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RESEARCH PAPER

Revised Healthy Lifestyle-Diet Index and associations with obesity and iron deficiency in schoolchildren: The Healthy Growth Study

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Abstract

Background: The Healthy Lifestyle-Diet Index (HLD-index), previously developed to assess the degree of adherence to dietary and lifestyle guidelines for primary schoolchildren, was revised according to updated recommendations. The association of the revised HLD-index (R-HLD-index) with obesity and iron deficiency (ID) was also examined.

Methods: A representative sample of 2660 primary schoolchildren from Greece (9–13 years old) participating in the 'Healthy Growth Study' was examined. Twelve components related to dietary and lifestyle patterns were used to develop the R-HLD-index. Scores from 0 up to 4 were assigned to each one of these components, giving a total score ranging from 0 to 48. The associations between the R-HLD-index, obesity and ID were examined via logistic regression analysis.

Results: The total score of the R-HLD-index calculated for each one of the study participants was found to range between 2 and 32 units, with higher scores being indicative of a healthier lifestyle and better diet quality. After adjusting for potential confounders, logistic regression analysis showed that an increase in the R-HLD-index score by one unit was associated with 6% lower odds for obesity. However, no significant association was observed between the R-HLD-index score and ID.

Conclusions: The R-HLD-index may be a useful tool for public health policy makers and healthcare professionals when assessing diet quality and lifestyle patterns of primary schoolchildren. Identification of children with lower scores in the R-HLD-index and its individual components could guide tailored made interventions targeting specific children and behaviors.

Introduction

Increasing obesity prevalence is of major global public health concern (Lavie *et al.*, 2009), whereas, at the same time, iron deficiency (ID) affects a great proportion of childhood population worldwide (Zimmermann & Hurrell, 2007). Dietary patterns, including the high consumption of energy-dense but nutrient-poor foods, have been reported as significant risk factors for both childhood obesity and ID (Nead *et al.*, 2004). More specifically, the positive energy balance, as a result of an increased consumption of energy-dense, high-fat and low-fibre foods in combination with low physical activity levels, is the main risk factor for childhood obesity (Moreno *et al.*, 2013). Furthermore, a higher consumption of foods with an increased content of nutrients that inhibit the intestinal absorption of dietary nonhaeme iron (e.g. calcium in dairy, phytates in cereals, etc.), combined with a lower consumption of foods rich in nutrients that enhance dietary nonhaeme iron bioavailability (e.g. vitamin C in citrus fruits), has been also implicated in the aetiology of ID in children (Zijp *et al.*, 2000). Additionally, the chronic inflammatory state induced by obesity *per se* has been identified as an independent risk factor of ID (Moschonis *et al.*, 2011).

Considering all of the above, the development of a practical tool that will provide a quantitative measure of such patterns, and will also be used as a practical guide for public health policy makers and healthcare professionals when making more targeted dietary and lifestyle recommendations to children and their families, is of great need and importance. The development of an index appropriate for such a purpose could be one such approach. To the best of our knowledge, the only composite indices that aim to evaluate the overall diet quality and are applicable to primary schoolchildren are the Youth Healthy Eating Index, the Mediterranean Diet Quality Index and E-KINDEX (Kennedy *et al.*, 1995; Feskanich *et al.*, 2004; Serra-Majem *et al.*, 2004; Lazarou *et al.*, 2009). However, because these indices also require the estimation of specific nutrients' intake in their scoring, this probably makes them less practical to be used by all healthcare professionals. Moreover, lifestyle characteristics have not been included as components in any of the aforementioned indices. The authors of the present study have previously developed the Healthy Lifestyle-Diet Index (HLD-index) to evaluate the degree of adherence to existing dietary and lifestyle guidelines for primary schoolchildren based on the US Department of Agriculture (USDA)'s My Pyramid and reported negative associations with insulin resistance (Manios *et al.*, 2010). However, in the light of the USDA's 'Choose My Plate' (http://www.choosemyplate.gov) new dietary recommendations and the need to extend the applicability of this index to the evaluation of clinical conditions other than insulin resistance, further modifications of this index were necessary.

The present study aimed, firstly, to revise the HLD-index in accordance with the updated dietary recommendations for children proposed by the USDA's 'Choose My Plate' (http://www.choosemyplate.gov) and, secondly, to examine the association of the revised HLD-index (R-HLD-index) with obesity and ID.

Materials and methods

Sampling

The 'Healthy Growth Study' was a cross-sectional epidemiological study initiated in May 2007. Approval to conduct the study was granted by the Greek Ministry of National Education and the Ethics Committee of Harokopio University of Athens. The study population comprised schoolchildren attending the fifth and sixth grades of primary schools located in municipalities within the wider regions of Attica, Aitoloakarnania, Thessaloniki and Heraklion. The sampling procedure has been described in detail previously (Moschonis *et al.*, 2010). In brief, the sampling of schools was random, multistage and stratified by parental educational level and by the total population of students attending schools within these municipalities. An extended letter explaining the aims of the present study and a consent form for conducting full measurements were provided to all parents or guardians having a child in these schools. Signed parental consent forms were collected for 2660 out of 4145 children (response rate of 64%).

Anthropometry and physical examination

Weight was measured without shoes in light clothes using a Seca digital scale (Model 770; Seca Alpha, Hamburg, Germany) to the nearest 0.1 kg. Height was measured to the nearest 0.1 cm using a commercial stadiometer (Leicester Height Measure; Invicta Plastics Ltd, Oadby, UK) with the participants not wearing shoes, their shoulders in a relaxed position, their arms hanging freely and their head in Frankfort horizontal plane. Two trained members of the research team carried out these measurements.

Body mass index (BMI) was calculated by dividing weight (kg) by height squared (m^2). The anthropometric categorisation of children was made in accordance with the threshold provided by the International Obesity Taskforce (IOTF) (Cole *et al.*, 2000, 2007) and children were divided into four groups: underweight, normal weight, overweight and obese. The pubertal stage of all participants was also assessed by a female paediatrician in each prefecture. Children were classified according to the five Tanner stages after visual inspection of breast development in girls and genital development in boys (Tanner, 1955).

Mothers were asked to recall and report their 'current' weight and height, from which the BMI was calculated and used to categorise them as normal-weight, overweight and obese on the basis of IOTF cut-off points [World Health Organization (WHO), 2000]. Finally, birth weight was recorded from each child's birth certificate and medical record. The above information was collected during scheduled meetings with parents at the school site.

Dietary intake

Dietary intake data were obtained for two consecutive weekdays and one weekend day using 24-h recalls. Data were collected from children during scheduled interviews conducted at school site by experienced dietitians who were rigorously trained to minimise the interviewer's effect and misreporting of food consumption by children. Food intake data were analysed using the NUTRITIONIST V diet analysis software, version 2.1 (First Databank, San Bruno, CA, USA), which was extensively amended to include traditional Greek foods and recipes, as described in the 'Composition of Greek Cooked Food and Dishes' (Trichopoulou, 2004). The food-grouping scheme was designed for all foods or entries (core and recipe) appearing in NUTRITIONIST V. Forty-seven food groups were initially established, based on similar nutrient content. Composite food items, such as recipes, were disaggregated and were assigned to food groups based on their main ingredient. A similar methodology for the extraction of food groups has been previously reported in studies with not only smaller sample size, but also with only one 24-h recall available (Nicklas *et al.*, 2003). Examples of foods included in the food groups have been documented previously (Nicklas *et al.*, 1990).

Other characteristics that were recorded

Children's television/video viewing and computer games playing time was assessed by children's report with regard to a usual weekday and a usual weekend. The mean daily television/video viewing and computer games playing time was calculated using the equation: daily television/video viewing and computer games playing hours = [(weekday television/video viewing and computer games playing hours × 2.5) + weekend television/video viewing and computer games playing hours]/7. Physical activity during leisure time was assessed using a standardised activity interview, based on a questionnaire completed by the participants in the presence of a member of the research team. Further details regarding the reliability and validity of the questionnaire are provided elsewhere (Manios *et al.*, 1998). Respondents reported the time spent on various physical activities on two weekdays and on weekends. Reported activities were grouped by a member of the research team into moderate-to-vigorous physical activities (MVPA) (intensity higher than four metabolic equivalents), including activities such as brisk walking, bicycling, gymnastics, dancing, basketball, soccer, athletics, tennis, swimming, jumping rope and general participation in active outdoors games. Given the age group, MVPA was defined as continuous physical activities causing sweating and heavy breathing for periods longer than 15 min, although with occasional breaks in intensity.

Biochemical analysis

Blood samples were obtained for biochemical and haematological screening tests between 08.30 and 10.30 h after a 12-h overnight fast. Reminders were distributed the previous day to both parents and children to ensure compliance with fasting. Professional staff performed venipuncture, using two types of test tubes, one of which contained ethylenediaminetetraacetic acid, to obtain a maximum of 10 mL of whole blood. The remaining blood was collected in plain test tubes for the preparation of serum, which was divided into aliquots and stored at −80 °C. When blood collection was completed in Aitoloakarnania, Thessaloniki and Heraklion, all serum samples were transported in dry ice to the Laboratory of Nutrition and Clinical Dietetics at Harokopio University, where biochemical analyses and central storage of back-up samples at −80 °C took place. Serum iron and total iron-binding capacity (TIBC) levels were determined by colorimetric assays (Roche Diagnostics SA, Basel, Switzerland). Transferrin saturation (TS) was calculated by dividing serum iron levels by TIBC and multiplying by 100. ID was defined using the age- and sex-specific threshold proposed by UNICEF and the WHO (WHO, 2001): TS < 16%. The Mentzer Index (Mentzer, 1973) was also calculated for all pupils participating in the present study to differentiate β-thalassaemia from ID. On the basis of this index, children with thalassaemia minor (18 cases) were excluded from further analysis.

Component selection for diet index development

The R-HLD-index resulted from the modification of the HLD-index (Manios *et al.*, 2010), in an attempt to increase its applicability in the estimation of the degree of children's adherence to the most recent dietary and lifestyle guidelines. For the R-HLD-index, 12 components were used. The first 10 components measure the consumption frequency of fruits, vegetables, grains, milk/dairy products, meat and meat products, fish/seafood, legumes, eggs, soft drinks, and sweets. The other two components reflect the physical activity status of children through measuring the time children spend on watching television or playing computer games (sedentary behaviour) and the time children spend on MVPA. These components were selected based on dietary recommendations from USDA's ChooseMyPlate and the recommendations of American Academy of Pediatrics with regard to television viewing time (American Academy of Pediatrics, 2001; Strasburger, 2006).

Scoring system for the development of the Revised Healthy Lifestyle-Diet index

A five-point scoring system (0–4) was used to assign the appropriate score to each index component. The highest score was ascribed to the dietary intake or participation in MVPA or watching televsion or playing computer games being within the recommended guidelines, whereas the lowest score was assigned to the dietary–lifestyle behaviours that were not in agreement with recommendations (http://www.choosemyplate.gov) (American Academy of Pediatrics, 2001; Strasburger, 2006). Proportionally, the intermediate scores were derived based on the recommendations. Regarding fruit intake, score 4 was assigned to a frequency of consumption ranging from one to three servings per day containing <50% juice and for vegetables to a consumption frequency from two or three servings per day. Regarding grains, score 4 was assigned to the consumption of four to six servings per day, with more than half being whole grains. Concerning milk/dairy consumption, score 4 was assigned to 2–4 servings per day with >50% of them being fat-free or low-fat dairy products. In terms of legumes and eggs, preferably a consumption of three to five and two or three servings per week, respectively, received the highest score of 4. As far as meat consumption was concerned, a score of 4 was assigned to a consumption frequency of two or three servings per week. The other components were scored in the same way as in the original HLD-index (Manios *et al.*, 2010). More details for the scores assigned to each component are presented in Table 1.

The total score of the R-HLD-index was obtained by summing the scores assigned to each index component. The total score of this index ranges from 0–48. Higher scores of the R-HLD-index indicate greater adherence to dietary–lifestyle recommendations or greater adherence to a 'healthy' dietary–lifestyle pattern. Based on the scoring derived from the use of the R-HLD-index, the children participating in the present study were divided into three groups using the tertiles of R-HLD-index: those considered as having (i) an 'unhealthy diet–lifestyle pattern' (first tertile); (ii) a 'moderate healthy diet–lifestyle pattern' (second tertile); and (iii) a 'healthy diet–lifestyle pattern' (third tertile).

Table 1 The scoring system for the Revised Healthy Lifestyle-Diet Index (R-HLD-index)

Index components	Frequency	Score
Fruit	Never or 1–6 servings per week containing <50% juice	0
	1–6 serving per week containing <50% juice or >3 servings per day >50% juice	1
	>3 servings per day containing <50% juice	2
	1–3 servings per day containing >50% juice	3
	1–3 servings per day containing <50% juice	4
Vegetables	Never	0
	1–6 servings per week	1
	1–2 servings per day or >4 servings per day	2
	3–4 servings per day	3
	2–3 servings per day	4
Fish and seafood	Never or rarely	0
	≥4 servings per week	1
	1–2 servings per week	2
	3–4 servings per week	3
	2–3 servings per week	4
Sweets	≥1 serving per day	0
	4–6 servings per week	1
	2–4 servings per week	2
	1–2 servings per week	3
	Never or rarely	4
Soft drinks	≥1serving per day	0
	4–6 servings per week	1
	2–4 servings per week	2
	1–2 servings per week	3
	Never or rarely	4
Grains	<1 serving per day or 1–2 servings per day and <50% whole grains	0
	1–2 servings per day and 50% whole grains or >6 servings and <50% whole grains	1
	2–4 servings per day and <50% whole grains or >6 servings per day and >50% whole grains	2
	2–4 servings per day and >50% whole grains or 4–6 servings per day and <50% whole grains	3
	4–6 servings per day and > 50% whole grains	4
Milk/dairy	<1 serving per day or 1–2 servings per day and >50% low- or no-fat	0
	1–2 servings per day and >50% low- or no-fat, >4 servings per day and <50% low- or no-fat	1
	<4 servings per day and >50% low- or no-fat	2
	2–4 servings per day and <50% low- or no-fat	3
	2–4 servings per day and >50% low- or no-fat	4

Statistical analysis

Continuous variables are presented as the mean (SD) and categorical variables are summarised as relative frequencies (%). Associations between categorical variables were tested by using the chi-squared test and the two-sample *Z*-test for proportions whenever appropriate. The associations between the continuous and binary variables (sex) were evaluated through Student's *t*-test or the Mann–Whitney test when continuous variables were normally distributed or non-normally, respectively. Comparisons between continuous variables (food groups' consumption) and the tertiles of the R-HLD-index were performed using the one-way analysis of variance, or the Kruskal–Wallis test, as appropriate. Bonferroni correction was

Table 1 *(Continued)*

Index components	Frequency	Score
Legumes	<1 serving per week	0
	>7 servings per week	1
	1–3 servings per week	2
	5–7 servings per week	3
	3–5 servings per week	4
Eggs	<1 serving per week	0
	>7 servings per week	1
	3–4 servings per week	2
	1–2 servings per week	3
	2–3 servings per week	4
Meat and meat products	<1 serving per week	0
	>4 servings per week	1
	1–2 servings per week	2
	3–4 servings per week	3
	2–3 servings per week	4
Television viewing	>4 h day^{-1}	0
	3–4 h day^{-1}	1
	2–3 h day^{-1}	2
	1–2 h day^{-1}	3
	<1 h day^{-1}	4
MVPA	<15 min day^{-1}	0
	15–30 min day^{-1}	1
	30–45 min day^{-1}	2
	45–60 min day^{-1}	3
	>60 min day^{-1}	4

MVPA, moderate to vigorous physical activity.

The total score of the R-HLD-Index was obtained summing the scores assigned to each component and this score ranges between 0 and 48.

Fruits: all fresh, frozen, canned and dried fruits and all fresh or packaged fruit juices with no added sugar or fat. The serving is equal to a medium fruit or ½ cup of fruit juice.

Vegetables: all vegetables with no added sugar or fats. The serving is equal to ½ cup.

Total grains: all whole-grain products and refined grain products and grains, such as breads, rice, pasta, cereals, crackers and oatmeal. The serving is equal to one slice of bread, ½ cup of cereals, pasta and rice.

Total dairy products: all milks, yogurts and cheeses. The serving is equal to one cup of milk or yogurt and 1.5 oz. of cheese.

Total meat: beef, pork, lamb, goat, meatballs, poultry, rabbits and legumes. The serving is equal to 2 oz.

Fish and seafood: all fishes and octopus, squid, cattlefish, shrimps and crabs. The serving is equal to 2 oz.

Sweets: all chocolates and cakes, biscuits, cookies, ice cream, butter cookies, traditional sweets, doughnuts, waffles, candies, lollipops, fruits in syrup and jelly beans. The serving size is equal to 1 oz.

used to account for increase in type I error owing to post-hoc multiple comparisons.

Multiple logistic regression models were used to assess the association between the R-HLD-index score (either as a quantitative variable or as a categorical variable with three categories based on its tertiles), obesity and iron deficiency.

Participants' sex, age, Tanner stage, total energy intake, and BMI were used as potential confounders for the association between the R-HLD-index score and iron deficiency, whereas age, sex, Tanner stage, total energy intake, birth weight, mother's BMI and MVPA were used as potential confounders for the association between R-HLD-index score and obesity. The results are presented as odds ratios and 95% confidence intervals. SPSS, version 17.0 (SPSS Inc., Chicago, IL, USA) was used for data analysis. The level of statistical significance was set at $P = 0.05$.

Results

The data on the prevalence of children's weight and iron status are presented in Table 2. In total, 2660 children were recruited aged 9–13 years old. Overall, the observed prevalence was 3.1% for underweight, 55.1% for normal-weight, 30.3% for overweight and 11.5% for obesity. Table 2 also summarises the differences in the prevalence of underweight, normal weight, overweight and obesity among boys and girls. Specifically, the prevalence of obesity was found to be significantly higher in boys than girls (13.6% versus 9.4%; $P = 0.001$). Furthermore, 16.3% of children were iron deficient but no significant differences were observed between sexes (i.e. 16.9% in boys and 15.7% in girls). By contrast, the prevalence of ID was found to be higher in obese children (25.9%) compared to their overweight (17.1%) and under/normal-weight (14.0%) peers ($P = 0.004$) (data not shown in tables).

Table 3 illustrates the descriptive characteristics of the R-HLD-index among all study participants per sex and weight group. According to these data, the mean (SD) of the R-HLD-index total score was 17.12 (4.5) and this score was normally distributed. No statistically significant differences were found in the R-HLD-index total score between boys and girls ($P = 0.572$), as well as between children with normal iron status and iron deficiency

Table 2 Descriptive characteristics of the study population including obesity and iron deficiency prevalence

	Boys (%) (n = 1345)	Girls (%) (n = 1315)	P^*	Total (%) (n = 2660)
Underweight	2.5	3.8	0.001	3.1
Normal weight	52.9	57.3		55.1
Overweight	31.0	29.5		30.3
Obese**	13.6	9.4		11.5
Normal iron status	83.1	85.4	0.219	84.3
Iron deficiency	16.9	15.7		16.3

*P-values derived from the chi-squared test.

**$P < 0.05$ derived from a two-sample Z-test for proportions indication differences between boys and girls.

Table 3 Descriptive characteristics of the Revised Healthy Lifestyle-Diet Index by sex, iron status and weight group

Descriptive characteristics	Total	Sex: Boys	Sex: Girls	$P^{\dagger}$	Iron status: Normal iron status	Iron status: Iron deficiency	$P^{\dagger}$	Weight status: Under/normal-weight	Weight status: Overweight	Weight status: Obese	$P^{\ddagger}$
Mean	17.12	17.18	17.06	0.572	17.04	17.28	0.462	17.28*	16.96	16.07*	0.015
SD	4.50	4.44	4.56		4.4	4.4		4.48	4.55	4.39	

†*P*-values derived from Student's *t*-test.
‡*P*-value derived from one-way analysis of variance, using the Bonferroni rule to correct for Type I error in the post-hoc multiple comparisons between weight groups. The asterisk (*) indicates statistically significant pairwise differences.

($P = 0.462$). However, obese children were found to have significantly lower mean R-HLD-index score compared to under/normal-weight children ($P = 0.015$).

According to the data from the logistic regression analysis presented in Table 4, the increase in the R-HLD-index score by one unit was associated with 6% lower odds of being obese. Moreover, the likelihood of being obese was 43% lower among children with higher R-HLD-index scores (third tertile) compared to children with lower scores (i.e. first tertile). No significant associations were observed between R-HLD-index and ID.

Discussion

The primary aim of the present study was to revise the HLD-index. The main alterations derived from the revision of the HLD-index involved changes in the scoring of certain components, as well as the addition of new components (i.e. the consumption frequency of legumes and eggs). More specifically, changes were made for the scoring of five components: fruits, vegetables, grains, milk/dairy, and meat/meat products. Regarding the consumption of fruit, fruit juice was also included in the scoring system with children consuming more fruits but less fruit juice receiving higher scores than children consuming more fruit juice but less fruits. This change was mainly a result of the positive associations observed between fruit juice consumption and childhood obesity in several studies conducted with children (O'Connor *et al.*, 2006). Another change was relevant to the scoring of vegetables because the consumption of two or three servings per day received the higher scoring in the revised index as opposed to >4 servings per day in the previous index. The rationale for this change was to follow the updated 'Choose My Plate' guidelines according to which the recommendation for vegetables' consumption among 9–13-year-old children is set to 2.5 cups per day. Vegetables are a rich source of dietary fibre, which is known for its health benefits (Kaczmarczyk *et al.*, 2012). However, there is some concern that a high intake of fibre may impair the absorption of certain minerals, such as iron (James *et al.*, 1978).

In the same context, the scoring for grains in the revised index was also based on the 'Choose My Plate' dietary recommendations suggesting that at least half of all grains consumed should be whole grain. Similarly, regarding the scoring of milk/dairy consumption, the percentage contribution of low-fat milk was also taken into consideration to adjust for the quality of dairy products consumed. Finally, eggs and legumes were separated from the meat/meat product component in the revised index mainly because eggs and legumes represent nutrient-dense foods with several favourable health effects for children (Hu *et al.*, 1999; Kushi *et al.*, 1999). As far as the scoring of meat and meat products was concerned, a similar approach was followed, with the lowest scores (i.e. 0 and 1)

Table 4 Associations between the Revised Healthy Lifestyle-Diet Index (independent variable), iron deficiency and obesity (dependent variables)

Independent variable	Dependent variable: iron deficiency*: OR (95% CI)	*P*	Dependent variable: obesity†: OR (95% CI)	*P*
R-HLD-index	1.02 (0.98–1.05)	0.233	0.94 (0.89–0.98)	0.014
Tertiles of R-HLD-index				
First tertile	Reference		Reference	
Second tertile	1.26 (0.89–1.78)	0.356	0.648 (0.40–1.04)	0.073
Third tertile	1.09 (0.76–1.57)	0.625	0.57 (0.33–0.97)	0.039

CI, confidence interval; OR, odds ratio.
*Adjusted for age, sex, Tanner stage, total energy intake and body mass index.
†Adjusted for age, sex, Tanner stage, total energy intake, birth weight, mother's BMI and moderate to vigorous physical activity.

provided to the lowest meat consumption (i.e. <1 serving per week, as a result of the fact that low meat consumption does not provide sufficient protein to support optimal growth in children), and to the highest (i.e. >4 servings per week, as a result of the fact that high meat consumption can also provide increased intake of saturated fat and cholesterol). By contrast, the highest scoring was attributed to an intermediate consumption of meat (i.e. two or three servings per week).

In the present study, the R-HLD-index score was calculated for the total sample of 2660 schoolchildren participating in the Healthy Growth Study. Based on the findings of the present study, the R-HLD-index was found to be a fairly useful instrument to assess healthy diet and lifestyle patterns in schoolchildren, considering that higher scores of this index were strongly associated with higher intakes of foods that are necessary to support children's optimum health status, growth and development.

In accordance with the overall prevalence reported for other Greek cohorts (Papadimitriou *et al.*, 2006; Tzotzas *et al.*, 2008), the present study showed relatively high rates of being overweight (30.3%) and obesity (11.5%) in primary schoolchildren. A strong inverse association of the R-HLD-index with weight status was also noted. The likelihood of being obese was statistically significantly higher for children in the higher R-HLD-index tertile. Our findings are in agreement with those reported from a previous work conducted with Cypriot children showing that a higher score of the E-KINDEX was related to 80% lower probability of being overweight/obese (Lazarou *et al.*, 2009).

Although many studies have shown that obese children are usually malnourished and this could increase the risk for nutritional deficiencies such as ID (Iriart *et al.*, 2011) and despite the significant association with obesity, the R-HLD-index was not found to be significantly associated with ID. In an attempt to provide an explanation of this observation, it would be important to note that the components of the R-HLD-index may not have a generic application to assess the risk for all clinical conditions. This is also true in the case of other similar indices, which, although designed to assess diet quality, appear to have a poor diagnostic value (Waijers *et al.*, 2007).

There are several methodological limitations that warrant brief discussion. Firstly, the present study is cross-sectional and cannot provide cause–effect associations. Although a valid structured questionnaire was used for physical activity assessment, a more reliable method, such as accelerometry, would provide more valid information. Similarly, several components of the R-HLD-index were self-reported and their validity was not examined. Furthermore, the recording of dietary intake was based on 24-h dietary recalls, which is not the optimal technique for assessing habitual diet. Lastly, although the scoring of the R- HDL-index was based on standard recommendations, there was also a subjective element in the procedures followed that could be considered as another limitation.

In conclusion, the proposed R-HLD-index is a simple diet–lifestyle score aiming to assess adherence to existing dietary and lifestyle guidelines available for schoolchildren. The R-HLD-index could be used by healthcare professionals and/or public health policy makers to identify children or subgroups of the population with unfavourable dietary and lifestyle habits. Identification of these children or population subgroups could guide the development and implementation of tailored made interventions, which by targeting changes in specific components/behaviours of the index, could produce important benefits for children's health status.

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Conflict of interests, source of funding and authorship

The authors declare that there are no conflicts of interest.
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All authors contributed to the study design, as well as the writing and revision of the manuscript. GM, and YM were responsible for data collection, data management and statistical analysis. All authors critically reviewed the manuscript and approved the final version submitted for publication.

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