Are there anthropometric differences between children with autism and healthy children?

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Abstract:

Anthropometric development and growth were assessed in two groups of 6- to 9-year-olds: children with autism or autism spectrum disorders (ASDs) and typically developing (TD) children.

This was a case-control study conducted during 2010 in Valencia, Spain. The body mass index (BMI) (kg/m2) of 40 ASD children and 113 TD children from the same area of residence and similar socioeconomic backgrounds were compared with the corresponding BMI percentile. The sex and age-adjusted odds ratios for being underweight in ASD children was 2.41 compared to TD children. Further, the BMI distribution of the autistic boys and girls was significantly offset to lower values with respect to that of the controls (p= 0.024). In particular, 20% of the ASD children had a BMI below the fifth percentile vs. just 8.85% of the TD children.

Our data suggest that the anthropometric development of ASD children should be monitored as part of routine care.

Key words

Autism. Autism spectrum disorders. Anthropometric growth. Physical growth. BMI. Spain.

There has been a long tradition of attempting to correlate anthropometric variables with specific psychiatric disorders. Autism spectrum disorders (ASDs) represent a range of neurodevelopmental disorders, characterized by impairments in social relationships and interactions, imagination, and communication, as well as tendency to repetitive behavior1. The most recent statistics have indicated a prevalence of ASDs of an average of 6.7 cases per 1,000 children aged 8 years, across six sites monitored by the Centers for Disease Control and Prevention2. As there are an increasing number of children under care for autism or ASD3, there is interest in treatment not only for the developmental and behavioral aspects of autism, but also in the identification, prevention and treatment of significant co-morbid conditions that might have adverse consequences, such as a negative effect on quality of life or on anthropometric development. The neurological and behavioral comorbidities that are sufficiently common in patients with autism and other ASDs to be of concern include mental

retardation, attention disorders, obsessive-compulsive disorders, anxiety and depression, and epilepsy1. There may also be associated gastrointestinal (GI) or immune system abnormalities4, as evidenced by reports of GI symptoms (diarrhea, and cramping) and GI inflammation in children with ASDs5.

Anthropometric measurements such as growth chart data and body mass index (BMI) are a primary source of data for assessing growth and nutrition. As a consequence of their behavioral differences or associated comorbid conditions, some children with autism or another ASD might have anthropometric development that is suboptimal, similar to children with other physical or developmental disabilities that affect eating behavior, nutritional intake, and activity levels. In particular, children with ASDs may be at risk of suboptimal development because of poor nutrition (e.g., low dietary calcium and vitamin D intake) associated with their repetitive or restrictive dietary intakes6; the adoption of gluten- and/or casein-free diets7,8,9; the use of medications that suppress appetite or interfere with metabolism; and/or decreased or limited physical activity and exposure to sunlight (i.e., low endogenous vitamin D) associated with activity restriction, motion disorders and requirements for supervision.

Our objective was to examine height, weight and BMI in children diagnosed with an ASD, compared with children with typical development from the same area of residence.

Methods

Sample

Forty 6- to 9-year-old children with autism or another ASD (cases) were enrolled on the case-control study. As there were too few girls in any one age category for meaningful statistical analysis (n = 5 total) by age, we only considered subgroups of the children by sex, reporting analysis of the data on 35 boys and 5 girls as well as the total group. The results are compared to a matched group of 113 children (boys and girls) with typical development (controls).

The cases were recruited from a special school for disabled children in Valencia, Spain (run by the Autism Project Association [ASPAU] and the Mira´m Foundation) in Spain. All the children diagnosed with an ASD attending this school were invited to participate in this study. Notably, as the prevalence of ASDs is higher in boys than in girls, there are fewer girls with these disorders at the school. Of 44 eligible cases identified, 4 were contacted but declined to participate; the remaining 40 children agreed to enroll on the study.

Definition of Spectrum Disorders and controls

Recent years have seen a growth in assessment instruments for diagnosing autism in children. In our study, we explored the combined use of two standardized assessment instruments--the Autism Diagnostic Interview Revised (ADI-R) and the Autism Diagnostic Observation Schedule-Generic (ADOS-G), which are both widely used10,11. For all children in the ASD group, a 'best estimate' clinical diagnosis was reached. The findings showed good agreement between the instruments especially for children with core autism. We consider that the instruments have a complementary effect in aiding diagnosis.

Children with DSM-IV-TR diagnoses other than oppositional defiant disorder and simple phobia were excluded from the study. In addition, children with ASD were excluded from the study if they were taking long-acting psychoactive medications (i.e., other than stimulants).

Control children were eligible for the study if they met the following criteria: no evidence of a neurological disorder; no diagnoses of ASD in any immediate family members (siblings, parents); free from diagnosis on a standardized psychiatric parent interview, the DICA-IV 12 (with exception of simple phobia); no elevated scores on the CPRS13; and no history or current use of any psychoactive medication. Diagnosis of any chronic disease was an exclusion criterion for the control group. A total of 113 healthy children were identified as eligible controls for this study.

Children with typical development were recruited as controls from grades 1 to 4 in “Colegio San Cristóbal de Picassent” (Valencia, Spain), an elementary school in the same area as the special school attended by those in the case group. This elementary school was recommended by the staff of the local education board as having children with similar socioeconomic backgrounds to those attending the special school.

Before we started the study, we explained the tests that would be carried out to the parents of all the children involved, including that data collected would be kept confidential in line with Spanish data protection law, and obtained their informed consent. In addition, the study was approved by the Ethics Committee of the Dr. Peset Hospital in Valencia.

Data collection and measures

Subjects were recruited for a broader study of the early childhood growth in relation to autism and ASDs in 6- to 9-year-olds. All children in the case group were evaluated at the center and had received a clinical diagnosis of autism or another ASD. The diagnosis was based on the Fourth Edition of the American Psychiatric Association’s Diagnostic and Statistical Manual of Mental Disorders IV-TR14 , Autism Diagnostic Interview Revised (ADI-R) and the Autism Diagnostic Observation Schedule – Generic (ADOS-G). Other eligibility criteria included absence of other chronic illnesses that might affect growth, absence of repeated or recent steroid use, and the availability of both biological parents to participate in the study.

Invitations to participate in the study were sent by mail to potentially eligible families, and responders were screened for eligibility by telephone and an appointment scheduled for an examination for the study. Those who did not respond to the mailings were invited to participate by telephone, and then if they agreed and met the eligibility criteria were given an appointment. Written informed consent was obtained from the parents of each participant (or whichever parent accompanied the child) at the time of the visit.

Examination Protocol and Measurements

At the visit, parents were interviewed using a brief questionnaire to elicit information about the child’s past medical history, use of over-the-counter and prescription medications, vitamin and mineral supplements, and any special dietary restrictions or food allergies. Prescription medications were grouped into categories based on their potential to affect dietary intake, growth, or calcium metabolism. In particular, categories were created for all the specific anti-epileptic drugs, stimulants, appetite suppressants, and appetite stimulants that were being taken by participating children.

Height and weight of all the participants (both cases and controls) were recoreded by the same research assistant. Height (in centimeters) and weight (in kilograms) were measured using standard anthropometric techniques15, with a SECA 213 stadiometer (height) and SECA 813 scales (weight). All anthropometric measurements were obtained in duplicate and averaged. The body mass index (BMI, kg/m2) was then calculated from the height and weight. Based on the percentile ranking obtained, BMI status was classified into the following four categories: obese (BMI ≥95th percentile), overweight (BMI ≥85th to <95th percentile), healthy (> 5th to <85th percentile) and underweight ≤5 th percentile).

Statistical Analysis

Socioeconomic background and other relevant characteristics were described as means ± standard deviations (SD) or percentages, as appropriate. The mean z-scores for height, weight, and BMI were tested for statistical significance from zero to determine whether the case and control children were either smaller or larger than average. We used analyses of variance models with age group as the main effect.

The age and anthropometric characteristics are reported as least square means (±standard error of the mean, SEM). In the models, we considered BMI (obese, overweight, healthy and underweight) and dummy variables for severity of disease (autism or ASD). Only significant covariates and those which were known a priori to be associated with development, age and sex were retained. For the deviations and percentage deviations, differences between the least square means were also tested for significance, to determine whether they differed from the reference medians. We used logistic regression analysis to estimate crude odds ratios (cORs) and 95% confidence limits (95% CI), and to take into account possible confounders, age and sex, also we calculated adjusted odds ratios (aORs). All analyses were performed using SPSS® (Statistical Package for Social Sciences) v17. In this study, the level of significance was set at 0.05.

RESULTS

All participating children were between 6 and 9 years old, ASD children (cases) and TD children (controls).

Table 1 summarizes the anthropometric characteristics (age, weight, height and BMI) of the two groups, those diagnosed with an ASD and TD children, stratified by sex. There were significant differences between the mean ages, comparing the children with ASDs to the control group, and also between the subgroups of boys with and without ASDs, though not among the girls. Specifically, boys with an ASD were significantly younger than boys with typical development (6.90 vs. 8.29 years).

In terms of height and weight, we found significant differences between the two groups, both the totals and the subgroups by sex, with children with ASDs being both shorter and lighter. This same pattern was seen comparing the BMIs, which overall was significantly lower among those with an ASD, though we found that the difference was not statistically different between the subgroups of girls ($p=0.102$).

Results from the one-way ANOVA confirmed that there were significant differences in weight, height and BMI. Table 2 reports the ≤5th, >5th to <85th, ≥85th to <95th and ≥95th percentiles of BMI for the two groups of children, using the values for the TD children as a point of reference. We found that the BMI distribution was shifted to the left among children with an ASD compared to TD children, that is, the cases had lower BMIs than the controls and the difference was statistically significant ($p<0.024$).

In Table 3, children with ASDs are compared to the healthy children by BMI category, with controls as the reference. The cORs indicate a higher probability of being overweight in girls with an ASD compared to girls with typical development; however, since we had found differences in age between cases and controls among girls (as

reported in Table 1), we recalculated the ORs adjusting for this factor. In the total groups (girls and boys with and without ASD) we also adjusted for sex, given that, as noted above, there were statistically significant differences between the case and control groups. The aORs indicate that the probability of being underweight was higher for the children with ASDs overall, but the girls could not be analyzed separately due to the small sample size. In summary, children with autism or another ASD were more likely to be underweight (BMI ≤5th percentile) than healthy children (aOR=2.41, 95% CI: 0.35-4.47).

DISCUSSION

A possible shortcoming of the current study was the use of children with typical development as a healthy reference population. On the other hand, cases and controls were similar in terms of ethnic group, socioeconomic status and living conditions.

The present study found that the BMI percentile of ASD children was significantly lower than that of matched controls from the general population after adjusting for both sex and age.

The exact reason for BMI being lower among autistic children is unknown. Possible mechanisms include neuroendocrine factors, reduced appetite, and a higher level of stress leading to increased energy expenditure. In addition, it is common that autistic children show some form of abnormal eating behavior, which might result in reduced energy intake, and hyperactivity may be another underlying factor. On the other hand, none of the children involved were referred for nutritional problems. Further, we are not aware of any studies demonstrating sex differences in eating problems among children with ASDs.

Increasingly, researchers are exploring clinical variables to use as a basis for meaningful subgroups in these disorders that may share some common etiological underpinning. Given the results of lower BMI in boys with ASDs, this clinical variation may be a potential stratification factor for clinical and genetic studies.

On the one hand, nutritional requirements are the same in the two populations, children with typical development and those with an ASD, in terms of the need for a balanced, varied, moderate, sufficient and pleasant diet 6,16,17,18. On the other hand, however, it is also true that some children with ASDs have limited food intake from preschool age onwards 19,20,21. According to what we have found in the literature, there have been relatively few studies focused on the growth and nutritional status of children with ASDs, and to date no great differences have been found with respect to control groups. Moreover, some of the studies which have been conducted may not be statistically valid as they did not use control groups, were case studies, involved mixed age groups, had small sample sizes, did not specify clear inclusion criteria and/or did not take phenotypic variation between individuals into account. Of the research which clearly has this type of statistical weakness, we draw attention to the following: a paper by Whiteley P et al. (2004)22 reporting a study in which the growth curves tend towards

high values with respect to the reference group, and one by Lainhart JE et al. (2006)23 on a cohort study showing similar levels of stature to that in a control group of individuals with typical development.

In the USA, the prevalence of being overweight among ASD children is similar to that in the general population, and this could be a result of the eating habits in that country24. In contrast, in other countries the distribution of BMI in ASD children has been found to be shifted to lower values than “normal” controls25,26, consistent with our findings, and this could be more attributable to levels of activity than to eating disorders7. Keen (2007)17 states that substantial abnormalities in height or weight seem to be rare, despite the first published discussion of this issue 28, and repeated references to eating disorders. Indeed, Curtin A et al (2010)29, based on US nationally representative data, report that the prevalence of obesity is at least as high among those with ASDs as among children overall. Further, Xiong N et al. (2009)30 found high values of BMI among ASD children in the sample they studied. Emond A et al. (2010)31 did not find significant differences in BMI between cases and controls, despite parents reporting that the children with ASDs were difficult, selective and demanding eaters, who started eating solids relatively late and resisted trying new foods, and the estimates suggested that energy intake was similar in the controls of a similar age. Herndon A. et al. (2009)32 found few differences in average nutrient intake between children with ASDs and children with typical development. While some children with autism do have serious eating problems33, in general the problems are related to specific characteristics, such as lack of appetite, a narrow range of favorite dishes, and autonomic nervous system disorders affecting the intestine, which are more common among autistic children than healthy controls. These authors conclude that, though there are rarely nutrient deficiencies, the physical growth of children with autism may be delayed, to different degrees, and this can be accompanied by other problem behaviors.

Limitations of the study

The main limitation of our study is the relatively small sample size, which could have affected whether differences between groups reached statistical significance.

CONCLUSIONS

In our study, we found there were significant differences in weight, height and BMI between cases and controls. All three characteristics were offset to lower values in the cases with respect to controls. On the one hand, growth is very sensitive to the balance between energy intake and total energy expenditure (basal metabolic rate + growth + physical activity + diet-induced thermogenesis), especially in children at this stage of

development and, on the other, the estimates of energy, macro- and micro-nutrient intake are similar in the two groups and so do not seem to be compromised per se. Accordingly, the differences is anthropometric characteristics could be attributed to physical activity patterns of children with ASDs or to development being different in children with ASDs to those with typical development. Our data suggest that anthropometric development should be monitored as part of the routine care of children with ASDs.

We conclude that more research is needed in this field. In general, this aspect of development needs more attention, including participation from the parents of children with ASDs. Given the findings, pediatricians and parents of children with ASDs need to monitor is the potential situation that intake is insufficient to compensate for hyperactivity, and consider the prevention of deficiencies a high-priority nutritional goal.

Replication and mechanistic research studies are warranted.

The authors have no conflicts of interest to declare.

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