Diet quality, general health and anthropometric outcomes in a Latin American population: evidence from the Colombian National Nutritional Survey (ENSIN) 2010

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Abstract

Objective: Colombia is experiencing a nutrition transition, characterised by nutritionally poor diets and an increased prevalence of non-communicable diseases (NCD). We aimed to investigate the association between diet quality and general health outcomes related to the risk of NCD, in a nationally representative sample of Colombian adolescents and adults.
Design: Cross-sectional analysis. The Alternative Healthy-Eating Index (AHEI) was derived to calculate diet quality. Adjusted regressions were used to examine the association between AHEI, self-perceived general health status (GHS) and anthropometric variables (i.e. age-specific z-scores for height, and BMI for adolescents; waist circumference and BMI for adults).
Setting: Nationally representative data from the Colombian National Nutrition Survey (ENSIN) 2010.
Participants: Adolescents aged 10–17 years (*n* 6566) and adults aged ≥18 years (*n* 6750).
Results: AHEI scores were similar between adolescents (mean 29·3 ± 7·2) and adults (mean 30·5 ± 7·2). In the whole sample, a better diet quality (higher AHEI score) was associated with worse self-perceived GHS (adjusted (a) β-coefficient: –0·004; $P < 0.001$) and with a smaller waist circumference ((a) β-coefficient: –0·06; $P < 0.01$). In adults, a higher AHEI score was negatively associated with BMI ((a) β-coefficient: –0·02; $P < 0.05$), whilst in adolescents it was associated with a reduced height-for-age z-score ((a) β-coefficient: –0·009; $P < 0.001$).
Conclusions: A better diet quality was associated with reduced prevalence of predictors of NCD and with some indicators of general health in the Colombian population. In light of the high prevalence of overweight, our findings support the need for public health interventions focused on sustainable positive changes in dietary habits in the general population.

Latin American countries are experiencing accelerated shifts in their dietary patterns, leading to a spread of low-quality diets characterised by high intakes of hyper-energetic, inexpensive and easy-to-prepare food products[1–3]. This transition in dietary behaviour has been widely associated with increasing rates of obesity, type 2 diabetes mellitus and high blood pressure among children and adults[4,5].

Colombia is already in the process of a complex and dynamic nutrition transition[6]. Recent studies in Colombian children have shown that new patterns of intake are of lower dietary quality and that they could be associated with the current obesity epidemic and increasing morbidity caused by non-communicable diseases (NCD)[7,8]. Despite this, a third (32·9 %) of patients do not receive advice from their primary care providers about healthier dietary options[9].

Promoting the adherence to healthy eating patterns is thought to be a feasible strategy to improve general health and reduce all-cause mortality. Evidence from population-based studies consistently shows that diets rich in fruits, vegetables and legumes, and low in processed foods are associated with reduced risk of obesity, metabolic

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disorders, cardiovascular diseases (CVD) and several types of cancer[10–12].

The Alternative Healthy Eating Index (AHEI) was developed based on the Dietary Guidelines for Americans, as an attempt to capture the cumulative effects of foods and nutrients regularly consumed that are the most predictive of chronic diseases[13]. Hence, an AHEI score has been suggested to reflect the diet quality at the individual level. In this scoring system, higher values indicate healthier eating patterns, whilst lower or zero points indicate unhealthy patterns[13]. Since the AHEI score has been associated with risk factors for NCD and risk of all-cause mortality[14,15], it can be used to determine the association between overall diet and risk of disease in the general population.

In this study, we describe for the first time the diet quality of a nationally representative sample of adolescents and adults from Colombia who participated in the 2010 National Nutrition Survey (ENSIN) and investigated the association between AHEI score and anthropometric outcomes related to obesity.

Methods

Participants
The 2010 Colombian National Nutrition Survey (Encuesta Nacional de la Situación Nutricional en Colombia 2010 (ENSIN 2010)) collected data from a nationally representative sample of 50 760 participants, selected through multistage cluster random sampling[16]. Of these, 6841 were adolescents aged 10–17 years and 7130 adults aged 18–65 years. All those who completed the survey's food frequency questionnaire (FFQ) were eligible for inclusion in the current analyses.

Demographic and socio-economic data were collected through a validated questionnaire developed for the National Demographic and Health Survey and administered before the nutritional survey. Information on age, sex, geographical localisation (by national sub-region) and wealth index was also collected. The wealth index was developed by the National Demographic and Health Survey to estimate a household's cumulative living standard (e.g. water access, television, type of vehicles, material used for housing construction). The population is categorised into quintiles to define their socio-economic status[17].

Dietary intake assessment
Dietary intake was evaluated using a validated FFQ through face-to-face interviews with trained staff. Monthly, weekly and daily consumption over the past year was enquired for thirty-two foods including meats (chicken, red and processed meat, fish), dairy products, vegetables, fruits, whole grains, nuts and legumes, sweetened beverages (including fruit juices), whole grains, sugar, coffee and 'fast

food', as well as consumption of nutritional supplements. Since no specific portion sizes were employed in the survey, standard portion sizes were used to estimate daily food and nutrient intakes. These reference portion sizes were based on the Food-based Dietary Guidelines for the Colombian Population (Guías Alimentarias Basadas en Alimentos para la Población Colombiana Mayor de 2 Años) developed by the National Institute of Family Welfare (Instituto Colombiano de Bienestar Familiar)[18]. The Colombian food composition table[19] was used to estimate daily total energy intake (TEI) (kilocalories), as well as consumption of fatty acids (polyunsaturated (PUFA), omega-3, and trans-fatty acids) and sodium.

Children of pre-school age (3–4 years) and of primary school (5–9 years) were excluded from our analyses – in Colombia, dietary reference intakes for these age groups are highly specific to physiological demands and focused on nutritional-related deficiencies rather than in the prevention of NCDs. We therefore restricted the diet quality assessment to adolescents (aged 10–17 years) and adults (aged 18 years and older). Participants were excluded from the final sample if they had 20 % or more missing data in the FFQ, or if they had unreliably low (<1st percentile) or high (>99th percentile) TEI values.

Dietary exposure: assessment of diet quality based on the Alternative Healthy-Eating Index score
The AHEI score was used as indicator of diet quality in adolescents and adults. The AHEI 2010 is comprised of eleven different food groups or components. Each component is scored using a ten-point scale, with zero being the lowest diet quality and 110 the highest. Six of these components are assumed to be of higher quality, namely higher scores indicate higher consumption of: (i) vegetables (excluding potatoes), (ii) fruits, (iii) nuts and legumes, (iv) whole grains, (v) *n*-3 fatty acids and (vi) PUFA (as percentage of TEI). The remaining five components are focused on moderation, with higher scores indicating lower or null consumption of: (i) sugar-sweetened beverages and juices, (ii) red and processed meat, (iii) trans-fatty acids (as percentage of TEI), (iv) sodium and (v) alcohol[13]. The ENSIN 2010 survey did not enquire about alcohol intake in adults (or adolescents); therefore, the maximum possible AHEI score in this survey was 100.

Outcomes
Waist circumference and body mass index (BMI) were used as outcomes of obesity, a known early risk factor for CVD and other NCDs. These anthropometric variables were measured by trained personnel using calibrated instruments. Waist circumference was measured following the Clinical Guidelines on the Identification, Evaluation, and Treatment of Overweight and Obesity in Adults[20]. Height was measured to the nearest millimetre using a stadiometer,

and weight was measured to the nearest 100 g, using SECA 872 scales. BMI was calculated in kg/m², and the WHO recommendations were used to categorise adults as overweight or obese[21]. In adolescents, sex-specific height for age and BMI for age z-scores were calculated following the WHO references[22].

Self-perceived health was used as outcome of general health status and considered to be somewhat influenced by dietary behaviour. This outcome was ascertained based on a question about the participant's perception of their health over the past year, ranking it with a semi-quantitative five-point scale, from 1 (worst) to 5 (excellent).

Statistical analyses

Socio-demographic, anthropometric and nutrition data were expressed as main tendency and frequency values, when appropriate. To assess the association between AHEI 2010 score and anthropometric outcomes, we used a linear regression model adjusted by age, sex, wealth index and sub-national region. Effect sizes were reported as β-coefficients and standard errors. Information on smoking habit was available in fewer than 500 of the subjects with outcome and dietary data; therefore, it was not included as potential confounder in the analyses. Associations with a P-value <0·05 were considered statistically significant. The association between AHEI 2010 score and general health status was examined with an ordinal logistic regression model, with effect sizes reported as odds ratios (OR), adjusting for the same four potential confounders used in the linear regressions. The standard child growth values were calculated using STATA WHO 2007 package. The analyses were carried out using statistical software STATA/se 13.0.

Results

A total of 13 316 participants (6566 adolescents and 6750 adults) were included in the study (Fig. 1). Approximately 58·8 % (n 7833) of the participants were women, and the average age was 24·5 ± 13·6 years. Socio-demographic characteristics are summarised in Table 1.

Adolescents

Table 1 describes the general anthropometric characteristics of adolescents and their dietary intake. Nearly 60 % of these participants considered they had a good health status. Their TEI averaged 8267 kJ/d, and they had a mean AHEI score of 29·3 (±7·2). The median intake of food components listed in the AHEI 2010 is described in Table 2. The daily intake of fruits and vegetables was below one portion each, whilst nearly 15 % of participants reported no consumption of whole grains.

Adults

The TEI in adults was slightly lower than that of adolescents (Table 1), and their mean AHEI score was 30·5 ± 7·2 (Table 1). Over half of the participants reported having a
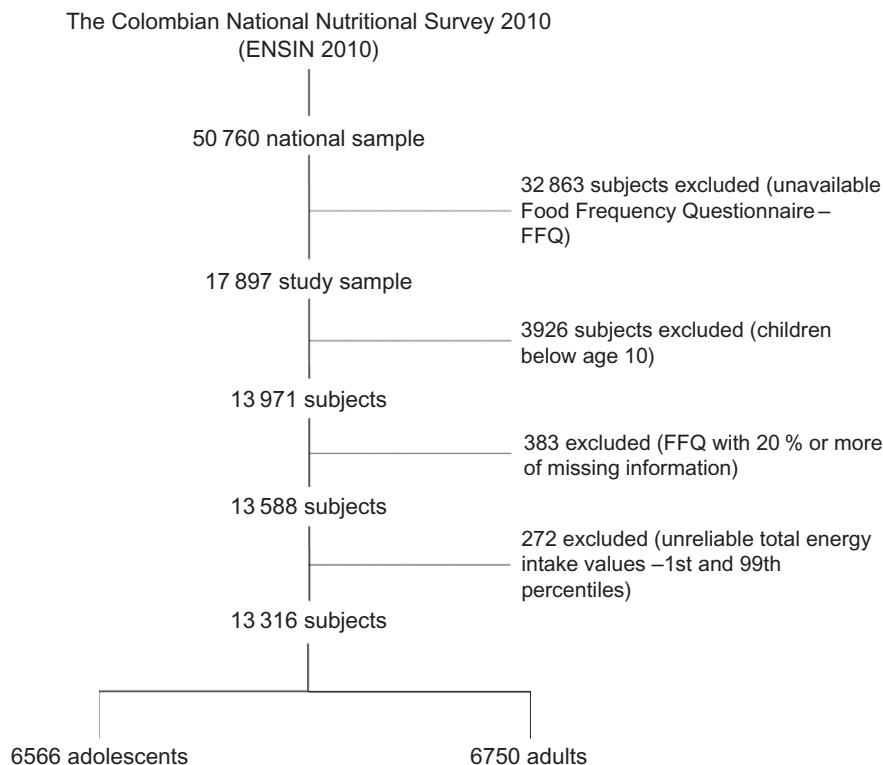

Fig. 1 Flowchart of participants included in the study

The Colombian National Nutritional Survey 2010
(ENSIN 2010)

50 760 national sample

32 863 subjects excluded (unavailable Food Frequency Questionnaire – FFQ)

17 897 study sample

3926 subjects excluded (children below age 10)

13 971 subjects

383 excluded (FFQ with 20 % or more of missing information)

13 588 subjects

272 excluded (unreliable total energy intake values – 1st and 99th percentiles)

13 316 subjects

6566 adolescents   6750 adults

Table 1 General characteristics of adolescents and adults participating in the ENSIN 2010 survey*

	Adolescents		Adults	
	%	n	%	n
Sex				
Female	51·5	3383	65·9	4450
Age				
Mean		14·2		34·4
SD		1·9		12·6
SISBEN index				
1	58·4	3834	42·3	2853
2	11·7	769	12·6	853
3	8·8	580	10·5	706
4 or more	21·1	1383	34·6	2338
Wealth index				
Mean		−0·4		−0·3
SD		1·1		1·1
Geographic region				
Atlantic-Caribbean (Northern)	22·2	1456	22·4	1513
Eastern	14·8	970	13·6	917
Central-Andean	23·5	154	25·4	1712
Pacific (Western)	14·5	951	15·3	1034
Bogota (capital city)	5·6	365	6·1	412
South-eastern	19·6	1284	17·2	1162
Education level				
None	0·5	34	3·6	244
Pre-school	0·3	20	0·2	11
Elementary	30·2	1982	31·4	2122
High school	68·1	4474	45·3	3060
Technology	0·3	19	8·3	562
Professional	0·5	34	9·5	641
Post-graduate	–	–	1·1	73
Unknown	0·1	3	0·6	37
Occupation				
Student	72·3	4750	5·1	347
Employed	5·6	374	53·7	3726
Unemployed†	12·0	793	41·2	2677
Unknown	9·9	649	–	–
Dietary variables				
Total energy intake				
Mean (kJ)		8267·2		7189·8
SD		2598·3		2256·8
Sodium intake				
Mean (mg)		1386·7		1157·3
SD		576·7		492·8
AHEI 2010 score				
Mean		29·3		30·5
SD		7·2		7·2
General health outcomes				
Self-perceived health				
Worst	0·6	39	1·8	124
Bad	15·3	1005	26·8	1806
Good	59·7	3921	54·2	3657
Very good	11·5	752	9·1	611
Excellent	12·9	849	8·2	552
Anthropometric variables				
Height				
Mean		155		159
SD		11·0		9·0
Weight *mean*				
Mean		49·5		65·5
SD		11·5		13·0
Waist circumference				
Mean		–		86
SD		–		12·0
BMI (kg/m^2)				
Mean		20·3		25·8
SD		4·3		5·1
Sex-specific height for age				
Mean		−0·7		–
SD		1·0		–
Sex-specific BMI for age				
Mean		0·2		–
SD		1·0		–

*Age in years; SISBEN: 'System of potential beneficiaries of social programs'; Wealth index summarises the participants' socio-economic status, total energy intake in kJ/d and sodium intake in mg/d; AHEI: 'Alternative Healthy Eating Index' employed for diet quality assessment. Height in cm; weight in kg; waist circumference in cm; BMI in kg/m^2; sex-specific height for age in z-score; sex-specific BMI for age in z-score. WHO references were employed to calculate specific z-scores in adolescents.
†Unemployment category includes participants involved in housekeeping and those who are retired.

Table 2 Alternative Healthy Eating Index (AHEI) scores for each dietary component

Dietary components included in the AHEI index	Adolescents (n 6566)				Adults (n 6750)			
	Daily intake		AHEI score		Daily intake		AHEI score	
	Median	Q1–Q3	Median	Q1–Q3	Median	Q1–Q3	Median	Q1–Q3
Vegetables	12·1 g	0·0–42·5	0·2	0·1–0·6	24·2 g	6·8–42·5	0·4	0·1–0·7
Fruits	33·3 g	16·6–91·8	0·4	0·2–1·0	33·3 g	9·4–91·8	0·4	0·1–1·0
Whole grains								
Women	0 g	0–0	0	0–0	0 g	0–0	0	0–0
Men	0 g	0–0	0	0–0	0 g	0–0	0	0–0
Sweetened beverages and juices	256·0 ml	134·1–468·4	0	0–0	234·1 ml	119·2–440·0	0	0–0
Nuts and legumes	16·5 g	4·7–16·5	5·8	1·7–5·8	9·4 g	4·7–16·5	3·3	1·7–5·8
Red/processed meat	67·0 g	36·4–117·5	5·0	0·0–7·5	60·2 g	32·7–102·5	5·7	2·0–7·5
Trans-fatty acids†	0·4 %	0·3–0·5	10·0	9·9–10·0	0·4 %	0·3–0·5	10·0	9·9–10·0
n-3 fat	1·6 mg	1·1–2·2	0·1	0·0–0·1	1·2 mg	0·8–1·6	0·0	0·0–0·1
PUFA†	4·9 %	4·2–5·6	3·7	2·8–4·6	4·3 %	3·7–5·1	2·9	2·1–3·9
Sodium	1311·1 mg	960·6–1726·7	4·4	1·1–6·7	1074·5 mg	812·2–1409·6	5·6	3·3–7·8

†Proportion of total energy intake.

Table 3 Adjusted association between Alternative Healthy Eating Index (AHEI) 2010 score and self-perceived health†

Dependent variable	Adolescents (n 6566)		Adults (n 6750)		Whole sample (n 13 316)	
	OR	95 % CI	OR	95 % CI	OR	95 % CI
Self-perceived health	0·989*	0·982, 0·996	0·986*	0·980, 0·993	0·988*	0·986, 0·993

†Ordinal logistic regression model adjusted by age, sex, socio-economic status and geographic region.
*$P < 0.001$.

Table 4 Association between the Alternative Healthy Eating Index (AHEI) 2010 score, BMI and anthropometric outcomes†

Dependent variables	Adolescents (n 6466)		Adults (n 4976)	
	β-Coefficient	SE	β-Coefficient	SE
Waist circumference (cm)	–	–	−0·06**	0·02
BMI (kg/m^2)	–	–	−0·02*	0·008
Sex-specific height for age (z-score)	−0·009***	0·002	–	–
Sex-specific BMI for age (z-score)	0·0003	0·002	–	–

†All models were adjusted by age, sex, socio-economic status and geographic region. Waist circumference and BMI were the anthropometric measures used as dependent variables in adults. Sex-specific height for age and sex-specific BMI for age z-scores were used as anthropometry outcomes in adolescents.
*$P < 0.05$, **$P < 0.01$, ***$P < 0.001$.

good general health status. There was a low consumption of foods considered to be of better quality, with the median intake of fruits, vegetables and whole grains being below one portion each (Table 2).

Associations between diet quality, general health and anthropometric outcomes

The results of the adjusted regression models examining the association between AHEI score and the outcomes studied are shown in Table 3. The AHEI score was statistically negatively associated with self-perceived health, both in the whole study sample and when analysed separately by age group.

Having a higher AHEI score was statistically negatively associated with height-for-age z-score in adolescents, whilst in adults AHEI score was associated with having a smaller waist circumference, and a lower BMI (Table 4).

Discussion

In this study, we examined the association between diet quality, anthropometric variables and self-perceived general health in a nationally representative sample of Colombian adolescents and adults. The average AHEI scores for adolescents and adults were 29·3 and 30, respectively, suggesting that

the overall diet quality in this population was low. Our results show that a higher (better) AHEI score was associated with having a smaller waist circumference and a lower BMI, both in adolescents and in adults, and that a higher diet quality was negatively associated with self-perceived general health.

Waist circumference and BMI are closely related to the risk of type 2 diabetes mellitus, CVD and some types of cancer[23]. A population-based study in Colombian adults found that those with a healthier dietary pattern had a BMI and waist circumference within the recommended range to prevent NCD[24]. Similarly, a study of Hispanic and Latino adults living in the USA reported that AHEI score was negatively associated with waist circumference[25]. Although these results are based on cross-sectional observations, as those reported in our study, the findings suggest that a low-quality diet is likely to be contributing to the current burden of cardio-metabolic traits in Colombia[24] and in the rest of Latin America where obesity is five times more common in individuals with the unhealthiest eating behaviours[26].

The association between healthy dietary patterns and waist circumference in adolescents has been confirmed in other population-based studies in school-aged children from Colombia, where serum concentrations of non-esterified fatty acids were correlated with waist circumference[27]. Considering that fatty acid consumption is a strong AHEI component and is assessed based on three criteria, this index might be associated with abdominal obesity. Such an approach could provide useful insights to determine whether further health interventions should be employed in Colombia, where waist circumference and other measures of obesity have been associated with cardio-metabolic markers in young children[28].

The negative association between self-perceived health (general health status) and diet quality reported in the current study might be due to several reasons. In low- and middle-income countries such as Colombia, obesogenic eating behaviours are still thought to be associated with privileged social position[29–31]. Although this social perception of wellness is more intense in the poorest communities, it remains a widespread determinant of eating behaviour and a factor in the ongoing nutrition transition[32]. Changing behaviours and beliefs about what a good diet should include are challenging issues and should be taken into consideration when designing public health policies and programmes.

Food preferences in low- and middle-income countries under transition are a concerning issue. Preferences for fast food, salty snacks and sugar-sweetened beverages were associated with psychological well-being and better self-perception of health[33]. Such positive response to unhealthy eating behaviours was described to be highly influenced by social determinants in transitional populations[34], where novel sensatory experiences linked to recently introduced ultra-processed food and aggressive advertising campaigns have led to an idealisation of these products[35]. To address this issue, some studies have proposed that restrictions against nocuous publicity should be applied to promote collective choices on healthy lifestyles in Latin America and Colombia[36].

Among the adolescent group, we found that diet quality was negatively associated with height-for-age z-score. Considering that this anthropometric measure is an indicator of long-term growth and development in adolescents, AHEI score might not be appropriate for the assessment of nutritional requirements in adolescents. Studies reporting the use of AHEI in adolescents are limited. Dahm et al.[37] reported an association between AHEI score during adolescence and the development of risk factors for CVD in mid-adulthood. However, they were unable to estimate the association between AHEI and anthropometric measures during adolescence since the participants were adult women who provided retrospective data on their dietary habits in high school years.

Our study has several strengths. We used a large and nationally representative sample of adolescents and adults from Colombia, from which we derived a diet quality score and obtained anthropometric measures. The ENSIN 2010 survey used a FFQ that captured several important staple foods consumed in the country, and deriving the AHEI score in a nationally representative sample of Colombian individuals facilitates international comparisons of diet quality. Our study also has some potential limitations. The ENSIN 2010 survey used a semi-quantitative FFQ, which did not include portion size estimates. We used reference standardised portion sizes to derive nutrient estimates, which might not necessarily represent the usual intake of the participants[18]. However, the average estimated daily TEI was similar to what has been reported in similar populations of Colombia[38]. As reported in other studies[37,39], we were unable to include alcohol intake in the construction of the AHEI score as information on this variable was not available in the adult survey. Given the current trends in alcohol consumption in Latin America, it is possible that the overall quality of the diet would have been even lower than that reported here[40]. Finally, the ENSIN survey contained partial information on smoking habit in fewer than 500 subjects with valid outcome and exposure data; therefore, we did not control for the potential confounding effect of this variable.

To our knowledge, this is the first study to examine diet quality in Colombian subjects, using data from the nationally representative ENSIN 2010 Survey. We found that diet quality was associated with some indicators of general health and predictors of NCD. The overall low diet quality found in this population highlights the need to strengthen public health actions that contribute to tackle the growing burden of NCD.

Acknowledgements

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Public Health Nutrition

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