



Original article

Health status and nutritional development of adopted Ethiopian children living in southern Spain: A prospective cohort study

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ABSTRACT

Objective: The first aim of this study was to evaluate the health status and anthropometrical development of adopted children from Ethiopia living in southern Spain. A second aim was to evaluate the association between these parameters and adherence to the Mediterranean dietary pattern.

Methods: The study sample included 53 adopted children from Ethiopia and a matched sample of 54 native-born children. A physical examination of the children, including height and weight, was conducted in Ethiopia at the time of entry into the adoption process. Height and weight were re-measured at the first day of adoption and 6, 12, and 24 mo after adoption. After 2 y of follow-up, another physical examination was performed, including the KIDMED test, to measure adherence to the Mediterranean diet.

Results: Skin and digestive conditions were the most prevalent disorders in Ethiopian children before adoption and at the end of follow-up. Baseline anthropometric characteristics indicated a low wasting prevalence (7.5%); however, stunted growth was more prevalent (35.8%). After 6 mo, the weight-for-age of Ethiopian children was restored (change from baseline $P < 0.001$), and not significantly different from the Spanish children at 1-y after adoption. Height-for-age also increased from baseline ($P < 0.001$). A higher KIDMED score was associated with increased weight-for-age ($r = 0.279$; $P = 0.045$) and height-for-age ($r = 0.385$; $P = 0.004$).

Conclusions: This prospective study of adopted Ethiopian children confirmed a rapid growth development that occurred from the beginning of the adoption process and continued after the 2-y of follow-up. A higher adherence to the Mediterranean diet was associated with better growth development, which reinforces the importance of a balanced and adequate diet in growing children.

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Introduction

Adoption of children from developing countries has increased over time, becoming an important social phenomenon. From a health perspective, children adopted from developing countries are considered at higher risk, as the incidence of health problems is significantly higher than in native-born children [1]. Among the main health problems detected in these children, neurologic development, physical growth, and nutritional disorders are the most

frequent, although anemia, infectious diseases, acute respiratory infections, and intestinal parasitosis also are common [2–4].

Adoption is a turning point in the evolutionary development of children. It means the beginning of a period of stability in "optimal" psychological and physiologic conditions for their development [5]. Three kinds of risk factors for the proper development of adopted children have been identified: birthplace, risk factors before institutionalization, and risk factors that appear during institutionalization [6]. However, to our knowledge, very few studies have examined the consequences of adoption and the subsequent health and nutritional evolution of these children.

Previous studies that focused on the health status of adopted children have highlighted significant growth delays at the time of arrival in their adoptive families [7,8]. Ethiopian children, who are most frequently adopted in Spain, have been studied in a few previous prospective studies, but none have been performed in our

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environment. Demographic data from Ethiopia have described that 29% of Ethiopian children are moderately to severely underweight, and 44% showed lower height. Additionally, malnutrition has been described as being responsible for 54% of infant mortality [9], which suggests that adopted children from Ethiopia may be at higher risk for nutritional disorders. A previous study also described the health status and development of adopted children from Ethiopia, showing that these children had better growth than adopted children from China, Guatemala, or Russia [6]. The authors speculated that children from Ethiopia spend less time in institutional care and more time with their biological families, although there may be other differences in terms of the quality of institutional care or other growth differences of an ethnic nature [6].

One of the most striking changes for Ethiopian children may be related to the adoption of the Mediterranean dietary pattern [10]. Although the traditional Mediterranean diet has been associated with many health benefits, the evolution of food consumption in Mediterranean countries is currently not encouraging as the population moves toward a higher intake of energy-dense, nutrient-poor foods [11]. However, to our knowledge, there are no previous investigations of the adherence of Ethiopian children to a Mediterranean dietary pattern after adoption or on the association between the Mediterranean diet and developmental growth of these children. This study aimed to examine the health status and

anthropometrical development of Ethiopian children after 2 y living in southern Spain. A secondary objective was to evaluate the association between adherence to the Mediterranean diet and the anthropometrical development of these children.

Participants and methods

Design and participants

All Ethiopian children adopted in Murcia, Spain during the period January 2010 to December 2016 were eligible and invited to take part in the cohort (N = 336). Families were contacted through email or by telephone, and 176 families volunteered to take part in the study (52.4% response rate) and 53 completed all the baseline evaluations. During the same period, a matched sample of 57 children from Murcia (31 girls and 26 boys of the same age), were also recruited for the purpose of comparison between the sample of adopted Ethiopian children and native-born children. The sample of native-born children was obtained through collaboration with two schools in Murcia. Figure 1 provides a flow diagram of the study.

The study was carried out after receiving written authorization from the Collaborative Entities of International Adoption –Asociacion Motivacion Familia Y Recursos Matrimoniales (AMOFREM; Murcia, Spain). The Ethics Committee of this Association approved the study. The data obtained in the present work was stored in this association. Parents were informed orally and in writing about the study. They were also given an explanation of the ethical aspects of the project, informing the possible participants about the main objective of the study and guaranteeing the confidentiality and anonymity of the data, in accordance with the Declaration of Helsinki and Biomedical Research Spanish Laws. All parents of Ethiopian and Spanish children provided written informed consent.

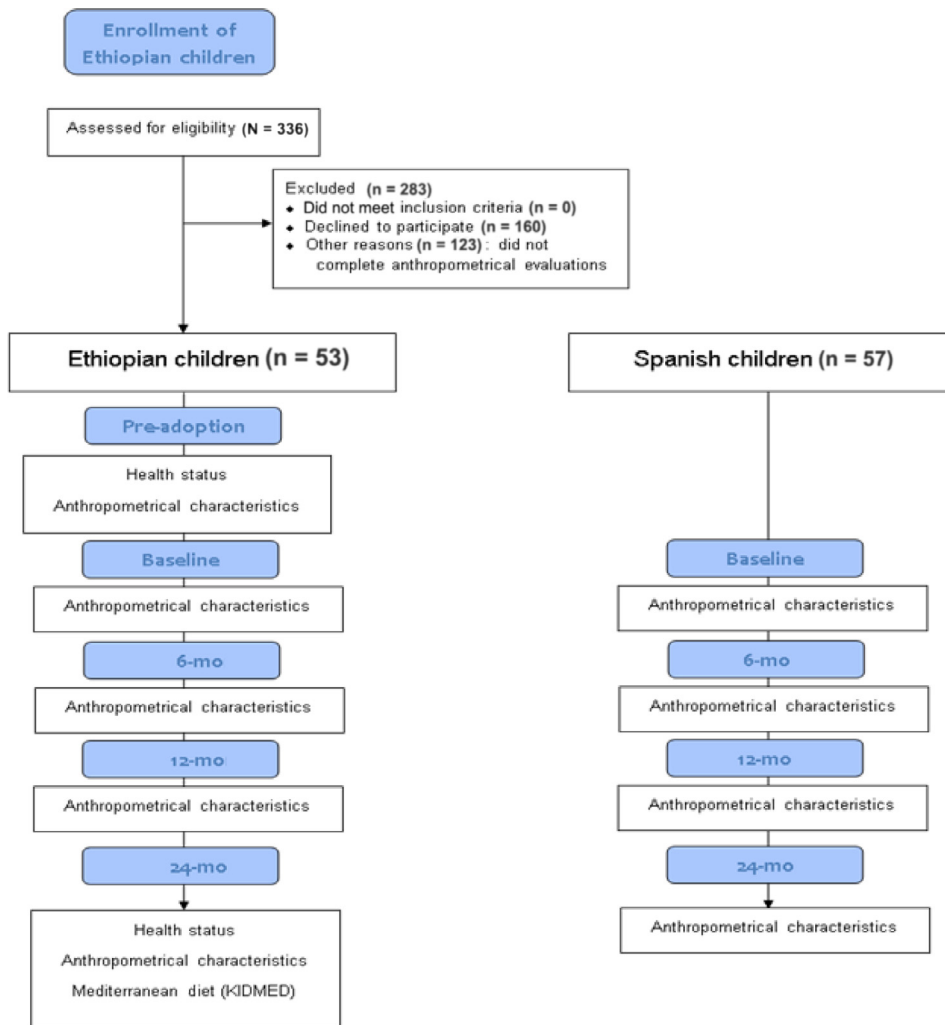


Fig. 1. Flowchart of the present study.

Measurements

A physical examination of the adopted children was conducted at the time they entered the orphanage in Ethiopia (pre-adoption period). This data was accessed through the AMOFREM. This physical examination evaluated the presence/absence of visual, hearing, cardiovascular, respiratory, digestive, cutaneous, reproductive, cognitive, psychomotor, infectious, and dental problems or any other clinical condition of interest. Other sociodemographic data, such as age (as reported by the Ethiopian adoption center), sex, and duration at the institution/orphanage were recorded. The same physical examination was performed at the end of the follow-up period (2 y after adoption).

Height and weight measurements were taken before adoption, at the time of arrival in Murcia (baseline), and at 6, 12, and 24-mo later. The same measurements were obtained from both Ethiopian and Spanish children following the World Health Organization (WHO) guidelines for the evaluation of children growth [12]. Body mass index (BMI) was calculated as the weight in kilograms divided by the squared height in meters. All measurements were z-standardized according to the WHO Child Growth standards. To better interpret the growth pattern of Ethiopian adopted children, height-for-age, weight-for-age and BMI-for-age parameters were calculated using the WHO-Anthro 3.0 Software [13]. Measurements were performed in the respective community health centers and recorded in a growth chart report by the pediatric nurse staff, from which parents reported the required study data.

At 2 y of follow-up, Ethiopian children completed the KIDMED to evaluate their adherence to the Mediterranean dietary pattern [14]. This validated test is composed of 16 items, divided into 12 items that are considered healthy habits (e. g., higher consumption of oil, fish, fruits, vegetables, cereals, nuts, pulses, pasta or rice, dairy products, and yogurt), and 4 items related to unhealthier habits (e.g., higher consumption of fast foods, baked goods, sweets, and skipping breakfast). The presence of healthier habits was scored as +1, whereas negative habits were scored as -1. The scoring range of the test is 0 to 12 points, where 0 to 3 points indicates low adherence to the Mediterranean diet, 4 to 7 describes average adherence, and 8–12 reflects good adherence to the Mediterranean dietary pattern [14]. Previous data have described a moderate to excellent reliability of this test ($\kappa = 0.6–0.9$) [15].

Statistical analysis

A frequency analysis of categorical variables, such as the presence of diseases, was estimated at the beginning and at the end of the follow-up period. McNemar test was employed to determine whether the proportion of children who had a clinical condition before adoption decreased after 2 y of follow-up. In order to analyze mean differences of anthropometrical parameters over the different follow-up times (baseline in Ethiopia, arrival, 6, 12, and 24-mo after adoption), a repeated-measures analysis of variance (ANOVA) was conducted with a post hoc test of Sidak correction, using time as the within-subjects factor, and group (sex and origin) as the between-subjects factors. The same procedure was conducted to compare progression of Ethiopian and Spanish children. In order to investigate the association between the KIDMED score and the children's growth, a correlation analysis adjusting for children's age and sex was performed. The data were

Table 1
Baseline characteristics of Ethiopian children.

	Ethiopian children (N = 53)
Girls, n (%)	18 (34)
Boys, n (%)	35 (66)
Age, mo	21 (6 to 36)
Weight	10.5 (7 to 15)
Weight-for-age z-score	-0.91 (-1.89 to -0.10)
Height, cm	80 (63 to 94)
Height-for-age z-score	-1.16 (-2.76 to -0.13)
BMI	16.10 (14.70 to 17.90)
BMI-for-age z-score	0.20 (-0.93 to 0.90)
Weight-for-height z-score	0.27 (-1.02 to 1.12)

BMI, body mass index
Data represent median with interquartile range (Q1 to Q3)

analyzed using SPSS version 24 (IBM, Armonk, NY, USA), and a $P < 0.05$ was set to denote statistical significance.

Results

General characteristics and health status

Data from the pre-adoption report showed that the mean age of children entering the orphanage in Ethiopia was 23 mo, and the age at the time of adoption was 30 mo. There were no statistical differences in age between Ethiopian girls and boys at the time of entry into the orphanage ($P = 0.160$) nor at their arrival in Murcia ($P = 0.292$).

Baseline anthropometric characteristics of Ethiopian children indicated a general malnutrition status, as most parameters (adjusted to age) showed negative z-scores (Table 1). Baseline wasting or thinness prevalence, considered as z-weight-for-length/height (WHZ) < -2 was 7.5%; whereas baseline stunted growth, determined as z-height-for-age (HAZ) < -2 was more prevalent (35.8%).

The main health problems of the Ethiopian children before adoption were related to skin, digestive, and psychomotor alterations (Fig. 2). Similarly, skin and digestive alterations remained the most prevalent disorders 2 y after adoption, although the number of cases was significantly reduced. Importantly, several medical problems not observed at baseline, including visual, cardiovascular, and reproductive disorders, were detected or appeared 2 y after adoption (Fig. 2).

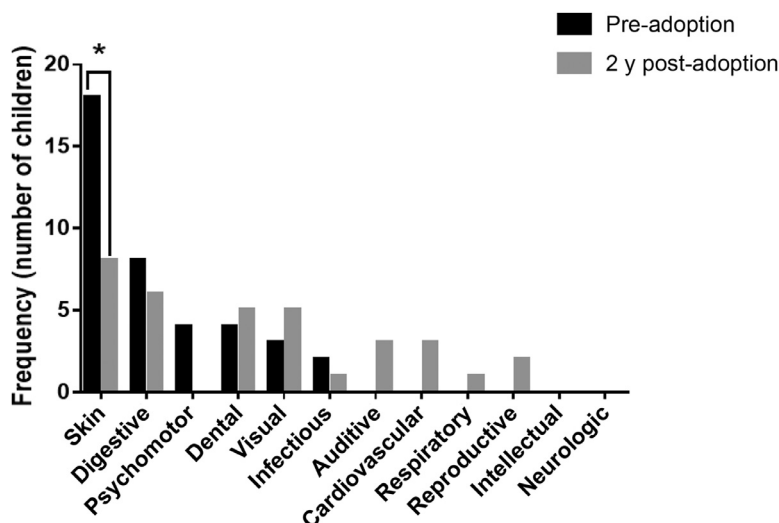


Fig. 2. Number of children with health problems before (determined in Ethiopia) and 2 y after adoption. Data represent the frequency (number of children presenting the clinical condition). To determine the possible effect of adoption on the presence of these conditions, a McNemar's test was performed. * $P < 0.050$.

Evolution of anthropometrical parameters

Among Ethiopian boys, repeated measures ANOVA revealed a significant effect of time on the different parameters evaluated (Fig. 3). Baseline z-scores of z-weight-for-age (WAZ) and HAZ indicated a delay in children's growth (Fig. 3A, B). At baseline, HAZ values were significantly lower in Ethiopian children than in the comparator group of Spanish children. However, these differences disappeared at 1 y and HAZ values were not different at 2 y of follow-up (Fig. 3B). Other indicators such as z-BMI-for-age (BAZ) and WHZ showed a similar trend for both Ethiopian and Spanish children (Fig. 3C, D).

Among Ethiopian girls, statistically significant differences for all anthropometrical parameters were observed at baseline when compared with the Spanish girls (Fig. 4). At follow-up, there was a significant improvement of WAZ and HAZ; with Ethiopian girls showing slightly higher values than Spanish girls (Fig. 4A, B). However, although BAZ and WHZ improved among Ethiopian girls during the first 12 mo, there were significant differences after 2 y compared with the Spanish girls (Fig. 4C, D).

When the evolution of anthropometric parameters among Ethiopian boys and girls was compared (Fig. 5), our data revealed that, although both improved significantly, WHZ and BAZ data were higher in boys after 24 mo (Fig. 5C, D), whereas Ethiopian girls showed higher HAZ, especially 12 and 24 mo after arrival (Fig. 5B). In fact, Ethiopian girls acquired a normalized height after 12 mo; however, Ethiopian boys were not able to reach an average height (HAZ = 0), even 24 mo after adoption. This situation was probably due to the higher baseline height of Ethiopian girls, although our data did not reflect a statistical difference in baseline HAZ between boys and girls ($P = 0.204$).

Mediterranean diet adherence and children growth

Data derived from the KIDMED questionnaire showed that at 2 y of follow-up, ~36% of the Ethiopian children showed adherence to the Mediterranean dietary pattern, whereas 64% showed a dietary pattern that lacked important nutrients for an optimal diet. Table 2 shows the degree of adherence to each of the KIDMED items. The adherence to the Mediterranean pattern was not associated with children's age ($P = 0.255$).

Overall, Ethiopian children showed good dietary habits as most of them consumed fruit and vegetables regularly. However, we also found that a high proportion of children consumed sweets several times every day, and went to fast food restaurants more than once a week, which clearly deviates from the traditional Mediterranean diet (Table 2).

To evaluate the association between growth parameters and adherence to the Mediterranean dietary pattern, a correlation analysis was performed in the adopted children. The data showed that there was a small but statistically significant positive correlation between the KIDMED score and increases in WHZ ($r = 0.279$, $P = 0.045$) and HAZ ($r = 0.385$, $P = 0.004$) after 6 mo. Additionally, the total HAZ increase after 2 y was positively correlated with the KIDMED score ($r = 0.374$, $P = 0.006$). These moderate correlations suggest that those children with higher KIDMED scores showed higher increases, especially in HAZ.

Discussion

The present study prospectively evaluated the health status and the anthropometrical development of adopted Ethiopian children, from the moment they enter the adoption process in Ethiopia, and

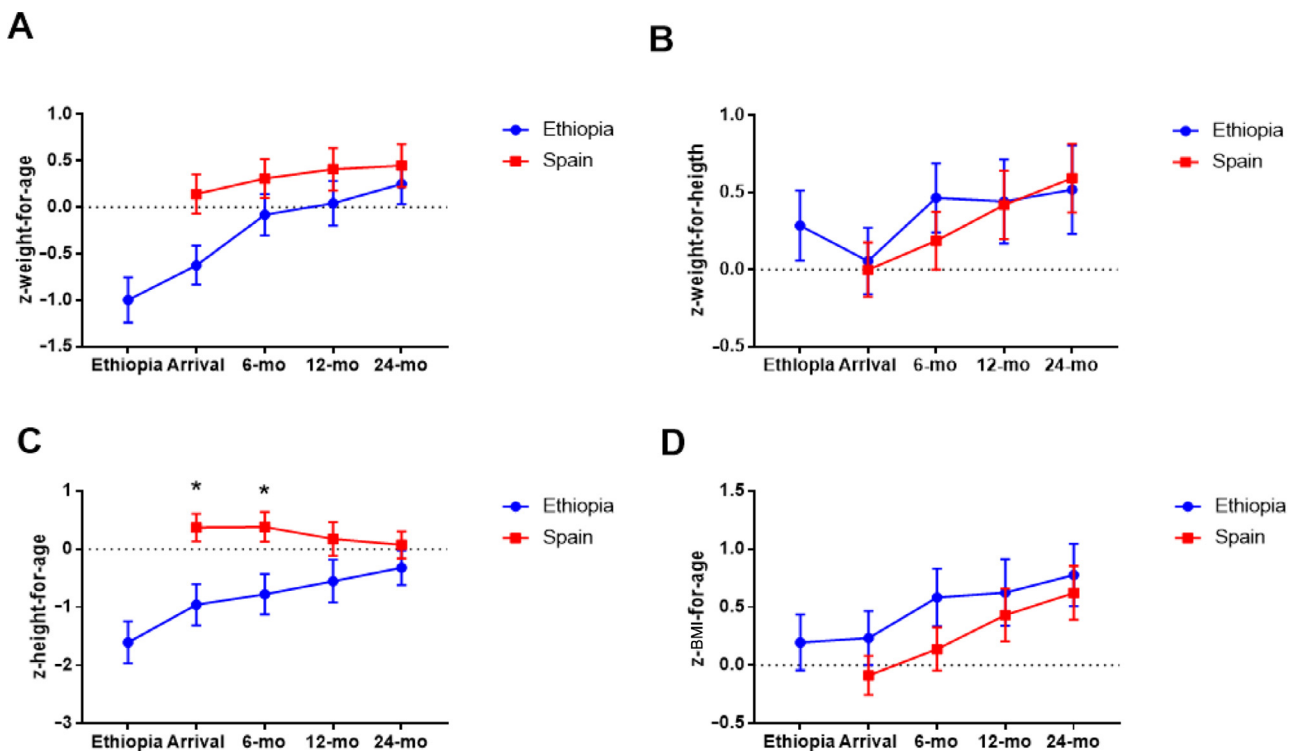


Fig. 3. Evolution of the anthropometrical parameters of the Ethiopian boys compared with the Spanish boys. Data indicate mean \pm SD. Baseline and follow-up z-scores for z-weight-for-age (A), z-weight-for-height (B), z-height-for-age (C) and z-BMI-for-age (D) are shown. Dotted line represents a z-score of 0. Repeated measures analysis of variance showed a statistically significant effect of time ($P < 0.001$) in all parameters. Sidak's multiple comparisons test was performed to compare data between Ethiopian and Spanish boys. * $P < 0.050$.

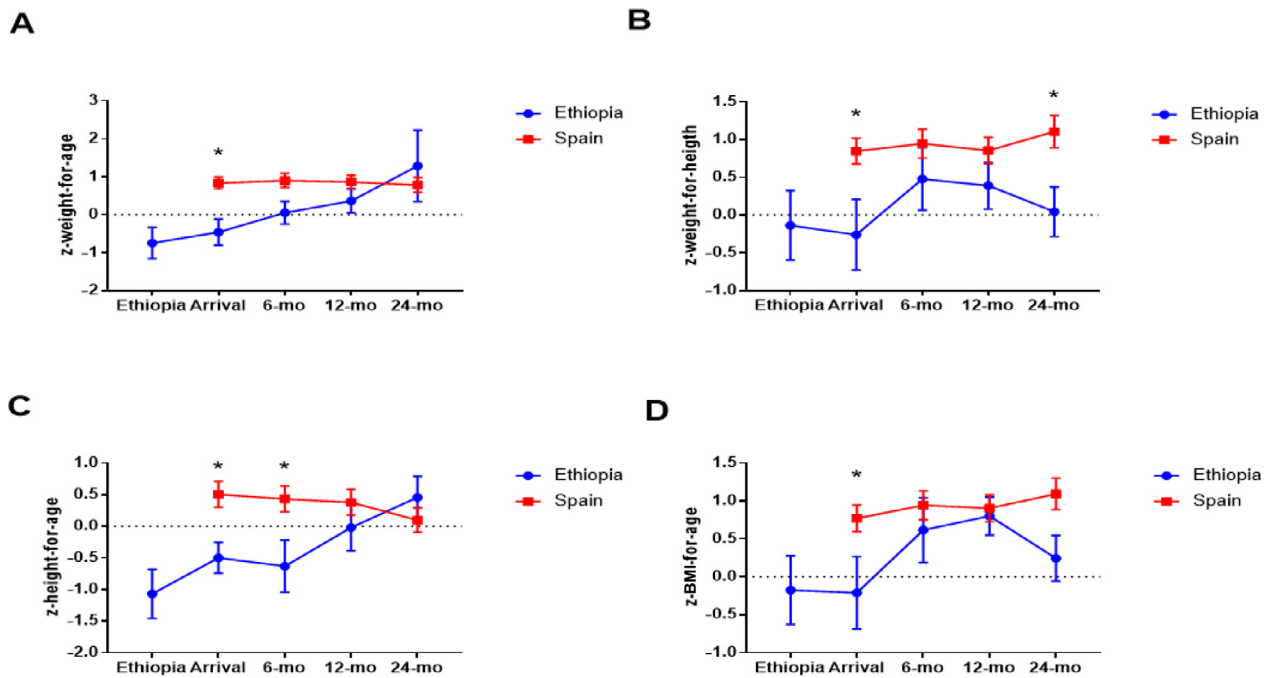


Fig. 4. Evolution of the anthropometrical parameters of the Ethiopian girls compared with the Spanish girls. Data indicate mean \pm SD. Baseline and follow-up z-scores for weight-for-age (A), weight-for-height (B), height-for-age (C) and BMI-for-age (D) are shown. Dotted line represents a z-score of 0. Repeated measures analysis of variance showed a statistically significant effect of time ($P < 0.001$) in all parameters. Sidak's multiple comparisons test was performed to compare data between Ethiopian and Spanish girls. * $P < 0.050$.

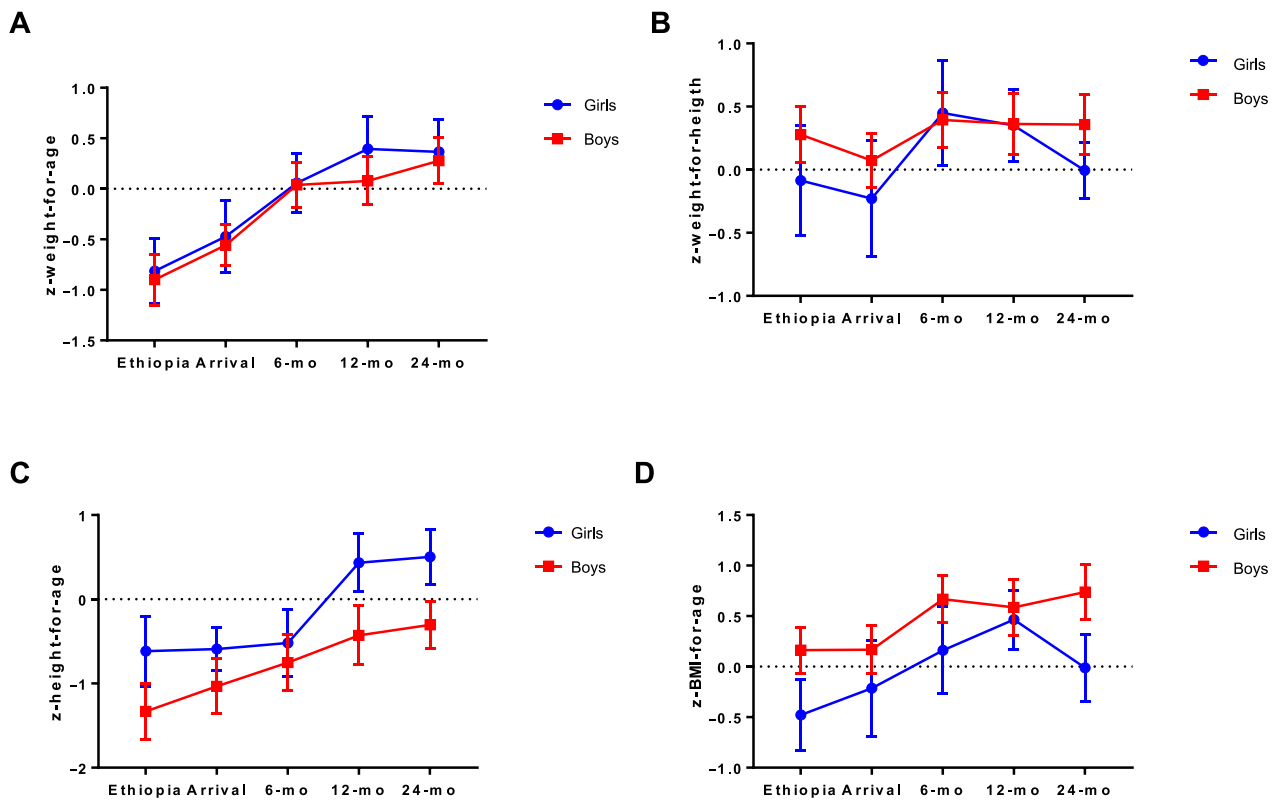


Fig. 5. Comparison of the anthropometrical parameters evolution between Ethiopian girls and boys. Data indicate mean \pm SD. Baseline and follow-up z-scores for weight-for-age (A), weight-for-height (B), height-for-age (C) and BMI-for-age (D) are shown. The dotted line represents a z-score = 0. Repeated measures ANOVA showed a statistically significant effect of time ($P < 0.001$) in all parameters. Sidak's multiple comparisons test was performed to compare data between Ethiopian girls and boys, but no statistically significant difference was observed.

Table 2
Degree of adherence* to each of the KIDMED items 2 y after adoption

	Frequency of reporting (%)
Takes a fruit or fruit juice	100
Has a second fruit every day	75.5
Has fresh or cooked vegetables regularly once a day	84.9
Has fresh or cooked vegetables more than once a day	73.6
Consumes fish regularly ($\geq 2-3$ /wk)	83
Goes ≥ 1 time/wk to a fast food restaurant (hamburger)	100
Likes pulses and eats them ≥ 1 time/wk	100
Consumes pasta or rice almost every day (≥ 5 times/wk)	30.2
Has cereals or grains (bread, etc) for breakfast	34
Consumes nuts regularly ($\geq 2-3$ /wk)	100
Uses olive oil at home	20.8
Skips breakfast	35.8
Has a dairy product for breakfast (yogurt, milk, etc)	5.7
Has commercially baked goods or pastries for breakfast	11.3
Takes two yogurts and/or some cheese (40 g) daily	60.4
Takes sweets and candy several times every day	100

*Degree of adherence refers to the percentage of children who scored +1 on positive items (items 1–5, 7–11, 13 and 15) and those who scored 0 on negative items (items 6, 12, 14, and 16). A score of 0–3 points indicates low adherence, 4–7 describes average adherence, and 8–12 reflects good adherence.

over their first 2 y with their adoptive families in Spain. The data showed that health problems decreased significantly 2 y after adoption. Adopted Ethiopian children showed progressive growth and were able to reach similar values when compared with the Spanish children. This growth was positively correlated with greater adherence to the Mediterranean diet.

Previous literature evaluating the health status of adopted Ethiopian children is limited. A study from 2016 evaluated the health status of these children upon arrival in Belgium [16], finding skin problems as the most prevalent, which is consistent with our findings. Martínez-Ortiz et al. observed similar health problems in this population, with more than 50% of the children presenting skin disorders [17]. Another study conducted in the United States confirmed a high prevalence of skin disorders, although these authors also highlighted the presence of infectious disorders [6].

Outstandingly, although most health problems decreased, other dental or visual problems increased after the adoption process. It is important to note that several problems not detected in Ethiopian institutions, including cardiovascular or respiratory problems, appeared after 2 y in Spain. This situation may indicate that adopted children could have developed health problems after adoption, or most probably these problems were underdiagnosed at their home country. In fact, this data is consistent with a previous report performed on eastern European children where several neurologic syndromes (e.g., fetal alcohol syndrome, Tourette syndrome, and attention-deficit/hyperactivity disorder) also were underdiagnosed [18]. Nevertheless, other factors such as intrauterine growth retardation [19] or a developmental origin of disease owing to fetal reprogramming cannot be excluded [20].

When evaluating the health problems of adopted children, one of the most determinant factors is their origin. Previous works focused on international adoption have been conducted with Chinese and eastern European children, showing differences with Ethiopian children. For example, Miller and Hendrie described that the most common problem in Chinese children was elevated lead levels [21], which we did not find in this research. Other work conducted with Romanian children adopted in the United States described recurrent intestinal and respiratory infections as frequent health conditions [22]. It is also important to note that medical information of internationally adopted children is limited and often outdated or inaccurate [23]. We advise that medical evaluation of these

children should be carried out by multidisciplinary teams specialized in international adoption.

Regarding the anthropometrical development of the children adopted from Ethiopia, the first aspect to be highlighted is the low prevalence of thinness or wasting, which may indicate the absence of acute unfavorable conditions in these children. However, as described by the WHO, the prevalence of wasting is usually <5%, even in developing countries [24,34]. On the other hand, stunted growth was more prevalent, which may reflect a suboptimal health and/or nutritional condition. The present data are quite similar to those obtained in other populations. Miller and Hendrie described a prevalence of low z-scores for height of 39% in children adopted from China [21]. Other studies on Eastern-European children reported a similar height but lower weight compared to the data we reported in this work [22,25]. Recent work of Fuglestad et al., with children from Eastern Europe, China and Ethiopia, have shown mean z-scores closer to those of our study [25]. In contrast, other work from Miller et al., in Ethiopian children, reported anthropometrical parameters that were mostly adequate [6].

Anthropometrical parameters of internationally adopted children are usually below the normal range. For this reason, one of the aims of the present study was to evaluate the prospective evolution of these children to determine if, in the long term, the growth parameters evolve similarly with those of the native-born population. Unfortunately, few studies have prospectively evaluated the evolution of adopted children, and most of them are focused on an endpoint analysis after a few years. We showed that the anthropometrical growth seems to be adequate at 2 y after adoption, which is consistent with the study of Rutter et al. conducted with Romanian children [22]. A prospective study carried out by Cohen et al. with Chinese children, described a constant increase in weight during the first 24 mo of follow-up, as occurred in the present study population [26]. On the other hand, Miller et al. also observed a significant catch-up growth after adoption, although not enough to reach normal values [6]. Because the work of Miller et al. did not subsequently evaluate the children, there is no evidence that the growth was sustained.

One of the key determinants of children's growth is dietary quality. The Ethiopian diet is characterized by a low energy intake, mainly derived from grains, roots, or tubers and little animal-sourced foods. Together with other factors (e.g., sanitation, hygiene, infectious diseases, etc.), a poor diet may be associated with a high rate of stunted growth [27]. The transition of these children toward a balanced diet can be challenging. However, the present study data indicated that most children had moderate or adequate adherence to the Mediterranean dietary pattern at 2 y of follow-up, which was higher than expected and similar to those of native Mediterranean populations [15,28]. However, the study of Mariscal-Arcas et al., carried out with Spanish children, indicated greater adherence (48.6%) than in the Ethiopian adopted children [29]. Overall, there seems to be a deterioration of the characteristics of healthy Mediterranean eating habits, which may explain the discrepancy between previous and more recent studies [30]. Consistent with our work, a study of Bibiloni et al. reported a large number of children who skip breakfast (25%) and go to fast food restaurants (17.6%) [28]. We have shown a positive correlation between the KIDMED score and growth. It remains to be determined whether the nutrients of the Mediterranean diet induce a better growth than other Western dietary patterns, but the few studies that have prospectively evaluated the growth of adopted children have only included other populations [22,25]. Overall, we observed a greater anthropometric development than that described in other studies with a similar follow-up period [26].

It is also important to note that a healthy growth pattern should consider not only anthropometric parameters, but also neurocognitive variables. Therefore, an adequate growth does not depend exclusively on dietary factors, but also on other environmental and psychological factors. For example, a study conducted with Ethiopian children showed that early exposure to maternal mental disorders was associated with impaired cognitive development. Attending to this work, several characteristics of the Ethiopian setting, such as poverty, interpersonal violence, and infant undernutrition, may decrease childhood development [31]. The study of Worku et al. with Ethiopian children, found that children in extreme poverty performed worse in all the developmental domains compared with the reference Ethiopian children in a lower poverty group [32]. Therefore, it seems reasonable to think that the adoption process can potentially improve not only the anthropometric parameters but also the neuropsychological development of these children. On the other hand, children's development can involve a modification of anthropometric parameters but also improvements in cognitive performance, as shown in previous studies [33]. Our physical examination did not detect any cognitive delay, suggesting an adequate cognitive functionality in the present study population.

Several limitations in our work deserve consideration. First, children's growth was determined solely through anthropometrical parameters, but other nutritional disorders (like anemia or vitamin deficiencies) were not analyzed. It is also important to note that the age provided by the Ethiopian adoption center might have been inaccurate, and may not correspond to the real biological age, which can influence the evaluation of growth. Furthermore, a large proportion of families with adopted children from Ethiopia (160 of 336 children) declined to take part in the study, limiting the representativeness of our population. It is possible that the parents of children with severe or undiagnosed disease decided not to take part in the study, so we cannot rule out a possible bias due to this circumstance. Finally, information on emotional, cognitive, and psychological status was not considered in our analysis and could potentially explain some of the growth trajectories observed. It was not possible to assess the health status and adherence to Mediterranean dietary pattern in the matched sample of children from Murcia.

Conclusions

The adoption process significantly improved the health status of children from Ethiopia in southern Spain. The number of clinical conditions was significantly reduced 2 y after adoption. Although the baseline anthropometrical data indicated significant chronic undernutrition, our prospective evaluation of the children revealed a rapid growth development, which reached similar values to those of the native-born population in a period of 2 y. We also described the benefits of internationally adopted children adapting to a balanced dietary pattern, such as the Mediterranean diet, as our data showed a positive association with adequate growth. Considering that the dietary habits of such young children depend almost exclusively on their parents, health education programs should be reinforced to improve the nutritional status of these children. Further studies are needed to fully evaluate the relevance of all potential factors involved in children's development, including emotional, cognitive, and psychological factors, in order to achieve an adequate health status, in all their dimensions, in these children.

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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