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Does overweight in infancy persist through the preschool years? An analysis of CDC Pediatric Nutrition Surveillance System data

Summary

Objective: To determine whether overweight in infancy (0–11 months) and young childhood (12–35 months) persists through the preschool years.

Methods: Analysis of longitudinal surveillance data for 380 518 low-income children monitored in the U.S. Pediatric Nutrition Surveillance System from birth to age 59 months. Overweight was defined as weight-for-height ≥95th percentile. We determined the proportion of the children (overweight vs non-overweight) above or below the 95th percentile of weight-for-height at the later ages.

Results: The relative risk (RR) for overweight among overweight infants (vs non-overweight infants) at 1, 2, 3, and 4 years old was 4.3, 3.5, 3.3, and 2.9, respectively. 62.5 % of overweight 3-year-old was still overweight a year later, but only 4.1 % non-overweight 3-year-old became overweight a year later (RR = 15.2). However, low birth weight children had the highest RR to remain overweight after they became overweight compared to normal and high birth weight children.

Conclusions: Overweight during infancy persists through the preschool years. Tracking of overweight appears to become stronger as children get older and is more pronounced among low birth weight children than normal or high birth weight children. Monitoring preschoolers' height and weight status should be a strategy for preventing of obesity in adolescence and adulthood.

Keywords: Overweight – Obesity – Longitudinal – Preschool children – Weight-for-height – Relative risk.

Childhood overweight or obesity is increasing in both developed and developing countries as reported earlier (Martorell et al. 1998; Mei et al. 1998; Ogden et al. 1997; Troiano et al. 1995; World Health Organization 1997). Its persistence into adulthood and the accompanying health risks have raised many concerns (Abraham et al. 1971; Freedman et al. 1999; Johnston 1985; Must et al. 1992; Shear et al. 1987; World Health Organization 1997). About half (42–63 %) of obese school-age children and one-third (26–41 %) of obese preschool children are obese as adults (Clarke & Lauer 1993; Garn & LaVelle 1985; Guo et al. 1994; Rolland-Cachera et al. 1987; Serdula et al. 1993; Stark et al. 1981; Whitaker et al. 1997). Among preschoolers, the risk of adult obesity is 2.0 to 2.6 times as high among obese children as in their non-obese counterparts; the risk ratio increases to 3.9–6.5 among obese school-age children in comparisons with their non-obese peers (Serdula et al. 1993). Obesity in childhood also appears to increase the risk of subsequent morbidity, regardless of whether obesity persists into adulthood (Freedman et al. 1999; Johnston 1985). To date, however, no study has tracked the weight of preschool children each year from birth. In this study, we determined whether overweight in low-income U.S. infants (0–11 months) and young children (12–35 months) persisted through the preschool years.

Methods

Since 1973, the U.S. Centers for Disease Control and Prevention (CDC) has assisted states in monitoring key growth and hematologic indicators of nutritional status of low-income children who participate in publicly funded health and nutrition programs such as the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC), Early Periodic Screening, Diagnosis and Treatment

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0303-8408/03/030161–07
DOI 10.1007/s00038-003-2022-x

Program (EPSDT), and clinics funded through Maternal and Child Health Program (MCH) block grants (Centers for Disease Control 1983; Yip et al. 1992). Data for the majority of the infants and children monitored by the Pediatric Nutrition Surveillance System (PedNSS) come from routine clinic service records of WIC. The WIC program, which was initiated in 1972, is administered by the Food and Nutrition Service of the U.S. Department of Agriculture (Burich & Murray 1992; Stefan & Robert 1993). The PedNSS has expanded from five participating states in 1973 to 48 states, the District of Columbia, Puerto Rico, and seven Indian Reservations in 1995. This surveillance system provides a rich source of data for studying the nutritional characteristics of low-income children on a state-by-state basis (Centers for Disease Control 1983; Yip et al. 1992). The CDC PedNSS is designed as a program-based surveillance system and it utilizes already available data collected from health, nutrition, and food assistance programs as described above. The key indicators in the PedNSS system are socio-demographic variables (ethnicity/race, age, geographic location), birth weight, anthropometric indices (height/length, weight), iron status (hemoglobin and/or hematocrit), and breastfeeding.

In the WIC program, height or length is measured to the nearest $^1/_8$ inch or 0.1 cm. A measuring board is used to measure the child's recumbent length if the child is less than 24 months, otherwise, a standing height is measured for children older than 24 months. Weight is measured to the nearest $^1/_4$ pound or 0.1 kg using a pediatric scale or other beam balance scale. All the height and weight measurements require trained public health nurses, nutritionists, or dieticians. Also, the WIC protocols recommend that two measurements of length or height of a child agree within $^1/_4$ inch, and two respective readings in weight agree within $^1/_4$ pound (Centers for Disease Control and Prevention 1981; 1994). All records are entered onto a standardized paper form or into an automated computer system in the clinics. After the records are computerized at the state level, they are transferred to CDC for inclusion in the PedNSS database.

The records of the CDC PedNSS database include unique identifiers that the states used for data management. Transmitting the state identifiers to CDC allows the federal agency's data processing staff to prevent duplication of records for a single child. To create a prospective longitudinal data set of children aged 0–59 months for this study, data processing staff at CDC combined PedNSS records for the years 1985 through 1995 and sorted them by unique identifier. They then replaced each identifier with a correlative number and supplied the data to the authors. Thus, the study authors did not have identifiable information on the children, but they were able to create longitudinal records of multiple visits. This study was determined to be exempt from review by the CDC Human Subject Review Board.

The linked prospective longitudinal data set included children born in 1985–1990 who had at least one height and weight measurement annually until age five years. If the child had more than one height and weight measurement per year of age, then one record per child per year of age was randomly selected to avoid double counting of children who visited the public health program more than once in the same age year. A total of 494 967 children were examined. We excluded all children for who did not have data on height, weight, birth weight, race, and gender. We also excluded children with weight-for-height z-scores below −4 or above +5, because these extreme values were most likely due to errors in measurement or data entry (World Health Organization 1995). A total of 380 518 children with 1 902 590 records were included in the analysis.

For this study, we defined weight-for-height status ≥95th percentile on the CDC growth reference (Kuczmarski et al. 2000) as overweight. To examine whether overweight persisted through the preschool years, we first categorized the children into two groups based on their weight-for-height percentile in an earlier age group – an overweight group and a non-overweight group (<95th of weight-for-height percentile). Then we determined the proportion in each group ≥ or <95th percentile of weight-for-height at the later ages. Then relative risk (RR) was calculated based on the proportions in each group. For example, to determine whether overweight in infancy persisted through the preschool years, we classified children as overweight or non-overweight during infancy, then calculated the proportion remaining overweight at ages 1, 2, 3, and 4 years and the proportion becoming overweight at those ages. The above analysis also stratified by sex, race, and birth weight groups. Data were analyzed using SAS software programs (SAS Institute Inc. 1990).

Results

The demographic and anthropometric characteristics of participants in the PedNSS longitudinal data are compared in Table 1 with characteristics obtained by analyzing the U.S. population-based survey (1989–1994) the Third National Health and Nutrition Examination Survey (NHANES III). PedNSS longitudinal data showed higher proportions of black and Hispanics children than the NHANES III data, but this is to be expected given that our sample includes only low-income children (less than 185% of poverty). Although mean birth weight in PedNSS was 93 g lower than that found

Table 1 Demographic and anthropometric characteristics (%) of participants in the Pediatric Nutrition Surveillance System (PedNSS) longitudinal data and the Third National Health and Nutrition Examination Survey (NHANES III)

Age (months)	PedNSS longitudinal data 1985–1995 (N = 380 518)	NHANES III data[a] 1988–1994 (N = 6 626)
0–11	20.0	16.7[b]
12–23	20.0	20.7
24–35	20.0	21.6
36–47	20.0	21.0
48–59	20.0	20.0
Boys	50.9	51.2
Girls	49.1	48.8
Non-Hispanic white	46.8	62.5
Non-Hispanic black	30.5	16.4
Hispanic	18.6	10.1
Others	4.1	11.1
Mean birthweight (g)[c]	3 263 (599)	3 356 (590)
% of birthweight <2500 g	9.1	10.0
Mean weight-for-height z-score[c]		
0–11 mos	0.01 (1.25)	0.28 (1.02)
12–23 mos	0.16 (1.20)	0.12 (1.06)
24–35 mos	0.10 (1.21)	0.03 (1.03)
36–47 mos	0.16 (1.17)	0.11 (1.06)
48–59 mos	0.21 (1.15)	0.25 (1.00)

[a] Original sample weight was used for the population-based NHANES III data analysis.
[b] Only for infants 2–11 months of age.
[c] Standard deviation in parentheses.

nationally, the percent of low birth weight (<2 500 g) was surprisingly 0.9% lower than that in NHANES III. The mean weight-for-height z-scores after age one year, however, were comparable for the two data sets.

The persistence of overweight through the preschool years is illustrated in Figure 1 by baseline age. For example, among overweight infants, 35.6%, 27.7%, 25.1%, and 23.7% remained overweight at 1, 2, 3, and 4 years old, respectively. In contrast, 8.2%, 7.9%, 7.7%, and 8.3% of non-overweight infants became overweight at 1, 2, 3, and 4 years old. The RR for overweight among overweight infants (vs non-overweight infants) at 1, 2, 3, and 4 years old was 4.3, 3.5, 3.3, and 2.9, respectively. 62.5% of overweight 3-year-old was still overweight a year later, but only 4.1% non-overweight 3-year-old became overweight a year later (RR = 15.2). At any follow-up age, the prevalence of overweight was consistently higher among children who were overweight at an earlier age, with the RR never falling below 2.9 and increasing with age. Thus, the tracking of overweight for these preschoolers appears to be stronger as they get older.

In Table 2, stratified by three birth weight groups – low (500–2 499 g), normal (2 500–3 999 g), and high (4 000–5 999 g), summarized the proportion of overweight group ($\geq 95^{th}$ weight-for-height) at baseline ages remaining overweight at follow-up ages, the proportion of non-overweight group ($< 95^{th}$ weight-for-height) at baseline ages becoming overweight at follow-up ages, and their RRs from non-overweight to become overweight at each follow-up age. Though the high-birth weight group had the highest prevalence of remaining or becoming overweight at follow-up ages, the low-birth weight group had the highest RRs of the three groups. For example, among overweight 3-year-old low birth weight children, 57.4% remained overweight at 4 years old, only 2.6% of non-overweight infants became overweight at 4 years old. The RR in low birth weight group for overweight among overweight 3-year-old (vs non-overweight 3-year-old) at 4 years old was 22.1. However, for the same age group, the RR was 15.2 for normal birth weight children and was 9.6 for high birth weight children.

The prevalence of overweight and the RR for boys and girls were comparable. Also, the tracking effect (RR) was similar among white, black, and Hispanic children, although the prevalence of overweight among Hispanics was higher than black and white children (results not shown).

Discussion

Although several studies have tracked body fat from childhood to adulthood (Clarke & Lauer 1993; Garn & LaVelle 1985; Guo et al. 1994; Rolland-Cachera et al. 1987; Serdula et al. 1993; Stark et al. 1981; Whitaker et al. 1997), none had tracked fatness annually from birth through early childhood. Our study, although did not follow these children to adolescent and adulthood, tracked children from birth to less than 5 years of age every single year with a large sample that was ethnically diverse. Thus, we were able to study the risk of children remaining or becoming overweight in their later preschool years based on their previous relative weight status (weight-for-height percentile). Our study showed that overweight persists through the preschool years. The risk of overweight infants remaining overweight at age 4 is over 2 times than that of non-overweight infants becoming overweight. The RR increases with age – the risk for 3 years old remaining overweight is 15.2 times higher than that of becoming overweight one year later (Fig. 1). Thus, the tracking of overweight appears to be stronger as children get older.

We also found that high birth weight children still remained in the high percentile of weight-for-height and had the highest prevalence of overweight after birth during all the preschool years. These children born in a high level of weight-for-height percentiles and most likely still remain in the high

Table 2 The proportion of overweight group (≥95th weight-for-height) at baseline ages remained overweight at follow-up ages, the proportion of non-overweight group (<95th weight-for-height) at baseline ages became overweight at follow-up ages, and their relative risks from non-overweight to become overweight at each follow-up age, stratified by birth weight, CDC Pediatric Nutrition Surveillance System longitudinal data

Age at baseline (months)	Weight-for-height percentile	Overweight (%) and relative risk (in parentheses) for children at follow-up ages (months)			
		12–23	24–35	36–47	48–59
Low birth weight group (500–2 499 g), N = 34 722					
0–11	<95	4.6	4.4	4.3	4.7
	≥95	26.1 (5.7)	19.5 (4.4)	15.5 (3.6)	14.8 (3.1)
12–23	<95		3.4	3.6	4.1
	≥95		36.8 (10.8)	27.6 (7.7)	26.0 (6.3)
24–35	<95			2.8	3.4
	≥95			45.6 (16.3)	40.8 (12.0)
36–47	<95				2.6
	≥95				57.4 (22.1)
Normal birth weight group (2 500–3 999 g), N = 312 518					
0–11	<95	8.0	7.7	7.5	8.0
	≥95	35.4 (4.4)	27.2 (3.5)	24.7 (3.3)	23.3 (2.9)
12–23	<95		5.4	5.7	6.4
	≥95		43.1 (8.0)	36.6 (6.4)	33.9 (5.3)
24–35	<95			4.4	5.4
	≥95			52.2 (11.9)	47.0 (8.7)
36–47	<95				4.1
	≥95				62.3 (15.2)
High birth weight group (4 000–5 999 g), N = 33 278					
0–11	<95	14.1	14.2	13.8	14.2
	≥95	41.9 (3.0)	35.5 (2.5)	33.1 (2.4)	30.8 (2.2)
12–23	<95		9.2	9.8	11.1
	≥95		52.6 (5.7)	46.2 (4.7)	40.8 (3.7)
24–35	<95			7.6	9.0
	≥95			58.8 (7.7)	52.1 (5.8)
36–47	<95				6.8
	≥95				65.4 (9.6)

percentiles of weight-for-height during preschool years (Yip & Mei 1996). Thus, very high birth weight children could be one of the target population for the prevention of obesity in adolescence and adults.

Our study shows that the tracking effect is stronger among low birth weight children than those of normal or high birth weight children (Tab. 2). It is possible that once low birth weight infants reach a high percentile in weight-for-height, they are more likely to stay in the high centile (heavy) because of environmental factors (such as parents feeding practice, pediatrician's attitude, etc). But additional research is needed to further explore the tracking effect observed.

Our study has several potential limitations. First of all, it examines overweight only up to age 5 years and thus can not describe whether tracking would continue into school ages. Second, the PedNSS did not collect data on the children's intrauterine growth and the parents' growth status, and thus we cannot adjust for these factors in our analysis. Third, the longitudinal data set we created for this study is not representative of the U.S. low-income population even though it covered 40 states plus other areas. Fourth, all the children included in a public health nutrition program from birth until 5 years of age, their growth may have differed from that of low-income children who stayed in the system for shorter time periods.

Overall, this study shows that overweight persists through the preschool years. Tracking of overweight appears to be stronger as children get older, and it is stronger among low birth weight children than normal or high birth weight children. Because of known health problems with pediatric overweight and the tracking of overweight into adulthood, monitoring preschoolers' height and weight status should be a strategy for preventing obesity in adolescence and adulthood. Further research is needed to extend this study to school-aged children and to adults.

Acknowledgments

We thank all state nutrition programs participating in the CDC PedNSS. We also thank Ellen Borland and Jimmy Simmons for providing data management support.

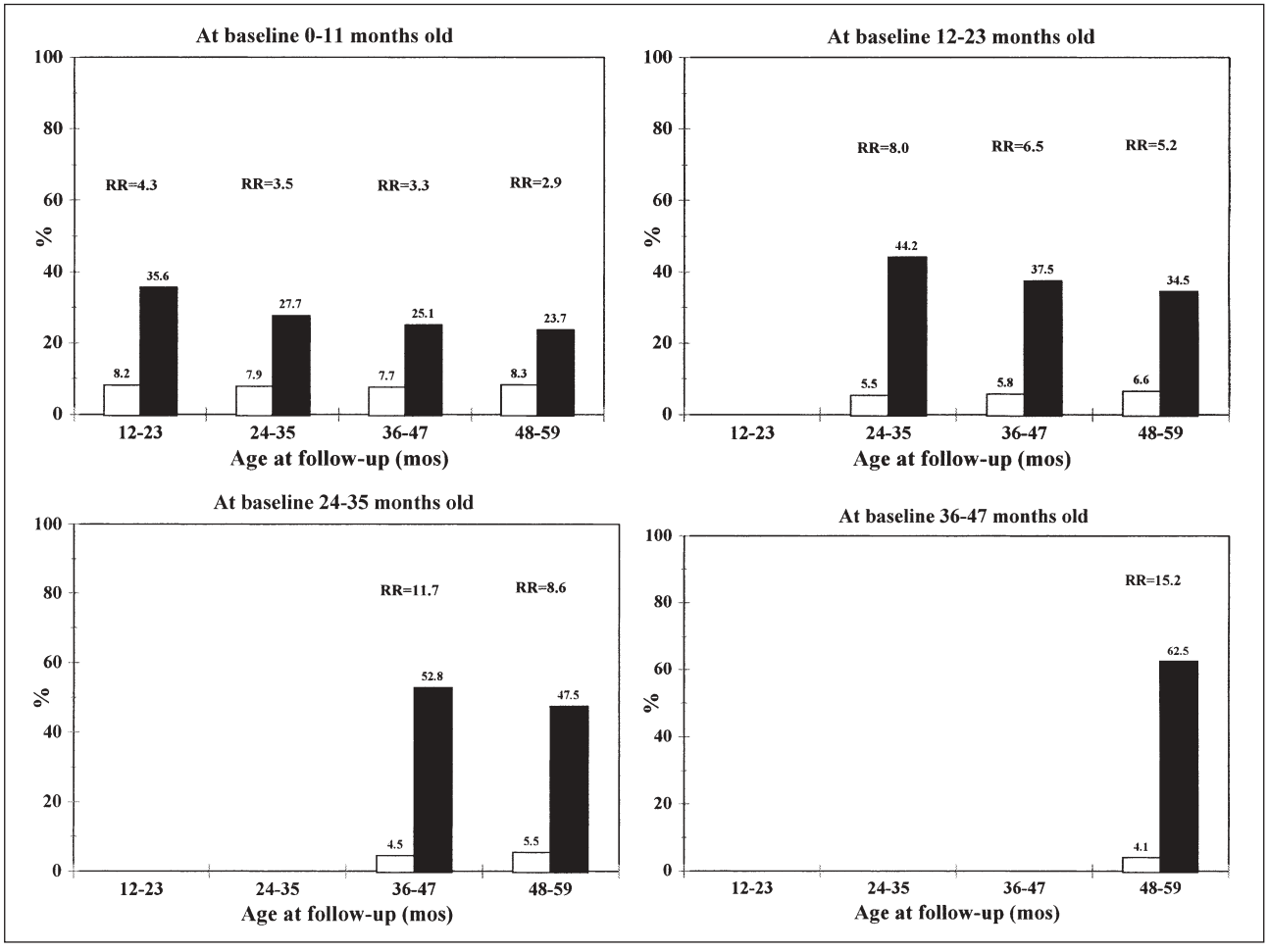

Figure 1 The proportion of overweight group (≥95th weight-for-height) at baseline ages remained overweight at follow-up ages, the proportion of non-overweight group (<95th weight-for-height) at baseline ages became overweight at follow-up ages, and their relative risks (RR) from non-overweight to become overweight at each follow-up age, CDC Pediatric Nutrition Surveillance System longitudinal data

Zusammenfassung

Bleibt das Übergewicht von Kleinkindern während der Vorschulzeit bestehen? Eine Analyse von Daten des CDC-Kinderernährungs-Surveillance-Systems

Zielsetzung: Bestimmen, ob das Übergewicht im Säuglings- und Kleinkindalter (0–11 resp. 12–35 Monate) während der Vorschulzeit bestehen bleibt.

Methoden: Analyse von Längsschnitt-Surveillance-Daten für 380518 Kinder aus Familien mit niedrigem Einkommen, die im Rahmen des U.S.-Kinderernährungs-Surveillance-Systems von der Geburt bis im Alter von 59 Monaten beobachtet werden. Übergewicht wurde definiert als ≥95. Gewichts-Grössen-Perzentil. Wir bestimmten den Anteil an älteren Kindern über oder unter der 95. Gewichts-Grössen-Perzentile (übergewichtig vs. nicht übergewichtig).

Ergebnisse: Das relative Risiko (RR) für Übergewicht unter den übergewichtigen Kleinkindern (im Vergleich zu den nicht Übergewichtigen) betrug im Alter von 1, 2, 3 und 4 Jahren 4,3; 3,5; 3,3 und 2,9. 62,5 % der übergewichtigen 3-jährigen Kinder war auch ein Jahr später noch übergewichtig, aber nur 4,1 % der nicht übergewichtigen 3-Jährigen wurden im selben Zeitraum übergewichtig (RR = 15,2). Kinder mit sehr geringem Geburtsgewicht hatten im Vergleich zu Kindern mit normalem oder hohem Geburtsgewicht das höchste RR übergewichtig zu bleiben nachdem sie einmal übergewichtig geworden waren.

Schlussfolgerungen: Übergewicht im Kleinkindalter bleibt während der Vorschuljahre bestehen. Mit zunehmendem Alter der Kinder scheint dieses Problem noch extremer zu werden und ist bei Kindern mit niedrigem Geburtsgewicht besonders ausgeprägt. Ein Monitoring von Körpergewicht und -grösse bei Vorschulkindern sollte als Strategie zur Vorbeugung von Adipositas bei Jugendlichen und Erwachsenen berücksichtigt werden.

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Résumé

Est-ce que le surpoids dans l'enfance persiste jusqu'aux années préscholaires? Une analyse des données du CDC Pediatric Nutrition Surveillance System

Objectif: Déterminer si le supoids pendant la très petite enfance (0 à 11 mois) et la petite enfance (12 à 35 mois) persiste jusqu'aux années préscolaires.

Méthodes: Analyses de données d'observation longitudinale portant sur 380 518 enfants de bas niveau socio-économique suivis par le système de surveillance de nutrition pédiatrique des Etats-Unis de la naissance jusqu'à l'âge de 59 mois. Le surpoids était défini comme un rapport poids/taille ≥95ème percentile. Nous avons déterminé la proportion d'enfants (avec vs. sans surpoids) au-dessous et au-dessus du 95ème percentile du rapport poids/taille à des âges plus avancés.

Résultats: Le risque relatif (RR) du surpoids (comparé à l'absence de surpoids) à 1,2,3 et 4 ans était de 4,3, 3,5, 3,3 et 2,9, respectivement. 62,5 % des enfants de 3 ans ayant du surpoids en avaient toujours un an plus tard, mais seulement 4,1 % des enfants de 3 ans sans surpoids développaient du surpoids un an plus tard (RR = 15,2). Cependant, les enfants de bas poids à la naissance avaient le plus grand risque relatif de conserver du surpoids après qu'ils en aient développé comparés aux enfants de poids normal ou élevé à la naissance.

Conclusions: Le surpoids pendant la petite et très petite enfance persiste jusqu'aux années préscolaire. La tendance au surpoids semble devenir plus forte lorsque les enfants grandissent et est plus prononcée chez les enfants de bas poids à la naissance que chez ceux de poids normal ou élevé à la naissance. L'observation continue de la taille et du poids des enfants en âge préscolaire devrait être une stratégie de prévention de l'obésité au cours de l'adolescence et de l'âge adulte.

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