Health of Children Adopted From China

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ABSTRACT. *Objective.* **Since 1989, American parents have adopted 18 846 Chinese children. This study assesses the health and developmental status of these children after their arrival in the United States.**

Patients and Methods. **A total of 452 children (443 girls) in 2 groups were evaluated. The clinic group children (n = 192) included all Chinese adoptees seen in an international adoption clinic between 1991 and 1998. The travel group comprised 260 of 325 Chinese children placed by a single Massachusetts adoption agency between 1991 and 1996 whose adoptive parents and American physicians responded to mailed questionnaires. One hundred ninety-one of the travel group children were cared for by 1 of us (N.W.H.) during the adoption process in China.**

Results. **Growth and developmental delays were frequent in the clinic group. Z scores ≤−2 were found in 39% of children for height, 18% for weight, and 24% for head circumference. The duration of orphanage confinement was inversely proportional to the linear height lag (r = .9), with a loss of 1 month of height age for every 2.86 months in the orphanage. Of the children, 75% had significant developmental delay in at least 1 domain: gross motor in 55%, fine motor in 49%, cognitive in 32%, language in 43%, social–emotional in 28%, activities of daily living in 30%, and global delays in 44%.**

The incidence of medical problems was similar in both groups of children (travel group and clinic group). Overall, among the 452 children, elevated lead levels were found in 14%, anemia in 35%, abnormal thyroid function tests in 10%, hepatitis B surface antigen in 6%, hepatitis B surface antibody in 22%, intestinal parasites (usually *Giardia*) in 9%, and positive skin test results for tuberculosis in 3.5%. One child each had hepatitis C exposure and congenital syphilis. No child had human immunodeficiency virus infection. Unsuspected significant medical diagnoses, including hearing loss, orthopedic problems, and congenital anomalies, were found in 18% (81/452) of the children.

Conclusions. **Chinese adoptees display a similar pattern of growth and developmental delays and medical problems as seen in other groups of internationally adopted children. An exception is the increased incidence of elevated lead levels (overall 14%). Although serious medical and developmental issues were found among the children, overall their condition was better than expected based on recent publicity about conditions in the Chinese orphanages. The long-term outcome of these children remains unknown.** *Pediatrics* **2000;105(6). URL: http://www.pediatrics.org/cgi/content/full/105/6/e76; *China, adoption, orphanage, institutionalized child.***

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ABBREVIATIONS. AST, asparate aminotransferase; ALT, alanine aminotransferase; HIV-1, human immunodeficiency virus type 1; SD, standard deviation; TSH, thyroid-stimulating hormone.

Over the past 10 years, the number of children adopted from abroad by American families has steadily increased. In 1988, there were 9120 children, whereas in 1999, there were 16 396 children, an increase of 58%. The distribution of birth countries of these children has changed markedly over time.[1] In 1988, for example, only 52 children were adopted from mainland China, whereas in 1999, 4101 Chinese children were adopted by American parents: 26% of all international adoptees. Since 1989, a total of 18 846 Chinese children have been adopted by American parents.

Adoptive parents, adoption agencies, and physicians caring for international adoptees have wondered whether the young age of most of the Chinese children at the time of placement reduced the frequency of health and developmental problems that have been described in children from Russia, Eastern Europe, and other regions.[2–7] Other speculations include the possibility that Chinese birth mothers may receive better prenatal care than birth mothers in other countries who relinquish their children, and the possibility that institutional care for abandoned children in China is superior to that provided in other countries. Therefore, we reviewed the health and developmental status of this enlarging group of children.

METHODS

We evaluated 2 groups of Chinese children adopted by American parents. The first group comprised 192 children evaluated in the International Adoption Clinic at the Floating Hospital for Children (clinic group) between 1991 and 1998. These children were self-referred by their families or by their primary pediatricians. All children were seen by a developmental therapist and a pediatrician (L.C.M.) and had the complete medical evaluation recommended for internationally adopted children.[8]

Routine evaluation in the clinic group included a complete history and physical examination by a pediatrician (L.C.M.). Supine length (0–24 months of age) or standing height (>2 years), weight, and head circumference were measured. Developmental evaluation was performed using the Peabody Developmental Motor Scales, the University of Michigan Early Intervention Development Profile,[9] and clinical assesssment of neuromuscular development. Developmental scores were given for gross motor skills, fine motor skills, cognition, language, social–emotional skills, and activities of daily living. Children were considered delayed if their developmental age was less than or equal to two thirds of their chronological age.[3,10] Thus, a 9-month-old child with 6-month

skills or a 36-month-old child with 24-month skills would be considered delayed. The designation globally delayed was assigned to children with 3 or more areas of significant delay.

Laboratory testing for each child in the clinic group included a complete blood cell count, urinalysis, lead level, rapid plasma reagin, thyroid stimulating hormone, thyroxine level, serum asparate aminotransferase (AST) and alanine aminotransferase (ALT), hepatitis B surface antigen and antibody, hepatitis C antibody, human immunodeficiency virus type 1 (HIV-1) antibody screen, and stool ova and parasites. Tests were performed by standard methods in the clinical laboratories of the New England Medical Center. Intradermal testing with purified protein derivative (5 tuberculin units) was performed on all children.

To evaluate possible referral bias in children evaluated in the International Adoption Clinic and to assess a distinct population of Chinese adoptees with different information available, we also included an additional group of children. The second group comprised 260 of 325 children placed by a single Massachusetts adoption agency between December 1991 and July 1996 whose physicians and families responded to questionnaires (sent by N.W.H.). Between July 1994 and July 1996, 1 of us (N.W.H.) examined and cared for 191 of these 260 children in China throughout the adoption process, after placement with their adoptive parents. All families were contacted by mail, phone, or in person within a few months of their return to the United States, except for the 43 families adopting before 1994, who were contacted by mail in June 1996. Parents were asked to submit a questionnaire about their child's health (laboratory test results and medical evaluation) to their child's American physician, who completed it and returned it directly to 1 of us (N.W.H.). Results of laboratory testing in the travel group were accepted as reported by the child's physician and not independently verified.

Thus, information on a total of 452 children was available for analysis. During this period, 15 children in the travel group were also evaluated at the International Adoption Clinic; these children were included in the travel group for purposes of analysis.

Statistics

To compare children of different ages, all anthropometric measurements were converted to *z* scores (the difference between the child's measurement and the age mean divided by the standard deviation [SD] for the child's age). For weight and height, this was calculated using the program Epi Info, Version 5 (USD, Inc, Stone Mountain, GA), based on means for age and SDs published by the World Health Organization. *Z* scores for head circumferences were calculated from age means and SDs of American children, because the World Health Organization has not published standards. Statistical comparisons included unpaired *t* tests, frequency distribution, and regression analysis, and were performed using the computer program, Statview (Calabasas, CA).

RESULTS

Clinic Group

The clinic group comprised 192 children ranging in age from 2 months to 149 months (12 years and 4 months) at arrival in the United States (mean ± SD: 14.2 ± 16.3 months). There were 188 girls and 4 boys. Age at the visit to the clinic ranged from 3 months to 151 months (mean ± SD: 15.7 ± 17.5). Children were evaluated within 1.3 ± .15 months of arrival (range: 1 week to 17 months). Eighty-eight percent were seen within 2 months of arrival; only 4 were seen >5 months after arrival.

Growth

Z scores for height ranged from −8.64 to 2.9 (mean ± SD: −1.51 ± 1.4), for weight from −3.77 to 2.4 (mean ± SD: −1.17 ± 1.00), and for head circumference from −5.2 to 1.37 (mean ± SD: −1.43 ± .93). *Z* scores ≤−2 were found in 39% of children for height, 18% for weight, and 24% for head circumference. The duration of orphanage confinement in months was inversely proportional to the linear growth lag ($r = .90$; $P = .0001$), such that for every 2.86 months of orphanage confinement, children lost 1 month of height age (Fig 1). *Z* scores for weight correlated with *z* scores for height ($r = .62$; $P = .0001$) and head circumference ($r = .404$; $P = .0001$; Fig 2A and B).

Developmental Status

All children in the clinic group had developmental testing. Delays were common. Gross motor delays were found in 55% of the children, fine motor delays in 49%, cognitive delays in 32%, language delays in 43%, social–emotional delays in 28%, and delays in activities of daily living in 30%. Seventy-nine children (44%) had global delays. Forty-nine children had mild or no delays. Compared with the remaining 143 children, these 49 children with mild or no delays had no differences in age at arrival (equivalent to duration of orphanage confinement), interval

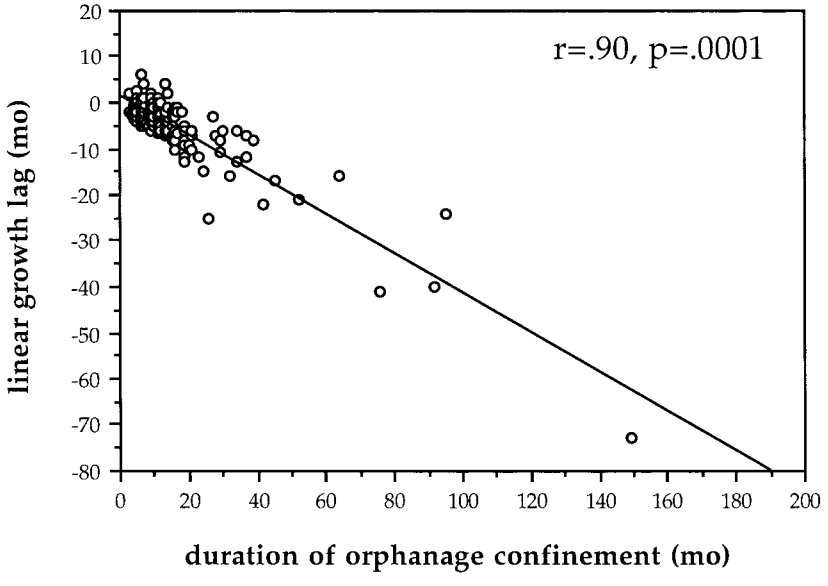

Fig 1. The linear growth in months is inversely proportional to the duration of orphanage confinement for 192 Chinese adoptees.

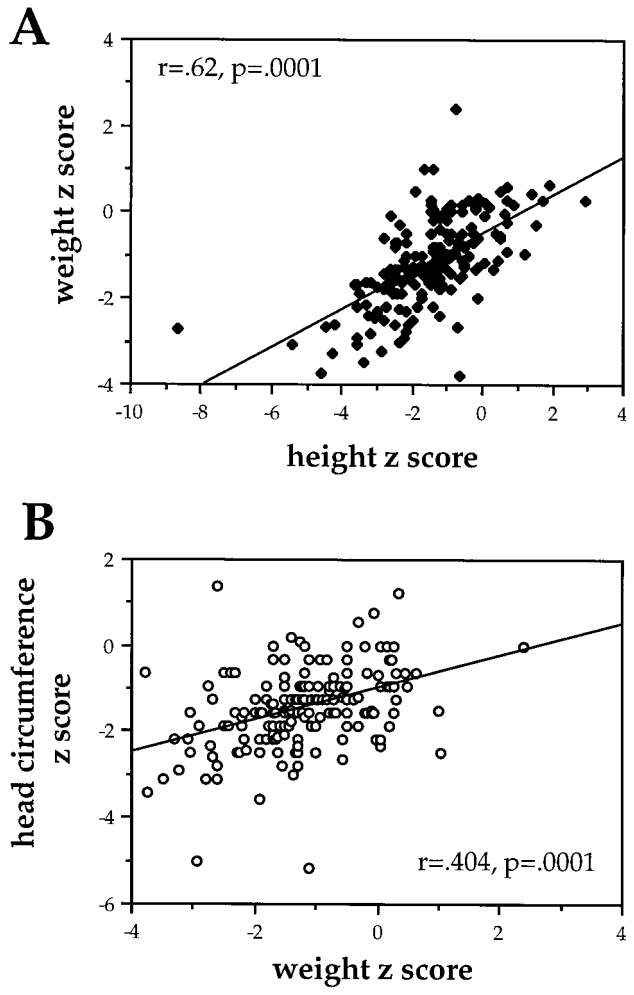

Fig 2. *Z* scores for weight correlate with *z* scores for height (A) and head circumference (B) in 192 newly arrived Chinese adoptees.

to the clinic visit, or the presence of medical problems (anemia, parasites, hepatitis B or C, lead poisoning, syphilis, tuberculosis, or abnormal thyroid or liver function tests). However, height (height *z* score was -1.09 ± 1.09 vs -1.65 ± 1.47; $P = .01$) and weight (weight *z* score was $-.76 \pm .77$ vs -1.30 ± 1.04; $P = .001$) delays were less severe in the normal children than in the developmentally delayed children. A similar trend was seen for head circumference ($-1.53 \pm .97$ vs $-1.22 \pm .78$; $P = .07$; Fig 3).

Delays in language and activities of daily living skills tended to increase with the duration of orphanage confinement, whereas delays in other domains did not show this pattern (Fig 4).

Growth and developmental delays were similar among children evaluated within 2 months or 3 months of arrival (data not shown).

Infectious Diseases

Fifteen children of 164 tested were positive for hepatitis B surface antigen (9%), while 46 of 164 (28%) of the children had antibody to hepatitis B. For most patients, it was unknown if this reflected natural or vaccine-induced immunity, although little hepatitis B vaccine was available in Chinese orphanages before 1996, when most of these children emigrated. One girl had antibody to hepatitis C; at follow-up, this had disappeared, suggesting that this was maternal antibody. Only 1 child, who was asymptomatic, had serologic evidence of congenital syphilis. Six percent of the children had Mantoux reactions >10 mm; none were clinically ill, and all had normal chest radiographs. Intestinal parasites were found in 7% (11/169) of the children: *Giardia lamblia* in 10 children, *Ascaris* in 1, and *Dientamoeba fragilis*, *Ascaris*, and *Giardia* in 1. HIV test results were negative in all children.

Other Laboratory Testing

Twenty-five children of 169 tested (13%) had elevated lead levels, ranging from 11.1 to 51 μg/dL. In 13 children, lead levels were 10 to 20 μg/dL; in 9, 21 to 30 μg/dL; and in 3, >30 μg/dL. Of the 25 children with elevated lead levels, 10 had hematocrits <35%, in 2 children concurrent hematocrits were unavailable, and 14 children had normal hematocrits. Overall, anemia (hematocrit <35%) was detected in 35% of the children. Ten children had thalassemia trait, confirmed by hemoglobin electrophoresis after correction of concurrent iron deficiency.

Abnormal urinalyses were found in 32 of the 177 children tested (17%). Abnormalities detected included pyuria alone (11 children), isolated hematuria (11 children), hematuria and pyuria (7 children), he-

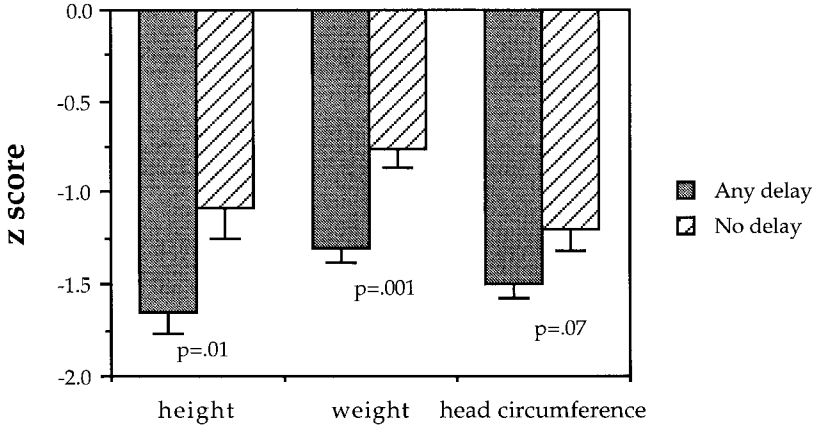

Fig 3. *Z* scores for height, weight, and head circumference were lower in children with developmental delays, compared with developmentally normal children.

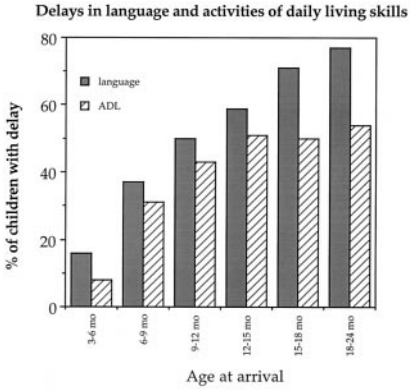

Fig 4. Delays in language and activities of daily living skills tended to increase with duration of orphanage confinement.

maturia and proteinuria (2 children), and isolated proteinuria (1 child). In 4 children, these abnormalities related to urinary tract infections. In all 32 children, urinary abnormalities resolved at follow-up.

Twenty children of 163 tested (12%) had abnormal thyroid function test results, including elevated thyroid-stimulating hormone (TSH; 14), elevated T4 (5), or both elevated (3). Abnormal results did not relate to specific developmental delays.

Of the children without hepatitis B, 23% had elevated liver function tests: 14 children had isolated elevations in AST, and 26 had elevated AST and ALT levels. In 11 children, ALT levels were less than twofold increased; in 2 children, ALT levels were increased twofold to threefold; and in 3 children, levels were increase fourfold to sixfold. In all, follow-up levels were normal within 3 months.

Other Medical Diagnoses

Unsuspected important medical diagnoses in this group included: hearing loss (6), strabismus (6), hip dysplasia (4), ear tags/preauricular ear pits (2), severe growth delay (2), pervasive developmental delay (2), and congenital heart disease (1 each with atrial septal defect and tetralogy of Fallot). Other diagnoses, found in 1 patient each, included severe rickets, torticollis, Blount's disease, umbilical hernia, severe genu valgum, seizure disorder, congenital toxoplasmosis, and a platelet anomaly. Isolated dysmorphic features were found in 4 children (1 each with malpositioned thumbs and finger flexion contractures, hypertelorism, hemihypertrophy, and clinodactyly). Only 1 birth defect, a cleft lip/palate, was identified before the adoption. Overall, 36 of 192 children had an unsuspected significant medical diagnosis.

Active infections were present in a small number of children (pneumonia [2], otitis media [2], thrush [1], and scabies [1]).

Travel Group

The travel group comprised 260 children from 26 different orphanages in 7 provinces in China. There were 5 boys and 255 girls. The assigned ages of the children at adoption ranged from 2 to 52 months old (mean: 6.5 months). Children now reside with their parents in 15 states in the United States and 2 foreign countries.

Infectious Diseases

Hepatitis B surface antigen testing was performed in 242 of 260 children. Of these, 3.7% or 9 of 242 children tested were positive for hepatitis B surface antigen. Surprisingly, 18 children were not tested; the physician questionnaire often included phrases such as "hepatitis testing not indicated," "testing was negative in China," or "I plan to give vaccine instead." Hepatitis B surface antibody testing was performed in 183 children and was positive in 29 children or 16%. Hepatitis B core antibody, representing acute or past infection, was present in 16 of 65 children tested. Of these, 3 had isolated core antibody, 6 were surface antigen-negative and surface antibody-positive, 5 were surface antigen-positive and surface antibody-negative, and 2 were surface antigen-positive with surface antibody not tested.

Stool parasites were found in 21 of 184 (11%) children tested. *Giardia lamblia* was most common, found in 13 children. Five children had *Ascaris* infection, and 1 child had both *Giardia* and *Ascaris lumbricoides*. In 1 child, *Dientamoeba fragilis* was identified, and in another child, the parasite was not specified. Stools were tested for bacterial pathogens in 86 children. Four were positive for *Salmonella*, 2 for *Campylobacter*, 2 for both *Salmonella* and *Campylobacter*, and 1 for *Clostridrium difficile*.

Skin testing for tuberculosis was performed in 212 children. Positive skin test results were reported in 4 (2%), but the size of induration was not given. In many children, skin testing was inappropriately deferred because of the presence of a Bacille Calmette–Guérin scar. No child had symptomatic tuberculosis.

Only 143 (38%) of the children were tested for syphilis, although this test is rarely performed in Chinese adoptees before placement. All test results were negative. Only 45 children (17%) were tested for HIV; all results were negative.

Other Laboratory Testing

Lead testing was performed in 174 of 260 children (67%) within 1 year of arrival. Levels were >10 μg/dL in 24 of 174 children tested (14%). These children had resided in 10 orphanages in 5 provinces. Sixteen of 24 children (67%) with elevated lead levels came from Hunan province, and 4 came from Hubei. In 8 children, levels were >20 μg/dL. Seven of these 8 children came from 3 orphanages in Hunan province, which also had the highest number of adoptions. Four children (16.5%) with lead levels >10 μg/dL were from Hubei. Overall, 106 of 260 (41%) children were adopted from Hunan, and 21% were from Hubei.

The date of lead testing was available in all 174 children. In 116 children, lead levels were tested within 1 month of arrival in the United States, in 27 children between 1 and 3 months after arrival, in 31 children between 3 and 12 months after arrival. Among the 24 children with lead levels >10 μg/dL, 11 had hematocrits $\geq 35\%$, 8 hematocrits $<35\%$, whereas in 5, no hematologic tests were performed.

Of the remaining 236 children, 98 had normal hematocrits, 85 were anemic, and 53 were not tested.

Only 45% of the children in the travel group (118) had any assay of thyroid function. In 39 of these children, this was accomplished by sending tests for newborn screening to state boards of health. In questionnaires returned from physicians of 11 children, thyroid function was designated normal. TSH only was checked in 9 children, T4 only in 34 children, and both T4 and TSH in 25 children. T4 levels were given for 59 children and were elevated in 2 and diminished in 6. TSH levels were elevated in 5 children. Overall, 6% of children tested had abnormal results. Abnormal results did not relate to specific developmental delays.

Other Medical Diagnoses

Other medical diagnoses in this group included: unsuspected hearing loss (6, including 1 child requiring bilateral hearing aids and 1 requiring cochlear implants), recurrent soft tissues infections (6), chronic otitis media (12), congenital hip dislocation (2), strabismus (3), congenital cardiac disease (1 each with pulmonic stenosis and ventricular septal defect), seizure disorders (2), febrile seizures (2), recurrent urinary tract infections (4, including 1 child with reflux), immunoglobulin G4 subclass deficiency (1), and various congenital anomalies (1 child each with severe dental hypoplasia, giant nevus, giant hemangioma, missing digits, duplicated thumb, bilateral club feet, and synbrachydactyly). One child had an amputated ring finger reportedly caused by a rat bite. In only 1 child, with a cleft lip/oral nasal fistula, was the anomaly reported to the family before the adoption. One child developed mumps within 1 month of arrival.

Comparison of Travel Group and Clinic Group

The incidence of some medical problems was similar in both groups of children. Similar numbers of children in each group had lead poisoning (14% in both groups), anemia (35% both groups), parasites (11% in travel group and 7% in clinic group), positive skin test results for tuberculosis (2% in travel group and 6% in clinic group), and abnormal thyroid function test results (6% and 12%; $P = .07$). The clinic group had a higher incidence of positive hepatitis B surface antigen (9% vs 3.7%; $P = .04$) and antibody (28% vs 16%; $P = .004$). Because children with these markers were asymptomatic, it seems unlikely that this resulted in a bias of the clinic population. Overall, among the 452 children included in this study, the incidences for these conditions were: hepatitis B surface antigen, 6%; hepatitis B surface antibody, 22%; lead toxicity, 14%; parasites, 9%; tuberculosis, 3.5%; anemia, 35%; and abnormal thyroid function test results, 10%.

Unsuspected medical conditions were found surprisingly consistently in the 2 groups of children. Six children in each group had significant hearing loss, 2 in each group had unrecognized major cardiac anomalies, various significant birth defects (including hip dysplasia) were found in 11 of the clinic group and 10 of the travel group. Strabismus, 1 of the more obvious birth defects, was more frequent in the clinic group than the travel group (2% vs .7%). Overall, an unsuspected, significant medical diagnosis was present in 18% of each group.

DISCUSSION

Cultural, economic, and political forces in China have resulted in an extraordinary increase in the numbers of Chinese children placed with adoptive families in the United States over the past 10 years. Most of these abandoned children are girls, attributable to strong cultural preferences for sons and the incentives for a 1-child family.[11,12] Many adoption professionals suppose that the Chinese girls have been healthier than the Eastern European children, in part, because they are generally younger at the time of adoption. Notably, in 1996, the China Center for Adoption Affairs (the national authority) reorganized, with resulting delays in adoptive placements. Children often now remain in institutional care for >1 year. It is hoped that these delays will be minimized in the future as new political appointments are made. Although foster care is now being used in some areas of China, the children included in this study nearly all resided in orphanages before adoption.

Medical information from China given to prospective adoptive parents about their children is minimal and often outdated or inaccurate. Typically, a medical report consists of a physical examination form in which every space is filled out "normal." Usually, a single set of growth measurements is given, often from many months or even a year, previously. Children are usually weighed with many layers of clothing on. Currently, medical reports often include results of hepatitis B surface antigen testing and liver function tests, but this was not so before 1996 for most children. No child is released for adoption who is known to be hepatitis B surface antigen-positive, except under unusual circumstances (1 of a twin, for example). Currently, some preadoptive chest radiographs are performed as well.

During the early 1990s, Chinese adoption authorities designated that healthy children could be placed only with parents without other children. Parents who already had children were offered special needs children. The special needs designation was assigned to children with obvious birth defects, but many other children received this designation because of square skull or pigeon breast deformity (which may be signs of rickets), a nevus or hemangioma, or even no obvious abnormality. The 3 most severely developmentally delayed and microcephalic children in the clinic group were all offered as healthy children to their adoptive parents. In the travel group, several children with obvious congenital heart disease, 2 with hip dislocations, several with marked esotropia, and children with anomalies were offered as normal children. On initial evaluation in China, 5 children had such severe impairments that different children were requested to be assigned to the adopting parents. Thus, the designations of normal or special needs seemed to poorly match the actual status of the children we evaluated.

One problematic area in the evaluation of the Chinese children has been their uncertain dates of birth. Typically, children are abandoned in public places, such as markets, police stations, hospitals, or orphanages. Most are reportedly abandoned as newborns. A very small number of children are found with notes pinned to their garments giving their lunar dates of birth; the reliability of this type of report is unknown. For many children, however, the story of their abandonment is not known with certainty, and an assigned age is given by the orphanage staff. Although the age assignment may be adequate, sometimes it is clearly in error. Our policy has been to observe the children for 6 to 12 months to monitor catch-up growth and development and then consider age reassignment if needed. Only 2 children in our study had age reassignments.

Although the health problems of international adoptees in general have been described, the increasingly large group of Chinese children has not been previously reported. We examined the health status of 2 distinct groups of children adopted from China, 260 children who traveled from China within a 4.5-year period, and 192 children visiting an established international adoption clinic. We wished to study both groups for several reasons. First, this allowed us to collect data on a total of 452 Chinese adoptees. Second, by including the travel group, we were able to ascertain the general health status of these children without the potential referral bias inherent in studying a population of children seeking care at a specialized international adoption clinic. Because most parents made appointments at our clinic before travel, we suspected that this bias was minimal, and indeed few differences were detected in the incidence of medical problems between these 2 groups of children.

Although we did not identify children in these groups with fetal alcohol syndrome, drug exposures, or HIV infection, these problems may appear in future children offered for adoption.

The long-term effects of the various medical problems, malnutrition, and developmental delays in this group of Chinese adoptees are unknown. The incidence of school problems such as hyperactivity, attention deficit disorder, learning disabilities, and persistent language delays will become apparent as the children age and enter the school years. Ten percent of children had abnormal thyroid function. Dietary changes at adoption may have reduced the incidence and/or severity of these abnormalities, if as suspected, they resulted from previous dietary iodine deficiency. The long-term effects of this condition remain to be determined. Frequent dental caries are also emerging as a problem, despite the fact that many of the children in this report were <6 months of age when adopted.

Of great concern is the 14% of children with elevated lead levels. China is a country with leaded gasoline and rice-growing fields adjacent to roads everywhere. In addition, industrial pollution is widespread. Lead is not currently mentioned in Chinese pediatric textbooks. Unlike the United States, lead paint is probably not the source of lead intoxication in most of these children. Physicians caring for these children after arrival in the United States must be aware of the urgency of this problem and test children promptly on arrival.

Although serious medical and developmental issues were found among the children, overall their health status was surprisingly better than expected based on the publicity about the conditions in the Chinese orphanages several years ago.[13–17] Clearly, the children selected for adoption may represent the healthiest abandoned children living in institutional care in China.[18] Although adoptive parents formerly were invited into the orphanages to see the living conditions of their children, this stopped abruptly in 1996.[19] The true condition of the estimated 1 million children,[15] mostly little girls, who remain institutionalized in China, is unknown.

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