

# Vegetarian children and adolescents' anthropometric characteristics do not significantly differ from their non-vegetarian counterparts

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## Abstract

Approximately 7% of American children and adolescents adhere to vegetarian diets. The few studies that assessed anthropometry among vegetarian children and adolescents were cross sectional, few included vegan children and a handful utilized growth charts. Available data is outdated and is limited to a handful of studies. The goal was to compare anthropometric characteristics of vegetarian with non-vegetarian children and adolescents. We hypothesized that the rate of obesity among vegetarian children and adolescents will be statistically significantly lower than the rate among their non-vegetarian counterparts and that there will be no statistically significant difference in any other anthropometric characteristics among these two groups. CDC's growth charts were utilized to assess anthropometric data of 218 vegetarians with 308 non-vegetarian children and adolescents. There was no statistically significant difference between the rate of vegetarian *vs.* non-vegetarian children below the 5<sup>th</sup> percentile length-for-age (14.1% *vs.* 10.4% for non-vegetarian girls; Chi square=0.52, df=1, p=0.4708; and 10.2% *vs.* 4.7%; Chi square=1.84, df=1, p=0.175 for vegetarian *vs.* non-vegetarian boys). No statistically significant differences were found between the dietary groups in regard to percentages of obese children, defined as BMI-for-age  $\geq$ 95<sup>th</sup> percentile, (9.5% *vs.* 12.7% for vegetarian *vs.* non-vegetarian girls; Chi-square=0.34, df=1, p=0.5598; and 14% *vs.* 15.9% for vegetarian *vs.* non-vegetarian boys; Chi-square=1.03, df=1, p=0.3102). Vegetarian children and adolescents' anthropometric characteristics do not significantly differ from their non-vegetarian counterparts.

## Introduction

Vegetarians comprise a diverse group of individuals who adhere to a variety of different diet types. Vegans avoid meat and all foods of animal origin. Lacto-vegetarians do not ingest meat but ingest milk and dairy products, ovo-vegetarians ingest eggs and exclude meat and dairy, while lacto-ovo-vegetarians include milk, dairy and eggs. Pescovegetarians ingest fish and/or seafood, while semi-vegetarians eat small amounts of meats. Within the above-described groups are also those who ingest most or all foods as raw foods and those who exclude specific plant products, such as the nightshade vegetables.

Vegetarians are not inclusive to adults. Data from the national poll from 2010 among 1,258, 8 to 18 years old, children and adolescents from the United States showed that 7% of the sample never ate meat [1]. It is generally accepted that vegetarian diets are nutritionally adequate in all stages of life. It has also been assumed that vegetarian diets sustain adequate growth and development among children and adolescents. However, there are surprisingly limited number of research studies that support these assumptions [2-8]. Most of these studies were cross sectional, few of them included vegan children and few utilized growth charts. In addition, the handful of available published studies assessed the growth of vegetarian children from several different countries and among children of different age and ethnic background, making the comparison difficult.

Findings from a number of research papers showed high rates of deficiency of some nutrients, especially vitamin B12 and iron, among vegetarians, especially vegans. Data regarding vitamin B12 status among children and adolescents is very scarce and mainly based on case reports. Vegetarian adults have a very high prevalence of vitamin B12 deficiency [9]. Data on iron status showed an inadequate iron status among children and adolescents that ranged from 4.3%-73% of the studied samples having ferritin below 10  $\mu$ g/L [10]. These nutrients

play a key role in fetal and child growth and development and thus, may impact anthropometric parameters of both children and adolescents.

The goal of the current study was to assess anthropometric differences among children adhering to different dietary patterns. Our hypothesis was that the rate of obesity among vegetarian children and adolescents will be statistically significantly lower than the rate among non-vegetarian children and adolescents and that this will be the only statistically significant difference in the anthropometry of these two groups. The specific objectives included: 1) compare anthropometric data using the Center for Disease Control and Prevention (CDC) growth charts [11], including length-for-age, weight-for-age and BMI-for-age among children and adolescents adhering to different dietary preferences (vegetarian *vs.* non-vegetarian); 2) to evaluate the percentage of the sample in different percentile categories (e.g. <5<sup>th</sup> percentile, at and/or above the 95<sup>th</sup> percentile) among vegetarian and non-vegetarian children; and 3) assess the weight status and obesity prevalence among children in different dietary group using BMI-for-age growth charts, defined as BMI-for-age at or above 95<sup>th</sup> percentile.

## Methods and materials

### Data collection

The research protocol was approved by the Institutional Review

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Board prior to collecting data. Permission from the North American Division of the Seventh-Day Adventist Church to contact its institutions requesting participations was received. Inquiry to different Seventh-Day Adventist Church schools and churches were sent via an e-mail, requesting participation in the research study. Surveys along with letters that explained the goal and the protocol of the study, along with consent forms for parents and assent forms for children were mailed to those institutions that indicated willingness to participate. Surveys were subsequently distributed by school/church officials to parents via students. Participants were asked to complete the survey as a child-parent pair. Completed surveys were either mailed directly to the Principal Investigator (PI) or were returned to schools/churches that subsequently mailed them to the PI. In order to include more vegan children in our study, we placed an announcement about the study on one web-based blog for vegans. Surveys were subsequently collected via e-mails from parents who replied to this advertisement. Students and parents were informed that their participation was completely voluntary. We offered no compensation of any kind to study participants. Data collection took place between the fall of 2011 and late summer 2012.

### Survey

The survey consisted of questions related to anthropometric data (e.g. height, weight) of children. Also, we asked questions regarding child's diet adherence (e.g. lacto-ovo-vegetarian, vegan) and the length of time a child adhered to the selected diet. The dietary options listed in the survey included six categories: 1) all foods including meats such as pork, lobster, and catfish; 2) biblically "clean" meat such as beef and chicken; 3) lacto-ovo-vegetarian diet; 4) lacto-vegetarian diet; 5) ovo-vegetarian diet and 6) only plant foods (vegan).

### Statistical analyses

Children's anthropometry was assessed using the CDC growth charts, using SAS program from the CDC's website. The gender specific analyses included the following growth charts: BMI-for-age, weight-for-age, and length-for-age. Frequency count and percentages were used to assess the number and the prevalence of children in the following percentile categories: less than 5<sup>th</sup> percentile, between 5<sup>th</sup> and less than 10<sup>th</sup> percentile, between 10<sup>th</sup> and less than 85<sup>th</sup> percentile, between 85<sup>th</sup> and less than 95<sup>th</sup> percentile, and at and/or above the 95<sup>th</sup> percentile for each of the three growth charts.

Analyses for vegetarian and non-vegetarian children were performed separately. Due to relatively small number of vegans (n=39), vegan children were included along with other vegetarians in one group called vegetarian group. Chi-square analyses was used to assess whether there were statistically significant differences regarding percentages of vegetarian vs. non-vegetarian children in different percentile categories. A value of <0.05 was used to indicate statistically significant difference.

## Results

### Demographics

A total of 602 surveys were collected of which 10 were excluded from analyses because a number of questions were left unanswered. An additional 19 surveys were excluded from the growth chart assessments because of missing data regarding age and/or gender. Lastly, we excluded 47 surveys for children younger than 3 years old. Thus, the analyses are based on 526 participants including 237 boys (45.1%) and 289 (54.9%) girls, mean (range) age of 11.4 years (3 to 19). A total of 422

**Table 1.** Anthropometric characteristics of the sample.

	Vegetarian	Non-vegetarian
<b>Gender</b>	Girls=108	Girls=181
	Boys=110	Boys=127
<b>Mean (range) Age</b>	Girls=10.41 (3-20)	Girls=12.09 (3-20)
	Boys=10.27 (3-19)	Boys=12.64 (3-18)
<b>Ethnic background</b>	African American=51	African American=102
	Asian American=1	Asian American=7
	Caucasian=90	Caucasian=29
	Hispanic American=36	Hispanic American=93
	Mixed=37	Mixed=77
	Missing=3	

of these children designated membership in the Seventh-Day Adventist Church. Children who adhered to vegetarian diets included 179 lacto- and/or lacto-ovo-vegetarians and 39 vegans. Of those who consumed meat, 304 indicated consuming only meat from animals defined in the Bible as clean animals (e.g. beef, chicken but not pork). Additional data describing participants are included in table 1.

### Growth charts analysis

**Length-for age:** The rate of vegetarian girls below the 5<sup>th</sup> percentile length-for-age reached 14.1% and was higher than the 10.4% for non-vegetarian girls. However, the difference was not statistically significant (Chi square=0.52, df=1, p=0.4708). Similarly, a higher percentage of vegetarian, compared to non-vegetarian, boys were below the 5<sup>th</sup> percentile length-for-age the difference was not statistically significant (10.2% vs. 4.7%; Chi square=1.84, df=1, p=0.175).

**Weight-for-age:** There was a statistically significant difference between the rate of vegetarian vs. non-vegetarian girls below the 5<sup>th</sup> percentile for weight-for-age (13.5% vs. 4.8%; Chi-square=6.46, df=1, p=0.011) but not boys (4.8% vs. 4.7%; Chi-square=0.85, df=1, p=0.3566). The difference between the vegetarian vs. non-vegetarian girls for the weight-for-age at and/or above the 95<sup>th</sup> percentile was statistically significant (5.8% vs. 15.0%; Chi square=5.36, df=1, p=0.0206). Likewise, there was a statistically significant difference between vegetarian and non-vegetarian boys classified at and/or above the 95<sup>th</sup> percentile weight-for-age (Chi square=7.04, df=1, p=0.008).

**BMI-for-age:** The BMI-for-age for the majority of children from both groups was between the 10<sup>th</sup> and 85<sup>th</sup> percentile (Table 2). No statistically significant differences were found between the different dietary groups in regard to percentages of obese children (BMI-for-age  $\geq$  95<sup>th</sup> percentile). For girls, 9.5% of vegetarian and 12.7% of non-vegetarian (Chi-square=0.34, df=1, p=0.5598) and for boys, 14% of vegetarian and 20.0% of non-vegetarian (Chi-square=1.03, df=1, p=0.3102) were in the obese category. The percentage of girls and boys in the BMI-for age 85<sup>th</sup>-<95<sup>th</sup> percentile was 18.9% for vegetarian girls vs. 20.4% of non-vegetarian girls (Chi square=0.01, df=1, p=0.9203) and 15.9% of vegetarian boys and 19.2% of non-vegetarian boys (Chi square=0.22, df=1, p=0.639).

## Discussion

This study compared anthropometric data of vegetarian with non-vegetarian children and adolescents using CDC growth charts. Although not statistically significantly different, compared to non-vegetarian girls and boys, vegetarian girls and boys had lower rate of overweight and obesity, indicative by a lower percentage of children in the at or above 95<sup>th</sup> and in the 85<sup>th</sup> to less than 95<sup>th</sup> percentile, respectively, BMI-for-age (Table 2). These findings are consistent

**Table 2.** Anthropometric findings based on CDC's growth charts.

Percentiles	Total % (N=526)	Vegetarian Girls (108)	Non-vegetarian girls (181)	Vegetarian Boys (110)	Non-vegetarian boys (127)
	Count (%)	Count (%)	Count (%)	Count (%)	Count (%)
<b>Length-for-age</b>	N=504	N=99	N=164	N=108	N=127
<5 <sup>th</sup>	50 (9.9%)	14 (14.1%)	17 (10.4%)	11 (10.2%)	6 (4.7%)
5 <sup>th</sup> -<10 <sup>th</sup>	26 (5.2%)	10 (10.1%)	8 (4.9%)	4 (3.7%)	4 (3.1%)
10 <sup>th</sup> -<85 <sup>th</sup>	303 (60.1%)	54 (54.5%)	94 (57.3%)	62 (57.4%)	89 (70.1%)
85 <sup>th</sup> -<95 <sup>th</sup>	59 (11.7%)	8 (8.1%)	22 (13.4%)	16 (14.8%)	13 (10.2%)
≥95 <sup>th</sup>	66 (13.1%)	13 (13.1%)	23 (14.0%)	15 (13.9%)	15 (11.8%)
<b>Weight-for-age</b>	N=506	N=104	N=167	N=107	N=123
<5 <sup>th</sup>	32 (6.3%)	14 (13.5%)	8 (4.8%)	5 (4.7%)	3 (2.4%)
5 <sup>th</sup> -<10 <sup>th</sup>	7 (1.4%)	0 (0%)	2 (1.2%)	4 (3.7%)	1 (0.8%)
10 <sup>th</sup> -<85 <sup>th</sup>	311 (61.5%)	70 (67.3%)	102 (61.1%)	69 (64.5%)	67 (54.5%)
85 <sup>th</sup> -<95 <sup>th</sup>	84 (16.6%)	14 (13.5%)	30 (18.0%)	11 (10.3%)	29 (23.6%)
≥95 <sup>th</sup>	72 (14.2%)	6 (5.8%)	25 (15.0%)	18 (16.8%)	23 (18.7%)
<b>BMI-for-age</b>	N=484	N=95	N=157	N=107	N=120
<5 <sup>th</sup>	26 (5.4%)	10 (10.5%)	4 (2.5%)	10 (9.3%)	3 (2.5%)
5 <sup>th</sup> -<10 <sup>th</sup>	18 (3.7%)	3 (3.2%)	4 (2.5%)	6 (5.6%)	4 (3.3%)
10 <sup>th</sup> -<85 <sup>th</sup>	282 (58.3%)	55 (57.9%)	97 (61.8%)	59 (55.1%)	66 (55%)
85 <sup>th</sup> -<95 <sup>th</sup>	90 (18.6%)	18 (18.9%)	32 (20.4%)	17 (15.9%)	23 (19.2%)
≥95 <sup>th</sup>	68 (14.0%)	9 (9.5%)	20 (12.7%)	15 (14.0%)	24 (20.0%)

with previous reports that compared vegetarian with non-vegetarian children and/or adolescents. For example, Grant et al. [12] reported 53 vegetarian 14 to 15 years old boys and girls having lower average waist (69.2 vs. 73.5 cm;  $p < 0.01$ ), BMI (20.5 vs. 21.9;  $p < 0.05$ ), and weight (57.8 vs. 62.2 kg;  $p < 0.05$ ), compared to 160 non-vegetarian age-matched peers from New South Wales, Australia.

The obesity rate among children and adolescents participating in this study was lower than the rate based on the National Health and Nutrition Examination Survey (NHANES) study [13]. This was true for male and female vegetarians and for non-vegetarian girls but not for non-vegetarian boys. Overall, 17.0% of the NHANES sample (years 2011-12014) were at or above 95<sup>th</sup> percentile BMI-for-age compared to 14% in the current study. The percentage of those at or above the 85<sup>th</sup> percentile among children in the NHANES study (years 2011 – 2012) was almost identical with that in the current study (31.8% vs. 32.6%) (14). Obesity rates among both vegetarian boys and girls was lower in comparison to the NHANES data (9.5% for girls, 14% for boy vs. 17.2% for girls, and 16.7% for boys in NHANES sample in the at and/or above 95<sup>th</sup> percentile. Likewise, in the current study 28.4% of girls and 29.9% of boys vs. 32.0% of boys and 31.6% of girls in the NHANES sample were in the at and/or above 85<sup>th</sup> percentile BMI-for-age) [14].

The data from the present study showed mixed results for non-vegetarian girls. Compared to NHANES sample, they had a lower rate of BMI-for-age at or above 95<sup>th</sup> percentile (12.7%) but a higher rate of BMI-for-age above 85<sup>th</sup> percentile (33.1%). Non-vegetarian boys from our study, on the other hand, had higher rate of BMI-for-age in both of these categories compared to boys from the NHANES sample (20% at or above 95<sup>th</sup> percentile and 39.2% above 85<sup>th</sup> percentile) [14].

With the exception of non-vegetarian boys, our participants had a relatively high rate of length-for-age below 5<sup>th</sup> percentile (Table 2). Overall, 9.9% of boys and girls (14.1% for vegetarian girls, 10.4% for non-vegetarian girls, 10.2% for vegetarian boys and 4.7% for non-vegetarian boys) were found in this category. This finding is somewhat consistent with data from the Farm Study [2]. In that sample, which was mainly comprised of vegan children, 8% of the sample were found in the length-for-age below 5<sup>th</sup> percentile. Similarly, our results seem

somewhat consistent with findings reported by Hebbelink et al. [4] In their sample comprised of Flemish vegetarian children, adolescents and young adults, adolescent boys had a mean stature that was 8.5 cm lower than the reference mean. Among participants of that study neither children nor young adults differed from the reference mean in regarding to their height [4].

## Limitation

The findings described in this manuscript are largely based on children and adolescent members of the Seventh-Day Adventist Church. Vegetarianism among Seventh-Day Adventists has been promoted since the church's establishment in the second half of the 19<sup>th</sup> century. Vegetarian Seventh-Day Adventists have been shown to have lower mortality rate due to cardiovascular disease compared to vegetarians who are not Seventh-Day Adventists [15]. This might mean that diets of Adventist vegetarians are healthier compared to diets of other vegetarians. Thus, the findings may not reflect all vegetarian individuals and communities. This may be especially true of those who become vegetarians for reasons such as weight loss/body image.

Our data is based on a convenience sample of volunteers. Further, we utilized self-reported heights and weights. Thus, the collected data may have had some discrepancies with actual heights and weights. Also, the findings may not be representative of all vegetarian children and adolescents. Although we made an effort to recruit more vegans, the number of vegan children was relatively small ( $n=39$ ). Thus, separate growth chart analyses were not possible for children in this diet group. Also, it is unclear how data on vegan children and adolescents skewed the findings.

## Conclusion and Implications

A smaller percentage of vegetarian compared to non-vegetarian boys and girls were found at and/or above the 95<sup>th</sup> percentile and at and/or above the 85<sup>th</sup> to less than the 95<sup>th</sup> percentile BMI-for-age, even though the differences were not statistically significant. Vegetarians have higher prevalence of being classified in the less than 5<sup>th</sup> percentile category for BMI-for-age, length-for-age and weight-for-age.

The findings of the current study are somewhat consistent with some previous reports. They show that, by and large, vegetarian children and adolescents' anthropometric characteristics do not significantly differ from their non-vegetarian counterparts. As stated in the introduction, vegetarians are among groups with high risk of vitamin B12 and iron deficiency. Although deficiencies of these nutrients can impair growth and development, it is unclear to what extent, if at all, they may impact vegetarian children and adolescents' anthropometry.

Vegetarian lifestyle seems to be on the rise. As many as 7% of American children and adolescents adhere to vegetarian diets [1]. Yet, reliable data based on well-controlled studies, regarding growth and development of vegetarian children and adolescents are lacking. Large, randomized, prospective studies are needed to assess growth and development of vegetarian children and adolescents compared with children on unrestricted diets.

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