International Journal of Obesity (2000) 24, 925–931
 0307–0565/00 $15.00
www.nature.com/ijo

Trends in body mass index and overweight prevalence among children and adolescents in the region of Aragón (Spain) from 1985 to 1995

LA Moreno[1]*, A Sarría[2], J Fleta[1], G Rodríguez[2] and M Bueno[2]

[1]*EU Ciencias de la Salud, Universidad de Zaragoza, Zaragoza, Spain; and* [2]*Departamento de Pediatría, Universidad de Zaragoza, Zaragoza, Spain*

OBJECTIVE: To analyse trends in body mass index (BMI) and overweight prevalence for children and adolescents in the region of Aragón (Spain), from 1985 to 1995.
DESIGN: Nine cross-sectional examinations of schoolchildren conducted yearly from 1985 to 1995.
SUBJECTS: A total of 90,997 children (45,970 males and 45,027 females) in the first school year (6–7 y of age); 106,284 scholars (52,772 males and 53,512 females) in the last school year (13–14 y of age).
MEASUREMENTS: Heights and weights were measured and BMI (kg/m^2) was calculated.
RESULTS: We observed a trend to higher BMI values across the surveys, by sex and age. The secular trends in BMI showed the largest increases at the upper ends of the distribution, especially in males. In children in the first school year, prevalences of overweight were higher in females than in males ($P<0.001$); however, in adolescents in the last school year, prevalences were higher in males than in females ($P<0.001$). We observed a significant trend in overweight prevalence from 1985 to 1995 in children from the first school year ($P=0.0183$, in males and $P=0.0168$, in females). In children in the last school year there was only a significant trend in males ($P<0.0001$).
CONCLUSION: Significant changes in BMI occurred in the population studied during the period 1985–1995, but these changes differ by age and sex. The increasing skewness of BMI in the upper percentiles of the population, especially in boys, suggests that, not only is the pediatric population getting fatter, but the fatter members are becoming more obese. Our results also show a striking increase in the prevalence of overweight children in the region of Aragón (Spain) during the 1985–1995 decade.
International Journal of Obesity (2000) **24,** 925–931

Keywords: overweight; obesity; child; body mass index; secular trends

Introduction

Overweight in childhood is gaining increasing recognition as an important public health concern, especially because overweight youths may become overweight adults[1,2] and both youths and adults are at increased risk for adverse health outcomes.[3–5] Defining obesity or overweight for children and adolescents is difficult, and there is no generally accepted definition of obesity or overweight for youths.[6–8] A variety of criteria for overweight and obesity have been used.[9–11] Body mass index (BMI), defined as weight/height^2 (kg/m^2) has been recently recommended as the basis for screening of obesity in children and adolescents.[7,8]

*Correspondence: LA Moreno, EU Ciencias de la Salud, Universidad de Zaragoza, Avda Domingo Miral s/n, 50009 Zaragoza, Spain.
E-mail: lmoreno@posta.unizar.es
Received 20 April 1999; revised 14 September 1999; accepted 18 February 2000

Temporal changes in BMI and in prevalence of overweight have been reported in adults from a number of countries.[12,13] For children, data on BMI and prevalence of overweight are scarce.[14,15] Data on temporal changes in BMI and prevalence of overweight in children and adolescents are even more so, and no so such data are known to exist in Spain. This article uses BMI as the basis to analyse trends on the prevalence of overweight for children and adolescents in the region of Aragón (Spain).

Population and method

Population

From 1985 to 1995, the School Health Examination Surveys staff (Dirección General de Salud Pública, Diputación General de Aragón, Zaragoza, Spain) surveyed the whole population of children in the first (6–7 y) and last (13–14 y) school years. During this period, there were nine cross-sectional examinations of schoolchildren. In the first school year, participation rates ranged from 66.75 (1990–

1991) to 89.68% (1989–1990) in males, and from 71.51 (1990–1991) to 94.46% (1989–1990) in females. In the last school year, participation rates ranged from 55.29 (1990–1991) to 78.75% (1994–1995) in males, and from 63.17 (1986–1987) to 83.38% (1989–1990) in females. These surveys began near the start of the school year and lasted 6–9 months. Of the 109,916 children (56,741 males and 53,175 females) in the first school year, 90,997 (45,970 males and 45,027 females) were examined in the nine cross-sectional surveys conducted between 1985 and 1995 (this represents the 82.79% of the school population in the first school year). Of the 147,251 scholars (75,478 males and 71,773 females) in the last school year, 106,284 (52,772 males and 53,512 females) were also examined in the nine cross-sectional surveys conducted (this represents the 72.18% of the school population in the last school year). These surveys were approved by the Aragon Government (Consejería de Sanidad).

Anthropometric methods and definitions of overweight

Heights and weights, obtained by primary health care staff (school health visitors and paediatricians) as part of the routine health surveillance programme were transferred to a central computer. All the school health visitors and paediatricians that took part in the surveys were adequately trained. Body weight was measured using a standard beam balance, in underclothes or adjusted for clothing weight (the beam balances were calibrated daily, early in the morning before starting the measurement session). Height was measured using a stadiometer, with the head held in the Frankfort plane. BMI (kg/m^2) was calculated. According to the WHO,[16] we defined overweight if BMI was $\geq$95th percentile (NHANES reference values).[17]

Data analysis and statistical methods

BMI values were compared with the NHANES reference data,[17] and we calculated standard deviation scores (SDS) or *Z*-scores: (observed value − mean)/standard deviation). Survey-specific mean values of BMI (kg/m^2 and SDS), by sex and age, were calculated as an initial summary of the data. Distribution of BMI (SDS) at the first and the last surveys were examined in percentile comparison plots. To compare prevalence estimates by sex, we used the χ^2 test. Trends in overweight prevalence were analysed by regression analysis. All the analyses were carried out using the SPSS 6.0 statistical package.

Results

In Tables 1 and 2 are shown survey-specific mean values of BMI (kg/m^2 and SDS), by sex and age. In all cases, we observed a trend to higher BMI values across the surveys. In male children mean BMI values increased by 0.68 kg/m^2 (0.57 SDS) in boys aged 6 y, and by 0.75 kg/m^2 (0.55 SDS) in those aged 7 y. In female children mean BMI values increased by 0.59 kg/m^2 (0.42 SDS) in girls aged 6 y, and by 0.61 kg/m^2 (0.43 SDS) in those aged 7 y (Table 1). In the last school year, male children mean BMI values increased by 0.84 kg/m^2 (0.34 SDS) in children aged 13 y, and by 0.90 kg/m^2 (0.37 SDS) in children

Table 1 Body mass index by sex, age and survey, in children of the first school year

	1985–1986 Mean (s.d.)	*1986–1987* Mean (s.d.)	*1988–1989* Mean (s.d.)	*1989–1990* Mean (s.d.)	*1990–1991* Mean (s.d.)	*1991–1992* Mean (s.d.)	*1992–1993* Mean (s.d.)	*1994–1995* Mean (s.d.)	*1995–1996* Mean (s.d.)
Males									
6 y									
BMI (kg/m^2)	16.28	16.41	16.73	16.33	16.24	16.32	16.37	16.79	16.96
	(1.86)	(1.88)	(2.02)	(1.96)	(1.97)	(2.15)	(2.04)	(2.17)	(2.23)
BMI (SDS)	0.63	0.75	1.01	0.66	0.59	0.64	0.70	1.05	1.20
	(1.62)	(1.59)	(1.70)	(1.69)	(1.70)	(1.81)	(1.73)	(1.79)	(1.84)
7 y									
BMI (kg/m^2)	16.42	16.61	16.80	16.45	16.40	16.36	16.61	17.13	17.17
	(1.98)	(2.03)	(2.07)	(2.16)	(2.22)	(2.02)	(2.11)	(2.43)	(2.28)
BMI (SDS)	0.54	0.68	0.83	0.55	0.51	0.49	0.68	1.05	1.09
	(1.47)	(1.48)	(1.52)	(1.55)	(1.62)	(1.54)	(1.53)	(1.69)	(1.63)
Females									
6 y									
BMI (kg/m^2)	16.32	16.44	16.71	16.42	16.27	16.22	16.42	16.74	16.91
	(2.15)	(2.13)	(2.20)	(2.16)	(2.11)	(2.21)	(2.24)	(2.13)	(2.23)
BMI (SDS)	0.73	0.82	1.01	0.79	0.68	0.63	0.80	1.04	1.15
	(1.55)	(1.52)	(1.58)	(1.56)	(1.57)	(1.64)	(1.56)	(1.52)	(1.60)
7 y									
BMI (kg/m^2)	16.56	16.61	16.92	16.56	16.33	16.33	16.63	17.12	17.17
	(2.17)	(2.31)	(2.16)	(2.13)	(2.15)	(2.43)	(2.22)	(2.33)	(2.42)
BMI (SDS)	0.85	0.88	1.11	0.84	0.67	0.65	0.89	1.25	1.28
	(1.56)	(1.58)	(1.52)	(1.54)	(1.57)	(1.71)	(1.58)	(1.62)	(1.66)

BMI: body mass index. s.d.: standard deviation. SDS: standard deviation score.

Table 2 Body mass index by sex, age and survey, in children of the last school year

	1985–1986 *Mean* *(s.d.)*	*1986–1987* *Mean* *(s.d.)*	*1988–1989* *Mean* *(s.d.)*	*1989–1990* *Mean* *(s.d.)*	*1990–1991* *Mean* *(s.d.)*	*1991–1992* *Mean* *(s.d.)*	*1992–1993* *Mean* *(s.d.)*	*1994–1995* *Mean* *(s.d.)*	*1995–1996* *Mean* *(s.d.)*
Males									
13 y									
BMI (kg/m^2)	19.65	19.75	20.08	20.03	20.17	20.16	20.34	20.31	20.49
	(2.74)	(2.79)	(2.92)	(2.93)	(3.00)	(3.01)	(3.14)	(3.02)	(3.15)
BMI (SDS)	0.71	0.75	0.89	0.86	0.93	0.92	0.99	0.98	1.05
	(1.17)	(1.18)	(1.22)	(1.23)	(1.24)	(1.26)	(1.29)	(1.25)	(1.29)
14 y									
BMI (kg/m^2)	19.90	20.15	20.43	20.43	20.43	20.50	20.61	20.79	20.80
	(2.79)	(2.96)	(3.00)	(2.92)	(3.09)	(3.11)	(3.03)	(3.20)	(3.26)
BMI (SDS)	0.41	0.52	0.64	0.64	0.63	0.66	0.71	0.78	0.78
	(1.20)	(1.24)	(1.20)	(1.20)	(1.28)	(1.27)	(1.24)	(1.29)	(1.30)
Females									
13 y									
BMI (kg/m^2)	20.17	20.28	20.35	20.24	20.41	20.36	20.45	20.52	20.60
	(2.85)	(2.90)	(2.88)	(2.90)	(2.99)	(3.16)	(2.99)	(2.99)	(2.97)
BMI (SDS)	0.74	0.78	0.81	0.76	0.83	0.80	0.85	0.88	0.92
	(1.17)	(1.20)	(1.17)	(1.18)	(1.20)	(1.27)	(1.21)	(1.20)	(1.18)
14 y									
BMI (kg/m^2)	20.48	20.77	20.82	20.67	20.84	20.78	20.97	21.08	20.90
	(2.78)	(2.94)	(3.02)	(2.90)	(3.03)	(3.04)	(2.99)	(3.28)	(3.00)
BMI (SDS)	0.46	0.57	0.59	0.54	0.59	0.57	0.65	0.68	0.62
	(1.08)	(1.14)	(1.15)	(1.11)	(1.15)	(1.15)	(1.14)	(1.22)	(1.13)

BMI: body mass index. s.d.: standard deviation. SDS: standard deviation score.

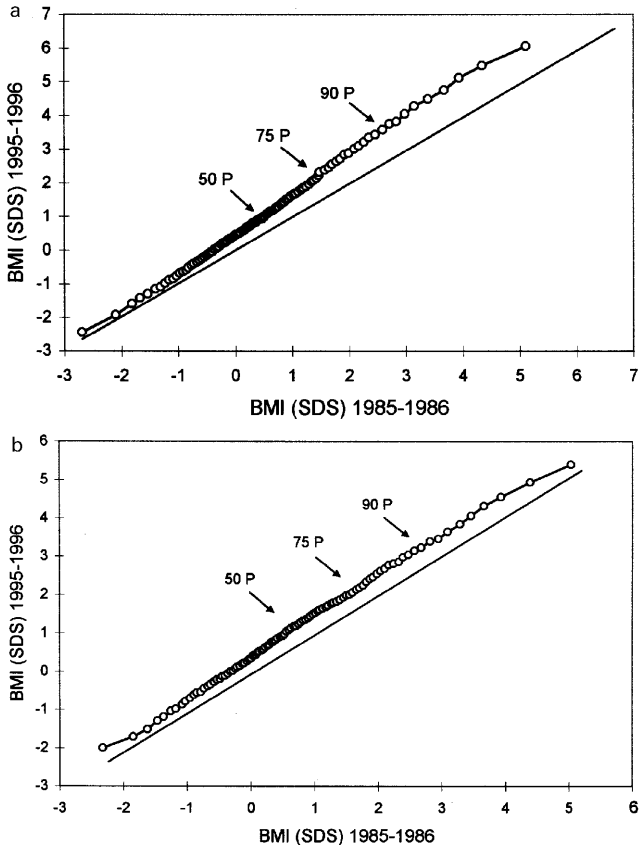

Figure 1 Percentile comparison plot for BMI (SDS) between the first (1985–1986) and the last (1995–1996) surveys, in children in the first school year (6–7 y old), both in males (a) and in females (b).

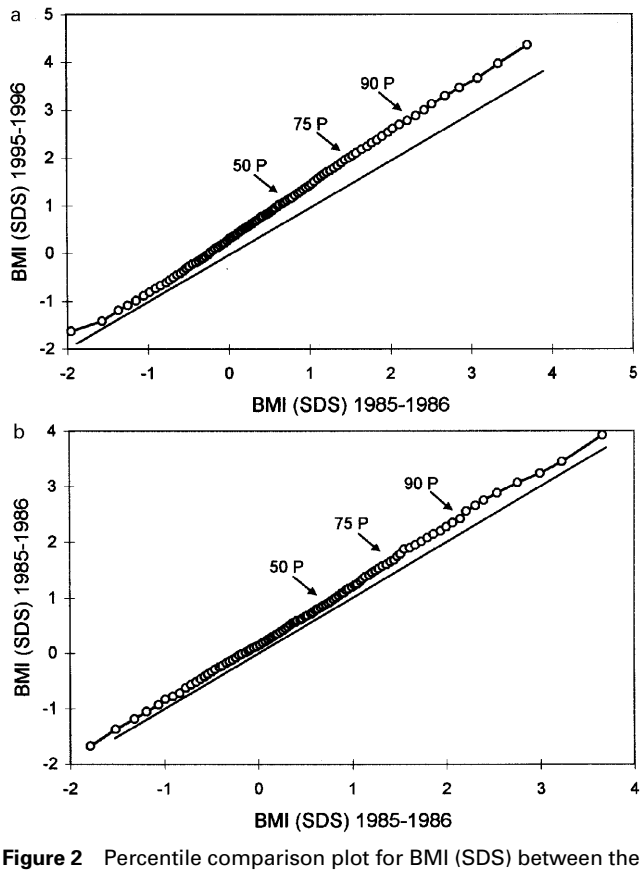

Figure 2 Percentile comparison plot for BMI (SDS) between the first (1985–1986) and the last (1995–1996) surveys, in children in the last school year (13–14 y old), both in males (a) and in females (b).

aged 14 y. In 13–14 y-old female children, mean BMI values increased by 0.43 kg/m^2 (0.18 SDS) in children aged 13 y, and 0.42 kg/m^2 (0.16 SDS) in children aged 14 y (Table 2).

Percentile comparison plots for BMI (SDS) between the first (1985–1986) and the last (1995–1996) surveys are shown in Figures 1 and 2. The diagonal line represents the expected value if there

had been no secular change, and the distance above the line represents the secular increase in BMI (SDS) at each percentile. In the first school year, there was a shift towards higher BMI values both in boys and in girls (Figure 1); this can only be seen in male children in the last school year (Figure 2). The secular trends in BMI showed the largest increases at the upper ends of the distribution, especially in males.

In children in the first school year, prevalences of overweight were higher in females than in males ($P < 0.001$; Figure 3); however, in adolescents in the last school year, prevalences were higher in males than in females ($P < 0.001$; Figure 4). We observed a significant trend in overweight prevalence from 1985 to 1995 in children from the first school year (percentage overweight = 5.6983% + 0.7017 time, $P = 0.0183$, in males; percentage overweight = 8.7626% + 0.7352 time, $P = 0.0168$, in females, Figure 3). In children in the last school year there was only a significant trend in males (percentage overweight = 2.6550% + 0.3922 time, $P < 0.0001$; Figure 4).

Discussion

Data on BMI and prevalence of overweight in children and adolescents are scarce.[14,15] Data on temporal changes in BMI and prevalence of overweight in children and adolescents arc even more so.[10,11] This

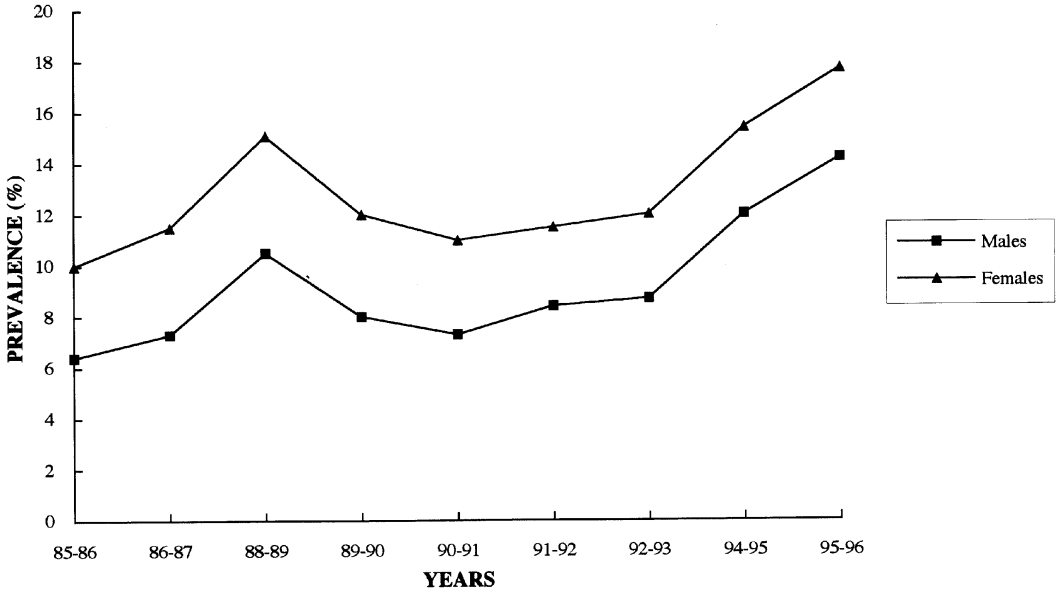

Figure 3 Overweight prevalence in children in the first school year (6–7 y old), from 1985–1986 to 1995–1996. Differences between sex were significant ($P < 0.001$) in the nine surveys. Trends in overweight prevalence were also significant both in males ($P = 0.0183$) and in females ($P = 0.0168$).

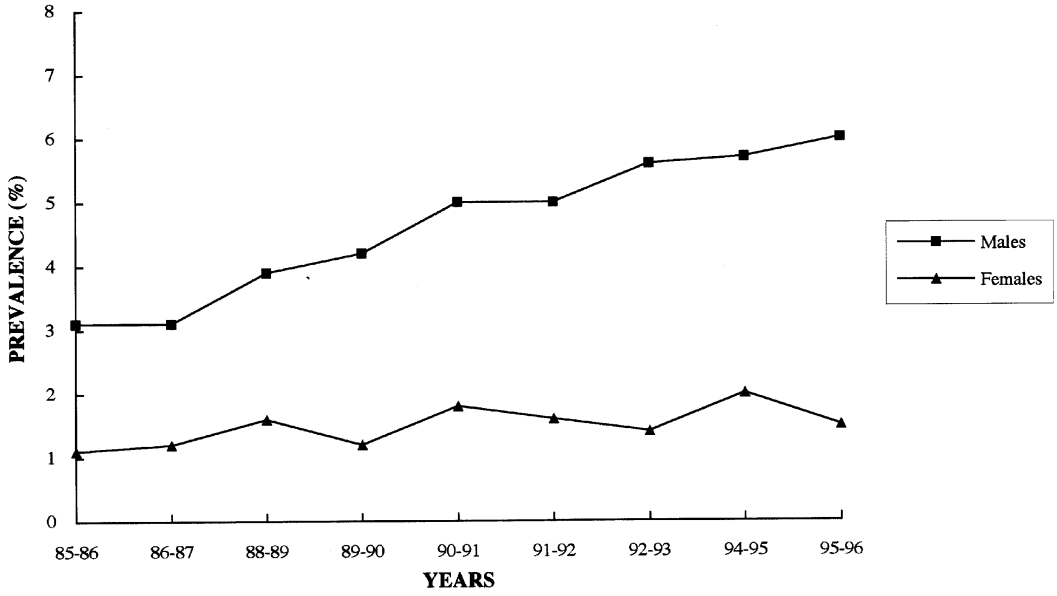

Figure 4 Overweight prevalence in children in the last school year (13–14 y old), from 1985–1986 to 1995–1996. Differences between sex were significant ($P < 0.001$) in the nine surveys. There was only a significant trend in males ($P < 0.0001$).

is the first time that trends in BMI and overweight prevalence have been quantified in Spanish children.

Significant changes in BMI occurred in the population studied during the period 1985–1995, but these changes differ by age and sex. The most interesting trends and those relevant to disease were not changes in the central tendency, but changes at the upper end of the distribution. The increasing skewness of BMI in the upper percentiles of the population, especially in boys, suggests that, not only is the pediatric population getting fatter, but the fatter members are becoming more obese.

Similar findings concerning trends on BMI distribution have been observed in different countries, both in adults and in children. In Finnish adults, there has also been a shift towards higher BMI values in men and towards lower values in women during the 1972–1992 period.[18] In Swedish women, the mean BMI of the whole population increased by 0.17 kg/m^2 during the 1980–1989 period; the increase was particularly important in the group aged 25–34 y (0.74 kg/m^2).[19] In Kuwait, mean BMI increased by 2.5 and 1.7 kg/m^2 among men and women, respectively, in the 1980–1981 to 1993–1994 period.[20]

In US children, Troiano and Flegal[21] found a general pattern of little or no difference between the NHES II or III and NHANES III surveys at the lower percentiles of the BMI distribution, but increasing differences at higher percentiles. The patterns were similar by sex. With increasing age, there was more evidence of an upwards shift of the entire distribution, combined with the disproportionate increase in the higher percentiles. In children of Bogalusa,[11] it was estimated that, over each 10-year period, BMI increased by 0.9 kg/m^2. The Rohrer index (kg/m^3) also showed the largest increases at the upper ends of the distribution. In 7-y-old Stockholm children, there was also a significant increase in BMI from 1970 to 1990;[22] in the 1980–1990 period, BMI increased by 0.32 and 0.20 kg/m^2 in boys and girls, respectively. These increases were lower than those observed in our population.

To estimate the number of overweight or obese children and adolescents, a definition must be chosen that specifies the measures to be used and the corresponding threshold values above which overweight or obesity is present. Ideally, the definition would reflect adiposity and be related to morbidity and mortality outcomes. Actually, there is no clear consensus on what that definition should be. A definition based on height and weight is desirable because these measures can be obtained with reasonable, precision in field, clinical and research settings. Comparison among various weight-for-height indexes for adults and children have led to the selection of BMI as most desirable. Moreover, in children, BMI is highly correlated with percentage body fat.[23] Nevertheless, there is a major disadvantage in using BMI alone in childhood. Mean normal values of BMI vary with age, and values for children of different ages cannot be compared without reference to age-related norms.[24,25]

Characterization as being overweight or obese leads to stigmatization,[26] and undue attention to body size may increase the incidence of eating disorders among children and adolescents.[27] In light of these potential adverse outcomes and the considerations noted above, the 95th percentile may be a more appropiate criterion of overweight for children and adolescents than lower percentile cutoffs in clinical and epidemiologic applications.[8]

Our results show a striking increase in the prevalence of overweight children in the region of Aragón (Spain) during the 1985–1995 decade. This effect was higher in children aged 6–7 y of age than in older ones. This observation could be due to a cohort effect implicating even faster increases in overweight compared to the secular trends, but also to body image control, because these differences were more important in girls than in boys.

In the United States, the secular trends appear to be accelerated, with larger increases observed during 1982–1990 than during 1972–1982.[10] These trends are similar to those observed in children of Bogalusa.[11] The increased prevalence of overweight could be associated with changes in fat distribution;[28] however, we have no way of testing this possibility.

The possible effects of nonparticipation, which could influence all studies of secular trends, should be considered when interpreting our findings. If participation was associated with obesity, then our prevalence estimates of obesity could be biased. However, in contrast to the estimate of individual prevalence estimates, the secular trend in obesity would be expected to be biased only if the association between participation and obesity changed during the time frame of the study. For example, if thin children were more likely to participate at the initial phase of the study than at the latter part, a spurious increase in obesity would be observed. In any case, in our surveys, participation rates were sufficiently high and constant over time.

The recent increase in the prevalence of overweight observed in children and adolescents reflects a population shift towards positive energy balance. The reasons for this shift are complex and multifactorial, but the consequence is dietary energy consumption that exceeds metabolic expenditure. The modifiable components of energy balance (energy intake through food consumption and energy expenditure through physical activity) cannot be measured as precisely as height and weight in national surveys.

Recent studies carried out in adults seem to confirm the notion that high-fat diets might lead over time to excess body fat deposition. In Spain, household dietary information obtained by the National Institute of Statistics in 1964–1965, 1980–1981 and 1990–1991,[29] showed a rise of the energy supplied by fat from 30% in 1964–1965, to 40% in 1980–1981 and 41.5% in 1990–1991. In our region (Aragón), in the last survey, fat intake represents 44.3% of total energy intake. Some individual dietary surveys carried out in

children seem also to show a trend to higher levels of fat consumption in Spanish children.[30] However, there is actually no conclusive evidence from epidemiologic studies that under isoenergetic conditions, dietary fat intake promotes the development of obesity more so than other macronutrients.[31,32]

Data to evaluate secular trends in activity for young children in Spain do not exist. Physical activity may play an important role in the trends observed in relative weight and obesity. In a sample of the 1990–1991 survey, we have observed that the amount of physical activity, assessed by means of a questionnaire,[33] was not related with BMI both in boys and in girls; however, physical activity was significantly related to fat deposition in adolescent girls, but not in boys.[34] The time spent watching television was related significantly to BMI in girls and with body fat percentage both in boys and in girls; in all the cases the effect was higher in girls than in boys.[35] Changes in parental work habits, television viewing, availability of video games, and other cultural aspects of the environment may have further decreased opportunities for exercise.[36]

Overweight children and adolescents may be at a physical disadvantage[37–39] as well as social and economical.[40,41] Although some overweight youths will lose their excess weight as they mature and develop, it is likely that many will become overweight adults. Researchers are challenged to understand the causes of increasing overweight among children and adolescents, but it seems crucial to focus on prevention of overweight among youths. Attempts to carry out health programmes for children and adolescents, aiming to substitute less sedentary activities for sitting in front of the television, computers, video cassettes and video games, may provide a promising avenue in this effort.

Acknowledgement

We thank all the members of the Dirección General de Salud Pública (Diputación General de Aragón, Zaragoza, Spain), especially Dr Julián de la Bárcena, for kindly providing us with the growth data from the Aragón School Health Examination Surveys Programme.

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