Dynamics of Obesity and Chronic Health Conditions Among Children and Youth

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Context Rates of obesity and other childhood chronic conditions have increased over recent decades. Patterns of how conditions change over time have not been widely examined.

Objective To evaluate change in prevalence of obesity and other chronic conditions in US children, including incidence, remission, and prevalence.

Design, Setting, and Participants Prospective study using the National Longitudinal Survey of Youth–Child Cohort (1988-2006) of 3 nationally representative cohorts of children. Children were aged 2 through 8 years at the beginning of each study period, and cohorts were followed up for 6 years, from 1988 to 1994 (cohort 1, n=2337), 1994 to 2000 (cohort 2, n=1759), and 2000 to 2006 (n=905).

Main Outcome Measures Parent report of a child having a health condition that limited activities or schooling or required medicine, special equipment, or specialized health services and that lasted at least 12 months. Obesity was defined as a body mass index at or above the 95th percentile for age. Chronic conditions were grouped into 4 categories: obesity, asthma, other physical conditions, and behavior/learning problems.

Results The end-study prevalence of any chronic health condition was 12.8% (95% confidence interval [CI], 11.2%-14.5%) for cohort 1 in 1994, 25.1% (95% CI, 22.7%-27.6%) for cohort 2 in 2000, and 26.6% (95% CI, 23.5%-29.9%) for cohort 3 in 2006. There was substantial turnover in chronic conditions: 7.4% (95% CI, 6.5%-8.3%) of participants in all cohorts had a chronic condition at the beginning of the study that persisted to the end, 9.3% (95% CI, 8.3%-10.3%) reported conditions at the beginning that resolved within 6 years, and 13.4% (95% CI, 12.3%-14.6%) had new conditions that arose during the 6-year study period. The prevalence of having a chronic condition during any part of the 6-year study period was highest for cohort 3 (51.5%; 95% CI, 47.3%-55.0%), and there were higher rates among male (adjusted odds ratio [AOR], 1.24; 95% CI, 1.07-1.42), Hispanic (AOR, 1.36; 95% CI, 1.11-1.67), and black (AOR, 1.60; 95% CI, 1.35-1.90) youth.

Conclusions Prevalence of chronic conditions among children and youth increased from 1988 to 2006. However, presence of these conditions was dynamic over each 6-year cohort.

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OVER THE PAST 30 YEARS, THE prevalence of chronic conditions in children and adolescents has increased,[1] particularly for asthma,[2] obesity,[3] and behavior/learning problems (eg, attention-deficit/hyperactivity disorder).[4] There have also been changes in rates of rarer conditions, such as sequelae of prematurity,[5] neonatal human immunodeficiency virus 1 infections,[6] and Down syndrome,[7] due to advances in treatment and prenatal care. Children with cystic fibrosis and sickle cell anemia now survive longer.[8] These increases raise important questions concerning the course of chronic conditions over time: what are the collective incidence, persistence, and remission rates?

In this analysis, we examined fluctuations in having a chronic health condition over time. The phrase *chronic condition* might imply permanence. Yet conditions change over time because of new treatments, environmental factors, and a child's development, in addition to the nature of the condition itself. Understanding prevalence and dynamics of chronic conditions on a national scale is important when designing health policy, making accurate clinical predictions, and targeting interventions to prevent chronic conditions. Because demographic variables are associated with prevalence of many conditions, as well as mitigating or causal factors (eg, health care access and environmental exposures),[1] understanding these changes among population subgroups can lead to intervention strategies to reduce disparities.

One previous study, using data from the 1960s to examine changes in having a chronic health condition over time, found that half of children with a chronic condition at the end of the study had been classified as having the condition at the beginning, and vice versa.[9] Since then, the epidemiology of chronic conditions in children has changed considerably, with a rise in overweight/obesity and mental health conditions. Furthermore, advances since 1960 in diagnosis and treatment

See also p 665 and Patient Page.

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Box. Specific Chronic Conditions Categorized as Behavior/Learning Problems and Other Physical Conditions

Behavior and learning problems:
- Learning disability
- Minimal brain dysfunction
- Minimal cerebral dysfunction
- Attention-deficit disorder
- Hyperkinesis
- Hyperactivity
- Mental retardation
- Serious emotional disturbance
- Chronic nervous disorder

Other physical conditions:
- Respiratory disorder (other than asthma)/sinus infections
- Speech impairment
- Serious difficulty hearing
- Serious difficulty seeing
- Allergic condition
- Crippled, orthopedic handicap
- Heart trouble
- Chronic ear problems/ear infections
- Blood disorder or immune deficiency
- Epilepsy or seizures
- Other condition

of other conditions may affect current persistence and remission rates. We therefore update this work with recent, nationally representative data and include obesity and behavior/learning problems. We estimated changes in prevalence, incidence, and rates of remission of broad categories of conditions using 3 consecutive cohorts of children. We also examined prevalence of having a condition during any part of the 6-year study period among these cohorts.

We asked the following questions: did prevalence of chronic conditions increase or decrease among cohorts over time and between same-aged cohorts measured 6 years apart? To what degree do chronic conditions persist, remit, and develop over time? Did the prevalence of chronic conditions during any part of the 6-year study period vary with sex, race/ethnicity, poverty, maternal educational attainment, or maternal obesity?

METHODS

We analyzed 3 cohorts of children born to women in the National Longitudinal Survey of Labor Market Experience, Youth Cohort (NLSY) (http://www.bls.gov/nls/nlsy79.htm). This ongoing survey collects annual data from a national probability sample of 12 686 youth aged 14 through 21 years in 1979 regarding their health, education, and employment, oversampling for racial/ethnic minority and economically disadvantaged white subjects. Of the original sample, 90% were interviewed in 1988 and 81% in 2000, and 56% of the original sample completed every annual survey from 1978 through 2006. In 1986, data collection extended to children of female participants, collected every 2 years. Children's eligibility required that they lived primarily with their mothers, and their mothers were interviewed in the same year. Until 2006, child-centered interviews were completed separately from mothers' interviews. The response rates for the child-centered interviews varied from 90% of eligible children in 1998 to 99% in 2006.

Interviews were typically conducted in the home by trained field staff. Verbal consent was obtained from mothers at each interview. The institutional review board at the Harvard School of Public Health deemed this study exempt from review.

This study focuses on 3 cohorts of children born to women in the NLSY. Cohort 1 includes children aged 2 through 8 years in 1988; cohort 2 includes children aged 2 through 8 years in 1994; and cohort 3 includes children aged 2 through 8 years in 2000. Each cohort was followed up for 6 years until ages 8 through 14 years in 1994 (cohort 1), 2000 (cohort 2), and 2006 (cohort 3). We included only children with complete health and measurement data for all biennial surveys during each study period (68% of all children surveyed during the first year of each study period). No child was in more than 1 cohort. Since all children had mothers who were aged 14 through 21 years in 1979, mothers of children in later cohorts were older.

Chronic Conditions

At each biennial interview, mothers were asked whether children had any physical, emotional, or mental condition that prevented him or her from attending school regularly, doing regular school work, or doing usual childhood activities or that required frequent attention or treatment from a doctor or other health professional, regular use of any medication, or use of special equipment. Mothers were then asked what conditions the child had and how long (number of years, or less than 1 year) the child had had the condition. Conditions were recorded verbatim and coded by the interviewer.

Because some conditions are rare, we categorized conditions into 4 groups: asthma, obesity, other physical conditions, and behavior/learning problems (BOX). Categories were not mutually exclusive: if a child had both asthma and seizure disorder, then she or he would be categorized as having asthma and other physical condition (seizure disorder). A condition was considered chronic if it lasted for at least 12 months. Obesity was defined as a body mass index (BMI), which was calculated as weight in kilograms divided by height in meters squared, at or above the age- and sex-specific 95th percentile.[10] Measurements were usually obtained by in-home interviewers with a scale and tape measure (eg, 83% of heights, 73% of weights in 1990; 74% of heights, 68% of weights in 2000); for others, parents reported the measurement. We also created a variable that identified children having a condition in any of the 4 subgroups.

Other Variables

We included several socioeconomic and demographic variables that we hypoth-

esized may be related to rates of chronic conditions and obesity, based on previous work.[11-13] We included child age, sex, and maternal education (≤12 years or >12 years of school). Although child race/ethnicity was unavailable, we used mother's race/ethnicity (black, Hispanic, or non-Hispanic white, assigned by surveyors based on the 1978 household screening data) as a proxy. Poverty level was defined as family income at the beginning of each study period (<100% or ≥100% of the federal poverty level)[14] and was missing for 16% of participants. Maternal obesity was defined as BMI at or above 30, derived from self-reported height and weight at the beginning of each cohort period.

Table 1. Baseline Characteristics of Children and Youth Aged 2 Through 8 Years in Longitudinal Cohorts in 1988, 1994, and 2000[a]

	Cohort 1 (n = 2337)[b]	Cohort 2 (n = 1759)[b]	Cohort 3 (n = 905)[b]
Age of child, mean (SD), y[c]	4.40 (1.83)	4.51 (1.60)	4.94 (1.49)
Age of mother, mean (SD), y[c]	27.6 (2.5)	32.9 (2.2)	38.3 (1.8)
Female sex, % (95% CI)	50.3 (47.8-52.7) n = 1156	48.4 (45.7-51.0) n = 902	49.0 (45.6-52.4) n = 451
Ethnicity, % (95% CI)			
Non-Hispanic white	72.6 (70.4-74.7) n = 1020	84.0 (82.2-85.7) n = 1028	83.8 (81.3-86.1) n = 589
Black	18.6 (16.9-20.4) n = 789	11.0 (9.6-12.5) n = 444	10.6 (8.9-12.7) n = 190
Hispanic	8.8 (7.8-10.1) n = 528	5.0 (4.2-5.9) n = 287	5.6 (4.3-7.2) n = 126
Mothers with >12 y of education, % (95% CI)[c]	28.4 (25.7-31.3) n = 610	49.9 (46.5-53.2) n = 806	62.9 (58.6-67.0) n = 530
Household poverty (<100% FPL), % (95% CI)[c]	25.1 (22.7-27.6) n = 791	13.1 (11.2-15.2) n = 342	12.0 (9.6-14.8) n = 152
Maternal obesity, % (95% CI)[c]	15.6 (13.6-17.9) n = 426	22.0 (19.4-24.9) n = 455	24.9 (21.4-28.6) n = 251

Abbreviations: CI, confidence interval; FPL, federal poverty level.
[a] All estimates weighted to nationally represent US children born to mothers who were 14 through 21 years old in 1979. Numbers are unweighted samples.
[b] Children were aged 2 through 8 years in their respective study periods: 1988 for cohort 1, 1994 for cohort 2, and 2000 for cohort 3.
[c] Measured in the first year of the cohort study (in 1988 for cohort 1, 1994 for cohort 2, 2000 for cohort 3).

Data Analysis

We used NLSY-provided weights to calculate means and proportions to represent children aged 2 through 8 years born to women who were aged 14 through 21 years in 1979 in the United States. We used a unique maternal identifier as the primary sampling unit to take into account clustering of observations within families. Data analysis was performed using SAS version 6 (SAS Institute, Cary, North Carolina) and Stata version 10 (StataCorp, College Station, Texas).

We calculated prevalence of any chronic condition and of conditions in the 4 subgroups (asthma, other physical condition, behavior/learning problem, and obesity) in the first and last year for all cohorts grouped together and for each cohort individually. Next, for any chronic condition and subgroups, we calculated incidence, persistence (proportion of children initially with a chronic condition who also had the condition at end of the study period), and "new cases" (proportion of conditions reported in the final year of each study period that were not present at the beginning). Estimations of behavior/learning problems were performed only for all cohorts combined because of small cell sizes for individual cohorts. Using data from each biennial data collection during the study periods, we then calculated the prevalence of having a chronic condition during any part of the 6-year study period for any chronic condition and subcategories of conditions for all cohorts.

We used χ^2 tests to compare differences in prevalence, incidence, persistence, new cases, and prevalence of having a chronic condition during any part of the 6-year study period between consecutive cohorts. A McNemar test (paired χ^2 test using the Yates correction) was used to estimate significance when evaluating changes in prevalence over time within cohorts. Finally, we examined the association between sociodemographic variables (child age, sex, race/ethnicity, maternal obesity, maternal education, poverty) and prevalence of having a chronic condition during any part of the 6-year study period in multivariate logistic regression models that included all participants. To account for missing poverty data, we used UVIS (univariate imputation sampling) in Stata version 10,[15] which imputes a variable using logit regression with sociodemographic variables having significant statistical association with nonmissing poverty data (child age, maternal obesity, maternal education, and race/ethnicity). All *P* values are 2-tailed. To account for multiple comparisons, *P* values of ≤.01 were considered significant. To account for cohort effects, we included a variable that designated the cohort in these models.

For sensitivity analyses, we separately performed the described analysis including only those with objectively measured height and weight and including only those with nonmissing poverty data.

RESULTS

Data were available for 2337 children in cohort 1, 1759 children in cohort 2, and 905 children in cohort 3 and their mothers (TABLE 1). Differences in race and poverty status among the cohorts largely reflect the age shift of mothers of the NLSY such that mothers of the children in cohorts 2 and 3 were progressively older than those in cohort 1. Rates of maternal obesity increased with each cohort (cohort 1, 15.6%; 95% confidence interval [CI], 13.6%-17.9%; cohort 2, 22.0%; 95% CI, 19.4%-24.9%; cohort 3, 24.9%; 95% CI, 21.4%-28.6%).

Prevalence, Incidence, Persistence, and New Cases

Prevalence of any chronic condition, including obesity, increased with subsequent cohorts (TABLE 2). The baseline prevalence for cohort 2 (16.6%; 95% CI, 14.6%-18.8%) and cohort 3 (25.2%; 95% CI, 22.0%-28.7%) was higher compared with cohort 1 (11.2%; 95% CI, 9.7%-12.8%; $P<.001$). Within-cohort differences between baseline and end-study prevalence of having any chronic condition were seen for cohort 1 (baseline, 11.2%; 95% CI, 9.7%-12.8%; end-study, 12.8%; 95% CI, 11.2%-14.5%; $P=.01$) and cohort 2 (baseline, 16.6%; 95% CI, 14.6%-18.8%; end-study, 25.1%; 95% CI, 22.7%-27.6%; $P<.001$) but not for cohort 3 (baseline, 25.2%; 95% CI, 22.0%-28.7%; end-study, 26.6%; 95% CI, 23.5%-29.9%; $P=.44$).

Having a chronic condition was dynamic over time. Combining all cohorts, 16.6% (95% CI, 15.3%-18.0%) of children had any chronic condition at baseline. At the end of the study period, 20.8% (95% CI, 19.4%-22.3%) reported a chronic condition. However, only 7.4% (95% CI, 6.5%-8.3%) of all children reported a chronic condition both at baseline and at the end of the study period; 13.4% (95% CI, 12.3%-14.6%) of participants represented new cases. For 9.3% of children (95% CI, 8.3%-10.3%), a chronic condition was

Table 2. Weighted Prevalence, Incidence, Percentage of New Cases, and Persistence of Chronic Conditions[a]

Cohort/Chronic Condition	% (95% Confidence Interval)											
	BL Prevalence	*P* Value[b]	ES Prevalence	*P* Value[b]	*P* Value vs BL of Same Cohort	Incidence During Study	*P* Value[b]	New Cases[c]	*P* Value[b]	Persisting Conditions[d]	*P* Value[b]
All cohorts (n = 5001)											
Chronic condition (any)	16.6 (15.3-18.0) n = 858		20.8 (19.4-22.3) n = 1069		<.001	16.1 (14.7-17.5) n = 667		77.3 (74.5-80.1) n = 884		37.6 (33.8-41.6) n = 351	
Asthma	2.0 (1.6-2.6) n = 119		3.6 (3.1-4.3) n = 195		<.001	2.9 (2.3-3.5) n = 145		76.7 (68.4-85.4) n = 145		42.4 (31.6-54.0) n = 50	
Other physical condition	3.9 (3.3-4.7) n = 170		5.7 (4.9-6.6) n = 235		<.001	4.6 (3.9-5.4) n = 184		77.3 (70.7-82.8) n = 184		32.9 (25.4-41.4) n = 51	
Obesity	11.9 (10.8-13.1) n = 611		13.3 (12.1-14.5) n = 721		<.001	10.1 (9.0-11.2) n = 467		66.7 (62.4-70.7) n = 467		37.2 (32.7-42.0) n = 254	
Behavior/learning problem[e]	1.0 (0.7-1.4) n = 48		4.7 (4.0-5.4) n = 221		<.001	4.2 (3.6-5.0) n = 202		89.9 (83.9-93.8) n = 202		45.5 (28.9-62.1) n = 19	
Cohort 1 (n = 2337)[f]											
Chronic condition (any)	11.2 (9.7-12.8) n = 285		12.8 (11.2-14.5) n = 334		.01	9.7 (8.2-11.5) n = 216		79.8 (75.1-84.6) n = 312		32.1 (25.9-38.9) n = 106	
Asthma	1.6 (1.1-2.3) n = 49		3.1 (2.3-4.1) n = 80		.002	2.5 (1.8-3.4) n = 61		78.0 (64.1-87.5) n = 61		42.3 (25.7-60.9) n = 19	
Other physical condition	3.1 (2.3-4.1) n = 63		2.3 (1.6-3.1) n = 43		.31	1.6 (1.0-2.4) n = 35		67.2 (50.1-80.6) n = 35		24.2 (14.0-38.5) n = 18	
Obesity	7.0 (5.9-8.3) n = 187		8.3 (7.0-9.7) n = 225		.03	6.5 (5.3-7.9) n = 157		73.2 (65.4-79.8) n = 157		31.5 (24.0-40.1) n = 68	
Cohort 2 (n = 1759)[f]											
Chronic condition (any)	16.6 (14.6-18.8) n = 324	<.001	25.1 (22.7-27.6) n = 475	<.001	<.001	20.4 (18.1-23.0) n = 306	<.001	79.7 (75.8-83.6) n = 393	.97	42.1 (35.8-48.7) n = 151	.04
Asthma	1.8 (1.2-2.7) n = 43	.65	4.5 (3.5-5.8) n = 82	.05	<.001	3.7 (2.8-4.9) n = 61	.06	80.6 (68.0-89.0) n = 61	.75	47.9 (29.5-66.9) n = 21	.69
Other physical condition	4.1 (3.1-5.4) n = 63	.13	7.7 (6.3-9.4) n = 118	<.001	<.001	6.3 (5.0-7.9) n = 97	<.001	78.6 (64.9-76.2) n = 97	.18	40.1 (27.3-54.3) n = 21	.12
Obesity	12.3 (10.6-14.3) n = 241	<.001	16.9 (14.9-19.2) n = 335	<.001	<.001	13.7 (11.7-15.4) n = 224	<.001	70.8 (64.9-76.2) n = 224	.42	40.1 (32.8-47.8) n = 111	.13
Cohort 3 (n = 905)[f]											
Chronic condition (any)	25.2 (22.0-28.7) n = 249	<.001	26.6 (23.5-29.9) n = 260	.44	.54	20.4 (17.2-24.0) n = 145	.98	71.3 (65.1-77.5) n = 179	.02	36.7 (30.2-43.9) n = 94	.26
Asthma	2.9 (1.8-4.6) n = 27	.10	3.1 (2.1-4.6) n = 33	.11	.43	2.1 (1.4-3.3) n = 23	.03	66.1 (45.4-81.9) n = 23	.26	37.0 (20.6-57.2) n = 10	.44
Other physical condition	5.0 (3.6-6.9) n = 44	.38	8.0 (6.2-10.3) n = 64	.81	.04	6.7 (5.0-8.9) n = 52	.81	79.9 (67.3-88.4) n = 52	.82	32.2 (18.8-49.3) n = 12	.46
Obesity	19.0 (16.2-22.3) n = 183	<.001	15.8 (13.2-18.9) n = 161	.43	.13	10.6 (8.3-13.4) n = 86	.06	54.4 (45.3-63.1) n = 86	.003	37.8 (30.3-46.2) n = 75	.69

Abbreviations: BL, baseline; ES, end study.
[a] Percentages will not necessarily sum to 100 because of differing denominators.
[b] *P* value vs previous cohort.
[c] Percentage of end-study new cases is the number of children who had the condition at the end of the study period who did not report the condition at study entry divided by the total number of children who reported a condition at the end of the study period.
[d] Percentage of conditions present at baseline that persisted is the number of children who reported the condition at study entry who also reported condition at the end of the study period divided by the total number of children with the condition at study entry.
[e] For individual cohorts, analysis of behavior/learning problems was not performed because of small cell sizes.
[f] Children were aged 2 through 8 years in their respective study periods: 1988 for cohort 1, 1994 for cohort 2, and 2000 for cohort 3.

reported at baseline but remitted by the study's end.

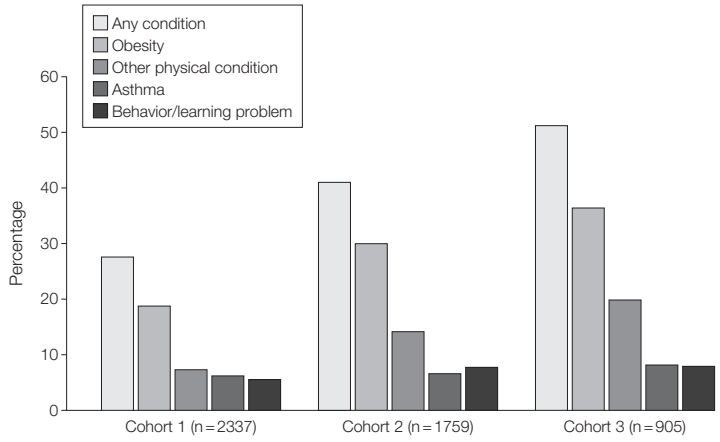
Similar to patterns for all chronic conditions, there was substantial change within individuals having or not having subcategory conditions (Table 2). The prevalence of asthma and behavior/learning problems was higher at the end of the study periods compared with baseline for all cohorts combined (asthma: baseline, 2.0%; 95% CI, 1.6%-2.6%; end-study, 3.6%; 95% CI, 3.1%-4.3%; behavior/learning problems: baseline, 1.0%; 95% CI, 0.7%-1.4%; end-study, 4.7%; 95% CI, 4.0%-5.4%; $P<.001$). For all cohorts, 42.4% (95% CI, 31.6%-54.0%) of children with asthma and 45.5% (95% CI, 28.9%-62.1%) of children with behavior/learning problems at the beginning of the study reported them 6 years later.

For obesity, the baseline prevalence increased substantially over time, with cohort 2 (12.3%; 95% CI, 10.6%-14.3%) and cohort 3 (19.0%; 95% CI, 16.2%-22.3%) higher compared with cohort 1 (7.0%; 95% CI, 5.9%-8.3%; $P<.001$). Also, prevalence increased over time in cohort 2 (end-study, 16.9%; 95% CI, 14.9%-19.2%; $P<.001$) but not in cohort 3 (end-study, 15.8%; 95% CI, 13.2%-18.9%, $P=.13$). Among-cohort differences in prevalence at the end of the study, compared with the previous cohort, were seen in cohort 2 ($P<.001$) but not in cohort 3 ($P=.44$). For all cohorts, 37.2% (95% CI, 32.7%-42.0%) of children with obesity at the beginning of the study were so classified 6 years later.

Although no significant change was found over time in the prevalence of other physical conditions within cohort 1 (baseline, 3.1%; 95% CI, 2.3%-4.1%; end-study, 2.3%, 95% CI, 1.6%-3.1%; $P=.31$), rates increased over time within cohort 2 (baseline, 4.1%, 95% CI, 3.1%-5.4%; end-study, 7.7%, 95% CI, 6.3%-9.4%; $P<.001$).

The prevalence of having a chronic condition during any part of the 6-year study period increased approximately 10% with each cohort, with 51.5% (95% CI, 47.3%-55.0%) of cohort 3 reporting a chronic condition during the most recent study period (FIGURE). Increases in obesity and other physical conditions largely drove this increase across the 3 cohorts.

Figure. Prevalence of Any Chronic Condition and Subgroups of Conditions During Any Part of the 6-Year Study Period for Cohorts 1, 2, and 3



For the prevalence of any condition and for the subgroups obesity and other physical condition, $P<.001$ for group comparison among cohorts. For asthma, $P=.01$ for group comparison among cohorts. For behavior/learning problem, $P=.07$ for group comparison among cohorts. Other physical conditions included respiratory disorders (other than asthma) and sinus infections, speech impairments, serious difficulties hearing, serious difficulties seeing, allergic conditions, crippled or orthopedic handicaps, heart trouble, chronic ear problems or ear infections, blood disorders or immune deficiency, epilepsy or seizures, or other conditions.

Association With Sociodemographic Characteristics

Greater odds of the prevalence of having a chronic condition during any part of the 6-year study period were found among black children (46.6%; 95% CI, 43.6%-49.7%) and Hispanic children (42.3%; 95% CI, 38.4%-46.3%) compared with non-Hispanic white children (36.8%; 95% CI, 34.7%-38.9%) (adjusted odds ratio [AOR], 1.60; 95% CI, 1.35-1.90, and AOR, 1.36; 95% CI, 1.11-1.67, respectively) (TABLE 3). The higher odds of prevalence of asthma and obesity among ethnic minority children contributed to these differences, although ethnic minority children were less likely to have reported other physical conditions and behavior/learning problems. We found associations between maternal obesity and having any chronic condition and all subcategories of conditions; this association was strongest for child obesity (42.1%; 95% CI, 38.2%-46.1%, vs 23.3%; 95% CI, 21.6%-25.1%, of children with mothers who were not obese) (AOR, 2.07; 95% CI, 1.70-2.51). There was also an association between male sex and prevalence of having a condition during any part of the 6-year study period for all conditions except obesity.

Sensitivity analyses with objective height and weight data and nonmissing poverty data were consistent with the main findings (eTable 1 and eTable 2, available at http://www.jama.com).

COMMENT

In our analysis of 3 nationally representative cohorts of children, we examined changes in the incidence, rates of remission, and prevalence of obesity and other chronic conditions at any time in 6 years. We offer 3 key findings. First, there was a high prevalence of having a chronic condition during any part of the 6-year study period. Second, this prevalence increased with each subsequent cohort. Third, the presence of a chronic condition was dynamic over time, with much variation in the persistence of conditions.

This study complements recent work documenting the increasing inci-

dence and prevalence of chronic conditions, especially asthma[2] and overweight/obesity.[3,16] Our study is among the first to examine increasing prevalence of chronic conditions in a cohort over time in the United States and to document the patterns of change in chronic conditions in different cohorts over several years. It also is congruent with work by Jessop and Stein,[9] who analyzed survey data from 1963 to 1970, and Neff et al,[17] who analyzed claims data from a large health insurer. Both studies found similar patterns of remission of conditions over time.

We found that prevalence of a chronic condition at any point during the study period was very high and increased over time. Among cohort 3, 51.5% of 8- through 14-year-olds at one point in the 6-year study period reported a chronic condition compared with 27.8% in cohort 1. Others report similar changes in prevalence over the past 2 decades in childhood obesity,[3,16] asthma,[2,18] and diagnoses of neurobehavioral disorders,[4] especially autism.[19]

Many factors may have contributed, including environmental changes, which may affect rates of chronic respiratory conditions[46] and obesity,[47] better survival rates of conditions such as prematurity,[5] and the development of "late effects" of some treatments, such as chemotherapy.[34] Medicaid expansions and the State Children's Health Insurance Plan (S-CHIP) increased access to health care during the time this study was conducted,[48,49] and children in later cohorts would have had greater opportunities for diagnosis and ongoing treatment of their chronic conditions. This may be especially true for less severe conditions that rarely flare to the point of needing emergent care. The push for increased surveillance for behavior/learning problems in children may have identified cases that would have previously gone undiagnosed. For some behavior/learning problems, patients qualify for therapies only with a diagnosis; thus, diagnosis may be influenced by pursuit of treatment.

A surprising finding is that many children with a reported chronic condition at ages 2 through 8 years did not have the condition 6 years later. Additionally, most chronic conditions at the end of each study period represented new conditions that developed in the previous 6 years. This dynamism challenges the notion that chronic conditions persist without change. Although having a chronic condition in childhood is a risk factor for having the same chronic condition later, many chronic conditions appear to remit for a significant period before relapsing or resolve completely. After cancer treatment, a child may no longer fit criteria for having a chronic condition, although late effects can result in other conditions.[34] Many young children with developmental delay receive therapy during critical years before catching up.[35,36] A child's natural development helps resolve conditions such as chronic constipation. For conditions where symptoms wax and wane, mild cases may be more common and likelier to remit, while severe cases may persist.[17] This cycling is distinct from patterns of chronic conditions in adults, where conditions present later in life and persist, and represents in part differences in epidemiology and development in children compared with adults.[20]

Our finding of limited persistence of asthma complements findings from earlier studies. In a study following up children from birth to puberty, more than 50% with wheezing before age 4 years

Table 3. Weighted Adjusted Odds Ratios of Prevalence of Having a Chronic Condition or Subcategory of Condition During Any Part of the 6-Year Study Period[a]

	Prevalence During Any Part of the 6-y Study Period, AOR (95% CI)[a]				
Cohorts 1, 2, and 3 (n = 5001)	Any Condition (n = 1959)	Asthma (n = 362)	Other Physical Condition (n = 548)	Behavior/Learning Problem (n = 317)	Obesity (n = 1429)
Age, continuous	0.95 (0.91-0.99)	1.02 (0.94-1.11)	1.15 (1.08-1.22)	1.13 (1.04-1.23)	0.85 (0.81-0.89)
Male sex	1.24 (1.07-1.42) n = 1025	1.59 (1.23-2.05) n = 218	1.52 (1.23-1.87) n = 324	2.96 (2.18-4.02) n = 238	1.06 (0.91-1.24) n = 712
Race/ethnicity					
Black	1.60 (1.35-1.90) n = 628	1.59 (1.17-2.17) n = 132	0.59 (0.45-0.77) n = 117	0.74 (0.42-0.95) n = 84	2.04 (1.69-2.46) n = 504
Hispanic	1.36 (1.11-1.67) n = 379	1.46 (1.02-2.01) n = 77	0.73 (0.53-0.99) n = 78	0.63 (0.49-0.95) n = 51	1.58 (1.27-1.97) n = 289
Maternal BMI ≥30	1.96 (1.63-2.36) n = 611	1.46 (1.07-1.99) n = 118	1.56 (1.20-2.03) n = 160	1.74 (1.27-2.40) n = 106	2.07 (1.70-2.51) n = 485
Maternal education >12 y	0.85 (0.71-1.00) n = 789	0.93 (0.68-1.27) n = 142	1.15 (0.91-1.46) n = 261	0.67 (0.49-0.91) n = 98	0.75 (0.62-0.91) n = 550
Household poverty <100% FPL	1.00 (0.82-1.20) n = 513	1.12 (0.81-1.56) n = 111	0.98 (0.73-1.32) n = 111	1.64 (1.15-2.32) n = 96	0.99 (0.80-1.22) n = 391

Abbreviations: AOR, adjusted odds ratio; BMI, body mass index (calculated as weight in kilograms divided by height in meters squared); CI, confidence interval; FPL, federal poverty level.
[a] Adjusted for age per 1-year increase, sex (reference category, female), race/ethnicity (reference, non-Hispanic white), maternal obesity (reference, maternal BMI <30), maternal education (reference, ≤12 years), poverty status (reference, ≥100% FPL), and cohort group using logistic regression, taking into account sample weights and clustering of observations within families.

had no wheezing at age 6 years[2]; among cases of persistent asthma before puberty, 40% remitted following puberty.[21] In other longitudinal, population-based studies, more than half of cases of mild asthma resolved.[22,23]

Fluctuations over time for obesity are also noteworthy. Although past reports emphasized that obesity in childhood predicts obesity later in life,[24,25] recent studies highlight individual variability of obesity during childhood. Robbins et al[26] followed up children aged 3 through 7 years in Philadelphia health centers, and although prevalence of obesity did not change after 2 years, a substantial minority changed classification. Studies of older children found less movement.[27,28] Notably, in our study, prevalence of obesity did not change from 2000 to 2006. This is likely due to the decrease in new cases at the end of the study among children in cohort 3 compared with cohort 2 and is consistent with previous reports of flattening childhood obesity rates in recent years.[29]

Previous longitudinal studies of children with attention-deficit/hyperactivity disorder demonstrated a higher degree of persistence than what we found among children with behavior/learning problems. One review estimated persistence of 69% to 79% at ages 10 through 21 years[30]; however, most subjects were patients referred to specialists or diagnosed by standardized research criteria with likely greater severity that is less apt to resolve. Patients with conduct disorder demonstrated a persistence of only 50% after 1 year, but many patients with remitted conditions met diagnostic criteria again in subsequent years.[31] In contrast, studies of patients with autism and Asperger syndrome reveal that it rarely resolves.[32,33] As behavior/learning problems often present in middle childhood, higher prevalence at the end of the study period is not surprising.

The prevalence of any chronic condition during any part of the 6-year study period was associated with male sex, minority race/ethnicity, and maternal obesity. The association between maternal obesity and offspring chronic conditions may be driven by the association between maternal weight and child weight. However, children of obese mothers were more likely to have other conditions as well. The association of maternal obesity during gestation and chronic conditions in children is beginning to be explored,[37,38] and previous studies alluded to an increased rate of health problems generally in caregivers of children with disabilities.[39,40] Associations between male sex and poverty and behavior/learning problems are congruent with other studies.[41-43] The association of minority race/ethnicity with asthma and obesity and the inverse relationship of minority race/ethnicity with other physical conditions and behavior/learning problems are consistent with previous studies.[12,43-45]

Limitations

Children's information was parent-reported and subject to recall bias. Except for obesity, the NLSY did not use objective criteria for diagnoses. Some children may have been overdiagnosed, which may affect perception of remission. The NLSY definition of chronic conditions differs from other surveys and methods, and rates cannot be directly compared.[50] We could not examine associations between disease severity and resolution. Some conditions are more common among children of older mothers, and older, more educated mothers may have different health care–seeking behaviors and access to services, which may affect prevalence of some conditions. If a child had a condition that resolved but then developed another, separate condition within the same subcategory, we categorized this child as having a persistent condition; however, this potential misclassification would bias toward the null hypothesis. Categories of behavior/learning problems and other chronic conditions were heterogeneous, and we could not make conclusions about specific conditions.

Implications

Chronic conditions in childhood are common and dynamic, underscoring the benefits of continuous, comprehensive health services for all children to adjust treatment of chronic conditions, promote remission, and prevent onset of new conditions. Future research should examine etiological differences between persistent and remitted cases.

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Study concept and design: Gortmaker, Perrin.
Acquisition of data: Gortmaker.
Analysis and interpretation of data: Van Cleave, Gortmaker, Perrin.
Drafting of the manuscript: Van Cleave, Gortmaker, Perrin.
Critical revision of the manuscript for important intellectual content: Gortmaker, Perrin.
Statistical analysis: Van Cleave, Gortmaker, Perrin.
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