and psychologically, in addition to providing adequate nutrition. Breastfeeding has familial, social and infantile significance [*1–5*]. In the first year, especially the first 6 months, when infants have rapid growth, regular anthropometric measurements are appropriate for growth monitoring [*3*].

Many studies have shown differences in the growth pattern of breast- and bottle-fed infants. Breastfed infants had ideal growth before 3 months of age, but from 4 to 6 months, weight gain for age is slower, especially in developing countries [*1–4,6*]. In countries with children living in favourable conditions and fed according to World Health Organization (WHO) recommendations, there was also a deviation from standard growth curves [*7*]. Therefore, it has been recommended that new growth charts be designed for breastfed infants [*8,9*]. Because of weaning protocols in different countries, genetic differences and different types of complementary foods, it has also been suggested that local charts should be developed for growth monitoring in infants for each region and for breast- and bottle-fed infants [*10*]. The aim of the present study was to compare growth patterns of breastfed and bottle-fed infants in Jahrom city, Islamic Republic of Iran and to compare these patterns with the National Center for Health Statistics (NCHS) growth charts [*11*].

Methods

This was a prospective study of children born in Jahrom conducted from April 2001 to December 2002. The children were attending Jahrom health centres for routine health care. Inclusion criteria were: birth weight > 2500 g, gestational age at birth 37–42 weeks, and absence of any congenital anomalies. The height and weight of these infants were recorded 18 times from 1 month to 2 years of age by trained personnel (every month up to 1 year and every 2 months up to 2 years of age). The children's length was measured in a prone position before walking and then in a standing position. Weight was measured with a precision of 10 g and height with a precision of 1 cm. The ages of children were recorded at each attendance at the centre.

The infants were divided to 3 groups based on feeding type: exclusively breastfed, exclusively bottle-fed and both breast- and bottle-fed (combined). Infants who were breastfed for the first 4 months of age with only vitamin drops given additionally were defined as exclusively breastfed [*12*]. Types and time of complementary food introduction were recorded at each visit. Based on social and local habits and guidelines of health centres, complementary foods usually included beans, vegetables, meat, eggs and fruit juice.

In order to estimate the children's weight and height percentiles based on age, the Healy, Rasbash, Yang (HRY) non-parametric method was used [*13*]. Percentiles related to age in the HRY method were evaluated and then a multiphase pattern was used to smooth the percentiles. This is a non-parametric method and there is no need to assume normal distribution of the data. Smooth and non-smooth quantiles were evaluated according to age using GROSTAT software [*14*]. *SPSS*, version 11.5 was used for statistical analysis and *t*-test and ANOVA were computed. $P < 0.05$ was considered significant.

Results

Our study included 597 children (391 boys and 206 girls) aged 0–2 years. Of these, 404 were exclusively breastfed, 46 were bottle-fed and 92 were both breast- and bottle-fed. Maternal and neonatal characteristics are shown in Table 1 according to the 3 groups.

Table 2 shows the mean weight of the infants by age and type of feeding. Up to 2 months of age, there was no significant difference in the mean weights between the 3 groups; however exclusively breastfed infants had a statistically significant greater weight gain than the 2 other groups from 3 to 10 months of age.

Table 3 shows the mean height of the infants according to age and type of feeding. Up to 3 months of age, there was no statistically significant difference in mean heights between the 3 groups; however breastfed infants were taller than the other 2 groups from 4 to 18 months of age although this was not always statistically significant. After 18 months the 2 other groups of infants were taller but this was not significant.

Figures 1–4 show the comparison of weight and height between the 3 groups in the present study and NCHS data by sex. Figures 1 and 2 show a favourable weight gain in the first months in comparison with NCHS measurements, but over time the weight gain in our sample slowed and the mean weight fell below that of the NCHS data. While the mean height of our sample after 1–2 months was lower than the NCHS data, the heights followed a similar curve over time.

Discussion

Many studies have been conducted about the relation between growth and types of feeding in infants. Kramer and co-workers in Canada in 2004 confirmed the growth-accelerating effects of formula and other milks (versus breast milk) on weight and length gain throughout infancy, with a dose–response gradient and the largest associations observed at 3 to 6 months of age [*15*]. The study of Baker and colleagues in America in 2004 showed

Table 1 **Characteristics of the mothers and infants by type of feeding**

	Breast-feeding	Bottle-feeding	Combined feeding
No. (%) in 6 months	404 (74.5)	46 (8.5)	92 (17.0)
No. (%) in 12 months	328 (65.4)	73 (14.6)	100 (20.0)
Mean age of mothers (years)	28.8	30.6	30.5
Vaginal delivery (%)	71.7	71.7	66.3
Mean birth weight (kg)	3.27	3.15	3.27

Table 2 **Mean weight of infants by age and type of feeding**

Age (months)	Mean weight (SD) (kg)			*F*	*P*-value
	Breast-feeding	Bottle-feeding	Combined feeding		
1	4.20 (0.87)	3.95 (0.48)	4.43 (0.95)	0.43	0.34
2	4.69 (0.76)	4.22 (0.73)	4.72 (0.87)	2.44	0.088
3	5.55 (0.81)[b]	5.29 (0.82)	5.23 (0.90)[a]	4.34	0.013
4	6.33 (0.83)[a]	5.88 (0.82)[b]	5.57 (0.97)[b]	16.32	< 0.001
5	6.94 (88)[a]	6.48 (0.81)[b]	6.42 (0.87)[b]	15.78	< 0.001
6	7.45 (0.90)[a]	7.06 (0.92)[b]	6.97 (0.81)[b]	13.34	< 0.001
7	7.84 (0.95)[a]	7.46 (0.87)[b]	7.38 (0.86)[b]	11.37	< 0.001
8	8.17 (1.03)[a]	7.87 (1.07)[b]	7.72 (0.86)[b]	9.06	< 0.001
9	8.43 (1.04)[a]	8.21 (1.01)	8.08 (0.91)[b]	5.29	0.005
10	8.73 (1.10)[a]	8.42 (1.08)	8.36 (0.96)[b]	6.43	0.002
11	8.89 (1.11)	8.71 (1.08)	8.70 (1.03)	1.69	0.185
12	9.22 (1.17)	9.08 (1.31)	8.97 (1.08)	1.91	0.149
14	9.67 (1.26)[a]	9.36 (1.26)[b]	9.39 (1.11)	3.03	0.049
16	10.00 (1.22)	10.00 (1.36)	10.05 (1.14)	0.02	0.980
18	10.44 (1.24)	10.46 (1.38)	10.24 (1.03)	0.65	0.520
20	10.66 (1.36)	10.87 (1.58)	10.81 (1.34)	1.15	0.317
22	10.99 (1.15)	11.13 (1.31)	11.06 (1.25)	0.28	0.751
24	11.28 (1.22)	11.47 (1.31)	11.66 (1.34)	1.35	0.261

[a,b]Signifies statistically significant difference of mean weights between groups.
SD = standard deviation

infant weight gain was associated with maternal prepregnancy body mass index and with an interaction between the duration of breastfeeding and the timing of the introduction of complementary foods [*16*]. They believed that short duration of breastfeeding and earlier introduction of complementary food were associated with additional weight gain during infancy [*16*]. Other factors such as the time of initiation of breastfeeding and duration of exclusive breastfeeding have been reported to have important roles in the improvement of infant growth [*17,18*]. Our study also shows significantly better growth in breastfed infants than bottle-fed and combined feeding infants especially in the first few months of birth. The difference became less after the introduction of complementary foods. Some studies have shown earlier introduction of complementary food results in better growth, but other studies have confirmed the adequacy of exclusive breastfeeding until 6 months of age with no need for complementary foods [*16,19–21*].

The difference of growth patterns between the 3 groups in our study is similar

Table 3 **Mean height of infants of infants by age and type of feeding**

Age (months)	Mean height (SD) (cm)			*F*	*P*-value
	Breast-feeding	Bottle-feeding	Combined feeding		
1	53.10 (3.26)	50.66 (1.16)	53.77 (2.82)	1.06	0.349
2	54.67 (3.00)	52.61 (2.55)	55.85 (2.76)	5.57	0.08
3	57.69 (3.06)	56.49 (3.50)	57.69 (3.42)	1.39	0.249
4	60.56 (3.42)[a]	59.41 (3.22)[b]	59.62 (3.36)	3.42	0.033
5	62.68 (2.91)	61.80 (2.87)	62.28 (3.18)	1.94	0.144
6	66.50 (2.84)[a]	64.28 (3.15)	63.60 (3.58)[b]	5.50	0.004
7	66.50 (2.92)[a]	65.87 (2.87)	65.66 (3.17)[b]	3.94	0.02
8	68.20 (3.18)[a]	67.91 (3.34)	67.19 (2.93)[b]	4.04	0.018
9	69.63 (2.87)	69.23 (2.93)	69.19 (2.81)	1.28	0.27
10	71.21 (2.87)[a]	70.52 (3.10)[b]	70.42 (3.10)[b]	3.68	0.026
11	72.59 (2.93)	72.10 (2.90)	72.04 (2.97)	1.74	0.175
12	74.27 (3.20)[a]	73.93 (2.77)	73.22 (3.05)[b]	4.40	0.013
14	75.96 (3.36)[a]	75.13 (3.29)[b]	75.11 (3.99)[b]	3.35	0.029
16	77.65 (3.43)	77.27 (3.51)	77.10 (3.22)	0.95	0.386
18	79.47 (3.52)	79.38 (4.00)	78.85 (3.59)	0.67	0.51
20	81.11 (3.46)	81.10 (3.58)	81.87 (3.73)	1.16	0.31
22	83.22 (3.60)	83.11 (3.95)	83.45 (3.45)	0.11	0.89
24	84.66 (3.48)	84.73 (3.90)	85.27 (3.13)	0.31	0.72

[a,b]*Signifies statistically significant difference of mean heights between groups.*
SD = standard deviation.

to other studies [*22,23*]. One study showed a slower growth rate in breastfed infants that was not compensated until 2 years of age [*22*]. Because of these differences, Yoneyama in Japan recommended the development of special growth curves for breastfed infants [*23*].

Comparison between the present study and NCHS data showed that breastfed infants had good growth until 6 months of age.

What is clear from the study is that breastfed infants thrive very well compared to bottled-fed and combined feeding infants. This reinforces the need to promote breastfeeding and encourage mothers to initiate and continue breastfeeding their infants. Maternal education about the benefits of breastfeeding and familial and government support are recommended to achieve this.

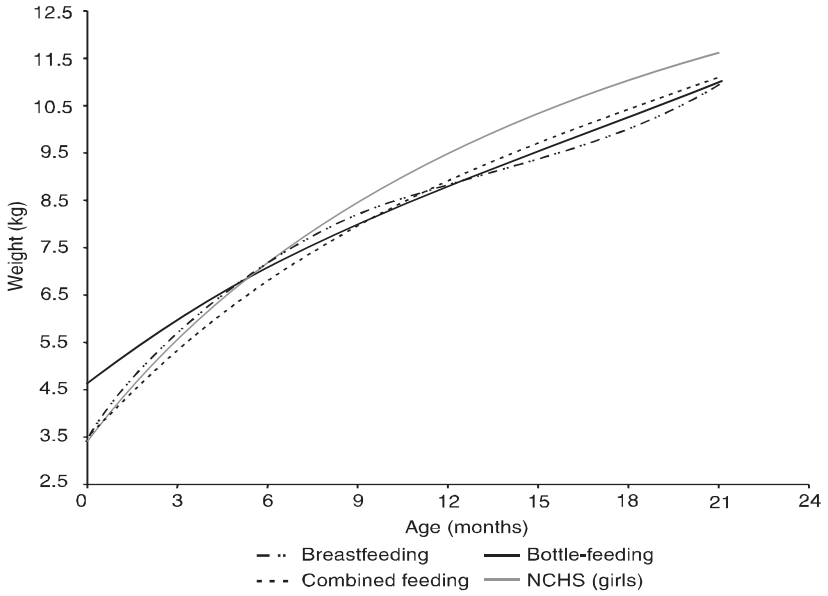

Figure 1 **Comparison of mean weights by age between the 3 types of feeding and the National Center for Health Statistics (NCHS) data for girls**

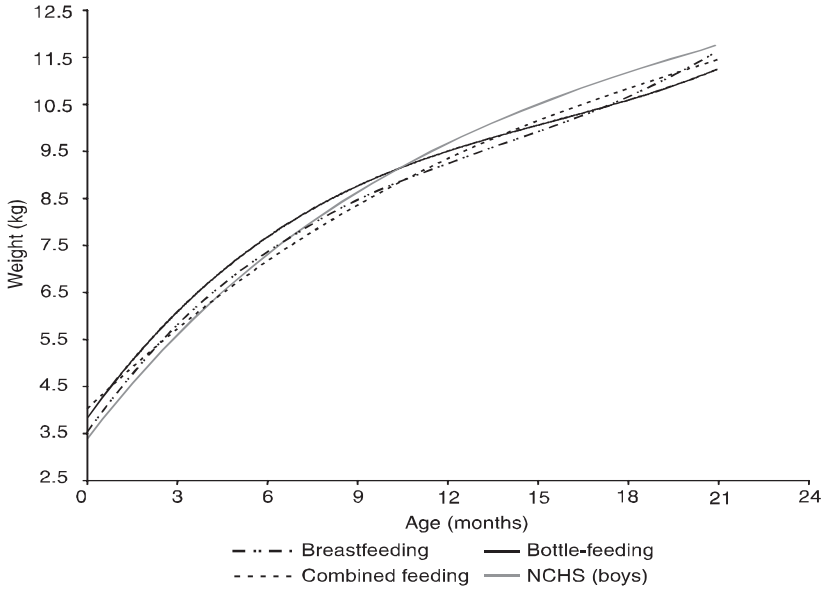

Figure 2 **Comparison of mean weights by age between the 3 types of feeding and the National Center for Health Statistics (NCHS) data for boys**

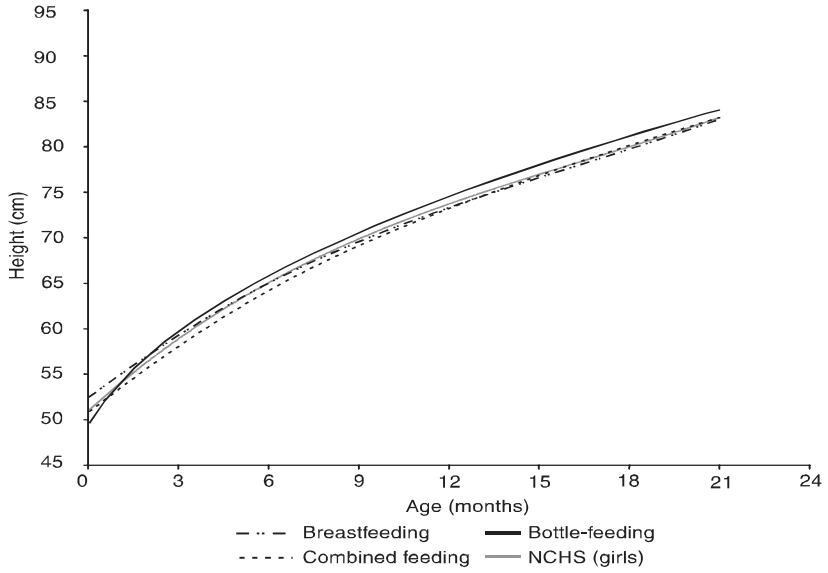

Figure 3 **Comparison of mean heights by age between the 3 types of feeding and the National Center for Health Statistics (NCHS) data for girls**

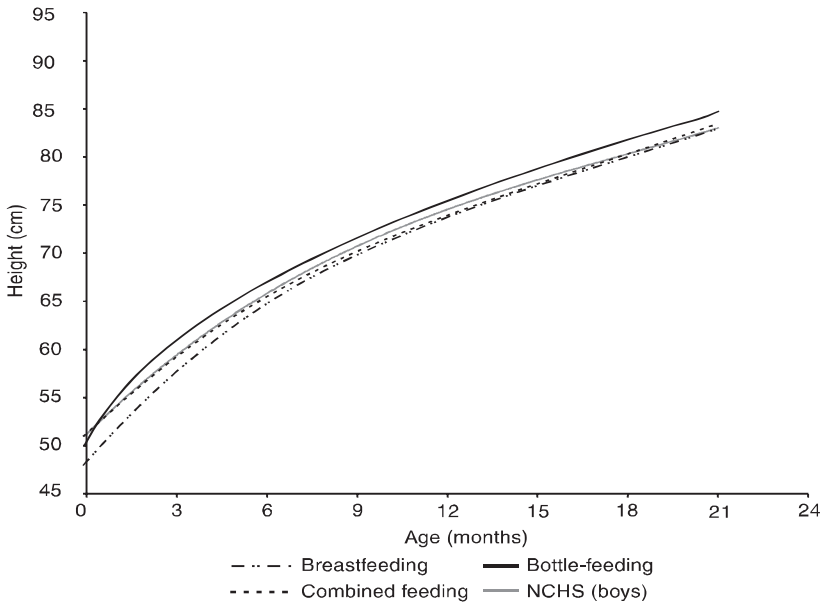

Figure 4 **Comparison of mean heights by age between the 3 types of feeding and the National Center for Health Statistics (NCHS) data for boys**

References

1. Murahovschi J et al. Curvas e tabelas de crescimento de lactentes brasileiros de 0–6 meses de idade alimentados exclusivamente com leite materno [Growth curves in Brazilian infants 0–6 months exclusively fed breast milk]. *Jornal de pediatria*, 1987, 63:153–7.
2. Butte NF et al. Human milk intake and growth in exclusively breast-fed infants. *Journal of pediatrics*, 1984, 104:187–95.
3. Seward JF, Serdula MK. Infant feeding and infant growth. *Pediatrics*, 1984, 74(4 Pt 2):728–62.
4. Diaz S et al. Breast-feeding duration and growth of fully breast-fed infants in a poor urban Chilean population. *American journal of clinical nutrition*, 1995, 62:371–6.
5. Lamounier JA, Vieira GO, Gouvêa LC. Composição do leite humano – fatores nutricionais. [Composition of human milk – nutritional factors]. In: Rego JD, ed. *Aleitamento materno*. [*Maternal diet*.] São Paulo, Atheneu, 2001:47–58.
6. Hitchcock NE, Gracey M. Growth of healthy breast-fed infants in the first six months. *Lancet*, 1981, 2(8237):64–5.
7. Dibley MJ et al. Interpretation of Z-score anthropometric indicators derived from the international growth reference. *American journal of clinical nutrition*, 1987, 46:749–62.
8. De Onis M, Garza C. Time for a new growth reference. *Pediatrics*, 1997, 100(5):E8.
9. De Onis M, Habicht JP. Anthropometric reference data for international use: recommendations from a World Health Organization expert committee. *American journal of clinical nutrition*, 1996, 64:650–8.
10. Hendricks KM, Badruddin SH. Weaning recommendations: the scientific basis. *Nutrition reviews*, 1992, 50:125–33.
11. An evaluation of infant growth: the use and interpretation of anthropometry in infants. WHO Working Group on Infant Growth. *Bulletin of the World Health Organization*, 1995, 73:165–74.
12. Hamilton BE, Martin JA, Sutton PD, Centers for Disease Control and Prevention, National Center for Health Statistics. Births: Preliminary data for 2003. *National vital statistics reports*, 2004, 53(9):1–18.
13. Healy MJR, Rasbash J, Yang M. Distribution free estimate for age-related centiles. *Annals of human biology*, 1988, 15:17–22.
14. Rasbash J, Healy MJR. *GROSTAT: A statistical package for acquisition and analysis of data related to growth and development*. London, London School of Hygiene and Tropical Medicine, 1988.
15. Kramer MS et al. Feeding effects on growth during infancy. *Journal of paediatrics*, 2004, 145(5):600–5.
16. Baker JL et al. Maternal prepregnant body mass index, duration of breastfeeding, and timing of complementary food introduction are associated with infant weight gain. *American journal of clinical nutrition*, 2004, 80(6):1579–88.
17. Saleemi MA et al. Feeding patterns, diarrhoeal illness and linear growth in 0–24-month-old children. *Journal of tropical paediatrics*, 2004, 50(3):164–9.
18. Morgan JB, Lucas A, Fewtrell MS. Does weaning influence growth and health up to 18 months? *Archives of disease in childhood*, 2004, 89(8):728–33.
19. Onayade AA et al. The first six month growth and illness of exclusively and non-exclusively breast-fed infants in Nigeria. *East African medical journal*, 2004, 81(3):146–53.

20. Marques RF, Lopez FA, Braga JA. O crescimento de criancas alimentadas com leite materno exclusivo nos primeiros 6 meses de vida [Growth of exclusively breastfed infants in the first 6 months of life]. *Jornal de pediatria*, 2004, 80(2):99–105.

21. Asha Bai PV, Leela M, Subramaniam VR. Adequacy of breast milk for optimal growth of infants. *Tropical and geographical medicine*, 1980, 32(2):158–62.

22. Zadik Z et al. Adult height and weight of breast-fed and bottle-fed Israeli infants. *Journal of pediatric gastroenterology and nutrition*, 2003, 37(4):462–7.

23. Yoneyama K, Nagata H, Asano H. Growth of Japanese breast-fed and bottle-fed infants from birth to 20 months. *Annals of human biology*, 1994, 21(6):597–608.

Child-related Millennium Development Goals (MDGs)

Of direct relevance to the work that the Child and Adolescent Health and Development unit of the World Health Organization Regional Office for the Eastern Mediterranean (EMRO) is pursuing in the Region is Goal 4 "Reduce child mortality", for which the target set is "Reduce by two-thirds, between 1990 and 2015, the under-5 mortality rate". For this target, 3 indicators have been selected to help track progress:

- under-five mortality rate,
- infant mortality rate,
- proportion of 1-year-old children immunized against measles.

Other targets of key importance to the work of EMRO in the Region are: Target 2 "Halve between 1990 and 2015 the proportion of people who suffer from hunger", and Target 8 "Have halted by 2015 and begun to reverse the incidence of malaria and other major diseases".