Evaluation of Obesity and Overweight in Children Aymaras of the Province of Arica, Chile

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ABSTRACT In recent years there has been an increase in childhood obesity worldwide. Chile has not been oblivious to this problem, considered among the countries with higher incidence. Arica, an extreme region of Chile, borders Bolivia and Peru, has a great ethnic diversity predominating Aymara. The inhabitants of Arica have experienced adaptations to urban lifestyles, carrying out modifications corporal. For this motive is necessary to evaluate the body composition and the somatotype in Aymara children of the Arica commune. A non-experimental, descriptive, cross-sectional study was carried out under a quantitative exploratory analysis of variables evaluating 170 Aymara children between 8 and 10 years of age. The main results classify children as overweight, showing a meso-endomorphic somatotype and endo-mesomorphic girls, with a greater tendency to obesity in girls than in boys.

INTRODUCTION

It has been proven in recent years that the increase of obesity in children runs parallel to the behavior in adulthood. There seems to be an inexorable tendency to increase weight in the child population, to the point that there is a talk of a real epidemic. Obesity today has become manifest at the international level, and this scourge has likewise affected Chile. According to the results of Sistema de System of Measurement of the Quality of Education (SIMCE) of Physical Education, made to children of educational establishments in 2016, they announced that there is an increase in obesity and a cardiovascular and metabolic risk (Physical Education SIMCE 2016; World Health Organization 2014).

There are many factors influencing obesity, including the impact of globalization, family and social lifestyles, lack of information regarding sound approaches to nutrition, the limited availability, and affordability of healthy foods, which contribute to aggravate the problem (De Ruiter et al. 2017).

The region of Arica and Parinacota, an extreme area in Chile, has a population of different ethnic origins and diverse nationalities, being Aymara a large population, inhabiting, not only in the rural and peripheral localities, but, in the commune of Arica. These populations have been acquiring urban lifestyles, not knowing how these styles have influenced their anthropometric characteristics. Therefore, it would be interesting to carry out cineanthropometrical evaluations in these populations to determine the obesity index in the population of the Arica commune, considering the cultural diversity of the region. This has inspired the researchers to develop the present research, for which the following objectives have been outlined.

General Objectives

To evaluate the body composition and the somatotype in children, boys, and girls Aymaras of the commune of Arica.

Specific Objectives

1. Determine the variables: weight, height, fat percentage, folds, perimeters and obesity index in Aymara boys and girls residing in the commune of Arica.
2. Identify the somatotype in children, boys and girls Aymaras of the commune of Arica.

Aymara Population Lifestyle Patterns

Aimara or aimará is a native group of people of South America that inhabits the Andean pla-

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teau of Lake Titicaca from pre-columbian times, with its population divided between the west of Bolivia, the south of Peru, northern Chile, and northern Argentina. Alternatively, they are called collas, although there is no biunivocal correspondence between both names (Caqueo et al. 2014). In 1970s, there was an exponential growth of the Andeanpopulation, generating migration as an alternative development and regulatory mechanism between land and the indigenous population.

Aymara migration was made in a variable way according to historical moments and areas of origin. During those two decades the composition of the farming communities was modified, the regional rural population was redistributed, and an urban Aymara population segment began to be visible, which was acquiring habits and customs mixed with their cultural heritage.

The little certainty and complexity of the current scenario regarding the movement of people, for different reasons, affects the coexistence in the transmitting society as a recipient of human groups, the aforementioned is reflected from many points of view, such as: habits, behaviors, skills, and relationships adopted by these populations (Mondaca and Gajardo 2015) being equally interfering with their nutritional habits. At the same time, this leads to modifications of their morphological characteristics, which should be evaluated for a better characterization of this population (Escartín et al. 2017).

METHODOLOGY

In the present investigation, a non-experimental, mixed study was carried out under an exploratory analysis of mixed, descriptive, cross-sectional variables, which allowed the researchers to study the proposed problem adequately.

Universe, Population, and Sample

It was taken into account as a universe all Aymara boys and girls of primary education of the commune of Arica. The population was made up of Aymara children of primary education of the Ignacio Cabrera Pinto (G-27) and Chile Norte schools. The sample consisted of a total of 170 Aymara boys and girls (102 females and 68 males)from primary education, aged 8-10 years,

Ignacio Cabrera Pinto and Chile Norte, who were selected according to the following inclusion criteria: children from schools with high enrollment in multi-ethnic and multinational populations, between 8 and 10, Aymaras, residents in the commune of Arica. Likewise, the verbal and written consent and assent were taken into account and the approval of the Bioethics Committee of the Institution was also sought.

Study Variables

Among the study variables, the following variables were considered: age, sex, weight, height, percentage of fat, body mass index (BMI), diameters, skinfolds, perimeters, ethnicity, nationality, obesity degree, weight overweight. Measurements of body composition and somatotype were made taking into account the hours of measurement, which were carried out in a private room, with lighting and adequate environment for that activity, the evaluator's experience, as well as the quality and certification of the implements and measuring equipment.

The following equipment was used: Digital Balance with Fitness Analyzer. Omron HBF-514 C, Portable Heightometer ADE. Germany MZ 10042, Tape measure: ADE. Germany White, Panicometer Adipose (Plicometer): Baseline Type Lange, Anthropometer Harpender Holtain (Game) and gauge, of the Mitutoyo brand.

Measurements Protocol

The different variables that make up the body composition and somatotype measurements were evaluated with a standardized profile and methodology, which allowed comparisons with other study populations. The anthropometric measurement protocol was applied based on the International Society for the Advancement of Cineanthropometry (ISAK 2001). The variables for the BMI analysis were: (mass or weight and height or height), based on the formula:

BMI = Weight (Kg)/ (Size)^2 (m)

As an evaluation range of overweight and obesity in children, the internationally accepted and revised curves by the Centers for Disease Control and Prevention (CDC), which included age and sex-specific BMI values, were taken into

account in boys and girls. These use percentiles ranging from less than 3 for girls to less than 5 for boys, classified as individuals with low BMI. Above the percentiles of 3 for girls and 5 for boys, up to the 85th percentile, in both genders, are classified as normal. Children who are in the 85-95 percentile range are classified as overweight and children who are in a percentile above 95 are classified as obese (Pizarro et al. 2004).

Fat Mass Percent

For the calculation, the following indirect methods were used in the present investigation
- Slaughter Protocol (1988) referred by Díaz and Espinoza (2012)for children and adolescents (7 to 18 years of age).

Where, percentage fat mass (percentage MG) was determined by the fatty folds: triceps and subscapular, using the following equation for males and females of any level of maturity:

Percentage MG $= 1.33^{*} (\Sigma 2) - 0.013^{*} (\Sigma 2)^{2} - 2.5$

Where: $\Sigma 2 =$ Sum of triceps and subscapular folds in millimeters (mm). In cases where the sum of the fat folds was greater than 35 mm, a unique equation for each gender was used, as recommended by Slaughter (1988), independent of race and maturation status:

Boys: Percentage MG $= 0.783^{*} (\Sigma 2) + 1.6$
Girls: Percentage MG $= 0.546^{*} (\Sigma 2) + 9.7$

Somatotype

From the data obtained in the measurements and their recording, the following equations were used for each of the known models (Heath and Carter1990).

1. Calculation of Endomorphism

Endomorphism $= -0.7182 + 0.1451 \times \Sigma PC - 0.00068 \times \Sigma PC^{2} + 0.0000014 \times \Sigma PC^{3}$

Σ PC $=$ Sum of tricipital, subscapular and supraspinal folds, corrected by height. Add folds in mm, multiplied by 170.18 and then divided by the height of the subject in cm.

Σ PC $=$ (PTricip+ PSubesc)*170.18/size.

2. Calculation of Mesomorphism

Mesomorphism $=$ [0.858 x humerus diameter + 0.601 x femoral diameter + 0.188 x corrected arm perimeter + 0.161 x corrected calf perimeter] - [height x 0.131] + 4.5

3. Calculation of Ectomorphism

Enter weight in Kg.
1. Obtain the weight-height ratio (CAP), dividing the height by the cubic root of the weight.
2. Mark the closest value on the right value scale.

On the scale of Ectomorphism, mark the value that corresponds vertically to the value marked above.
- CAP ≥ 40.75
Ectomorphism $= 0.732 \times$ CAP $- 28.58$
- CAP < 40.75 y CAP > 38.25
Ectomorphism $= 0.463 \times$ CAP $- 17.63$
- CAP ≤ 38.25
Ectomorphism $= 0.1$

Subsequently, after defining these three characteristics or components (Endomorph, Mesomorph, and Ectomorph), the coordinates (x, y) were found to be represented in a letter of Cartesian planes (Somatic letter) as follows:

X= Ectomorph value– Endomorph Value. = (III – I)

Y= (2* Mesomorph value) –(Ectomorph + Endomorph). = (II * 2) –(III + I). Carter (1990).

Statistic Treatment

A computerized analysis of all the data achieved through the IBM SPSS Static 21 program was carried out. Variables taken into account were:
- Nominal qualitative variables: Demographic variables: Ethnicity and gender.
- Ordinal qualitative variables: Somatotype.
- Quantitative or scalar continues variables: Weight, size, circumferences, folds, etc.

All variables were processed in mathematical statistics, including Mean (X) and Standard Deviation (DS), depending on the type of data processed. At the same time, the significance was evaluated through the T-student test, taking into account the quantitative nature of the variables to be analyzed. According to the Levene test, it was considered as hypothesis and criteria to determine if there is significant difference in the mean:

p-Value $\leq \alpha$; accepted $H_{1}=$ there is a significant mean difference

p-Value $> \alpha$; accepted $H_{0}=$ there is no significant mean difference

RESULTS

Body weight has been a variable analyzed in our research, in which it was possible to show that Aymara girls aged eight to ten had weights of 34.3, 35.2 and 44.6 respectively. For their part, the Vaorenes showed weights of 30.8, 33.9 and 48.5 (Table 1).

As shown in Table 2, the size of the eight-year-old Aymara girls from the Arica commune showed values of 128. 6 cm, while in the girls of ten years, these findings were 140.7 cm. The boys behaved with a similar similarity with respect to the ladies, presenting the eight-year-old children with a size of 130.8 cm. and those of ten years 141.6 cm.

The cephalic perimeter did not show significant differences between the different age groups, neither between sexes, being able to mention the cephalic perimeter shown by the Aymara girls of ten years, which presented an average of 54.9 cm, meanwhile the males of this same group They showed a cephalic perimeter of 54.1 cm. (Table 3).

The perimeter of the chest shows values of 71.6, 72.5 and 81.2 cm. in the female representatives, for their part, the men exhibited perimeters of 62.3, 73.0 and 82.0 cm. in the ages of eight, nine and ten years of age respectively. (Table 4).

The waist perimeter variable nowadays is taken into account for the diagnosis of cardiovascular and metabolic risk, being necessary its evaluation. In this study this variable has attracted attention, for the evidenced values, standing out a perimeter of waist of 73.5 cm. in girls of ten years and a perimeter in males of 76.4 cm. (Table 5).

On the other hand, the hip perimeter shows values of 84.8 cm. in the ladies and 80.7 cm. in males (Table 6).

The results of the evaluation show that the percentage of fat mass is high in both sexes, with a greater influence in the ladies who showed values of 28.9, 28.0 and 32.4 percent, meanwhile the results shown by the men were slightly lower, being these: 15.7, 18.5 and 27.4 percent for the different age groups studied (Table 7).

Table 1: Aymara boys and girls body weight: Group statistics

Gender	Age		Ethnicity	N	Mean	Deviation tip.	Typical mean error
Male	8	Weight (Kg)	Aymaras	6	30.8	4.8	2.7
	9	Weight (Kg)	Aymaras	28	33.9	8.7	2.0
	10	Weight (Kg)	Aymaras	34	48.5	14.2	3.8
Female	8	Weight (Kg)	Aymaras	11	34.3	8.9	3.3
	9	Weight (Kg)	Aymaras	45	35.2	7.8	1.6
	10	Weight (Kg)	Aymaras	46	44.6	11.9	2.5

Table 2: Aymaras boys and girls size: Group statistics

Gender	Age		Ethnicity	N	Mean	Deviation tip.	Typical mean error
Male	8	Size (cm)	Aymaras	6	130.8	1.0	.6
	9	Size (cm)	Aymaras	28	132.4	6.1	1.4
	10	Size (cm)	Aymaras	34	141.6	9.5	2.5
Female	8	Size (cm)	Aymaras	11	128.6	2.5	1.4
	9	Size (cm)	Aymaras	45	132.0	8.6	1.8
	10	Size (cm)	Aymaras	46	140.7	7.0	1.5

Table 3: Cephalic perimeter for Aymara boys and girls: Group statistics

Gender	Age		Ethnicity	N	Mean	Deviation tip.	Typical mean error
Male	8	Cephalic Perimeter (cm)	Aymaras	6	53.0	1.8	.7
	9	Cephalic Perimeter (cm)	Aymaras	28	53.4	1.9	.4
	10	Cephalic Perimeter (cm)	Aymaras	34	54.1	1.2	.3
Female	8	Cephalic Perimeter (cm)	Aymaras	11	53.5	1.1	.4
	9	Cephalic Perimeter (cm)	Aymaras	45	53.0	1.8	.3
	10	Cephalic Perimeter (cm)	Aymaras	46	54.9	2.0	.4

Table 4: Thorax perimeter for Aymara boys and girls: Group statistics

Gender	Age		Ethnicity	N	Mean	Deviation tip.	Typical mean error
Male	8	Thorax Perimeter	Aymaras	6	62.3	6.1	3.5
	9	Thorax Perimeter	Aymaras	28	73.0	7.9	1.8
	10	Thorax Perimeter	Aymaras	34	82.0	12.0	3.2
Female	8	Thorax Perimeter	Aymaras	11	71.6	7.5	2.8
	9	Thorax Perimeter	Aymaras	45	72.5	7.9	1.6
	10	Thorax Perimeter	Aymaras	46	81.2	9.7	2.1

Table 5: Waist circumference for Aymara boys and girls: Group statistics

Gender	Age		Ethnicity	N	Mean	Deviation tip.	Typical mean error
Male	8	Waist Perimeter	Aymaras	6	61.0	3.0	1.7
	9	Waist Perimeter	Aymaras	28	66.6	9.2	2.1
	10	Waist Perimeter	Aymaras	34	76.4	12.1	3.2
Female	8	Waist Perimeter	Aymaras	11	66.5	7.5	2.8
	9	Waist Perimeter	Aymaras	45	66.0	8.4	1.7
	10	Waist Perimeter	Aymaras	46	73.5	9.5	2.0

Table 6: Hip circumference for Aymara boys and girls: Group statistics

Gender	Age		Ethnicity	N	Mean	Deviation tip.	Typical mean error
Male	8	Hip Perimeter	Aymaras	6	68.7	5.6	3.2
	9	Hip Perimeter	Aymaras	28	72.1	8.1	1.8
	10	Hip Perimeter	Aymaras	34	80.7	13.4	3.5
Female	8	Hip Perimeter	Aymaras	11	75.7	10.1	3.8
	9	Hip Perimeter	Aymaras	45	76.0	6.9	1.4
	10	Hip Perimeter	Aymaras	46	84.8	9.4	2.0

Table 7: Percentage fat mass, Aymaras boys and girls: Group statistics

Gender	Age		Ethnicity	N	Mean	Deviation tip.	Typical mean error
Male	8	% Fat	Aymaras	6	15.7	8.1	4.6
	9	% Fat	Aymaras	28	18.5	9.1	2.1
	10	% Fat	Aymaras	34	27.4	11.6	3.1
Female	8	% Fat	Aymaras	11	28.9	10.8	4.0
	9	% Fat	Aymaras	45	28.0	8.6	1.8
	10	% Fat	Aymaras	46	32.4	7.5	1.6

The results of the evaluation of the somatotype in the Aymara children of the commune of Arica, are shown in the Figures 1 and 2. An endomorphic somatotype is highlighted in girls and in meso-endomorphic males.

DISCUSSION

The obesity and its physio pathological consequencesare a current and global epidemiological problem between those that stand out among the metabolic problems and of the cardiovascular system (Castañeda 2017). Based on this criterion, the body composition and the somatotype of Aymara children in the Arica commune were evaluated, verifying as main results a greater corporal weightthan those found in previous studies such as the one made by Díaz and Espinoza (2012).

On the other hand, in the study elaborated by Espinoza et al. in the year 2009, they made a comparison about the body composition between Aymara boys and girls from Putre in comparison to Aymara boys and girls from San Miguel
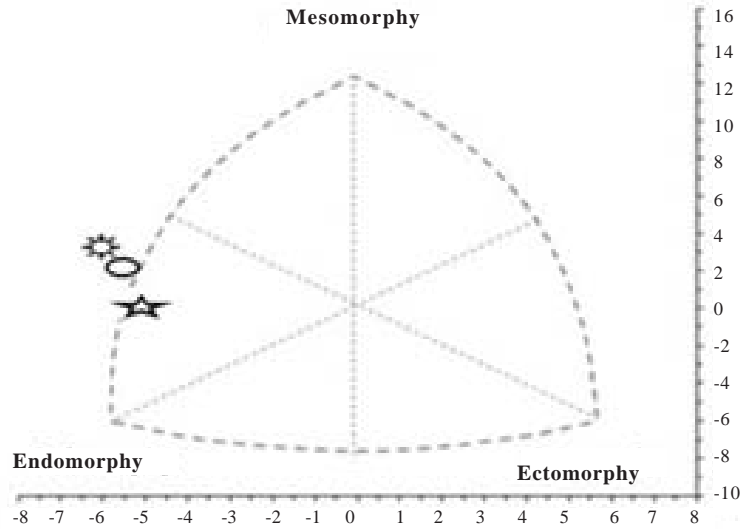
Fig. 1. Somatochart of Aymora girl between 8 to 10 years
Legend:
Age 10   x-6.06   and 2.92
Age 9   x-5.14   and 0.02
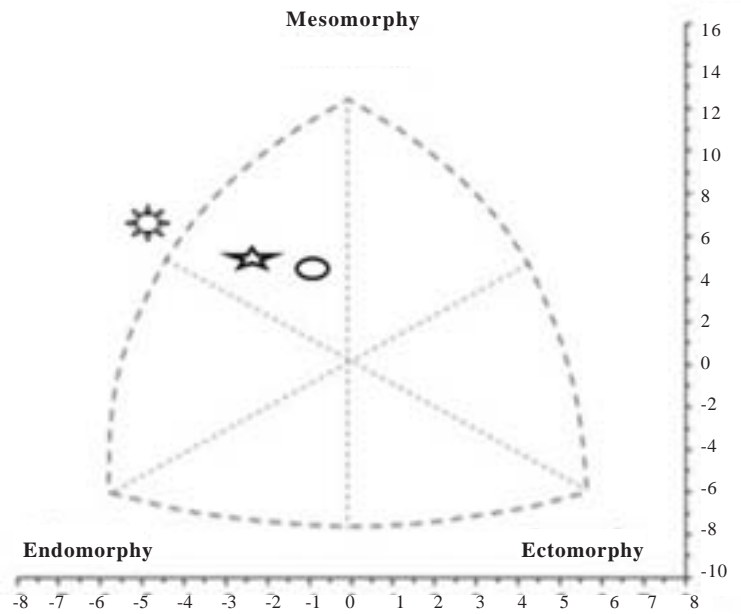Age 8   x-5.40   and 2.34

Fig. 2. Somatochart of Aymora boys between 8 to 10 years
Legend:
Age 10   x-4.73   and 6.61
Age 9   x-3.36   and 4.88
Age 8   X-0.96   and 4.66

de Azapa. The study showed that the Aymara boys and girls from Putre, presented significantly lower weight than the Aymara population of San Miguel de Azapa. These results were smaller than those evidenced to the researchers' of the present study.

A similar result was found when comparing the present study with that carried out by Bruneau et al. in the year 2015, which evaluated the body composition and somatotype of Mapuche and non-Mapuche school children in the Temuco region in Chile. The study emphasized values of corporal weight in the Mapuche population below those evidenced in researchers' study.

A comparative study with children with an international scope showed that the children of Aymaras de Arica had body weight above those evidenced in the research carried out by Vargas et al. in 2011, which evaluated children from Zulia, Venezuela of 8 years with an average of 27.5 kg.

The researchers consider that the migration of the Aymara population to the city and the urban influence could be a prominent factor in the increase of the corporal weight of the infants, modifying in them the form of acquisition and consumption of the alimentary products. A similar criterion was expressed by Gutiérrez and Magaña (2017) who demonstrated in their study that migration modified the family dynamics and the production of self-consumption, influencing the acquisition of food and the diversity of the family diet.

For his part, Ramírez (2017), considers that the consumption of foods with high caloric content and refined sugars is among the main factors associated with overweight and obesity. Ramírez alsorelates the socio-economic factors with the consumption of hyper caloric foods, highlighting that children in private schools consumed foods with higher caloric content and showed a higher prevalence of overweight and obesity.

The results regarding height in Aymara children aged 8 to 10 years shown values slightly higher than the results offered by Díaz and Espinoza (2012), who showed a size for the male population of 10 years of age in the range of 140 ± 6.9 cm and for girls in the same age group 141 ± 7.6 cm. Similar behavior was evidenced when comparing the results of the present investigation with the study carried out by Espinoza et al.

in 2009 in Aymara children, both from San Miguel de Azapa and Putre.

Vargas et al. (2011), showed smaller values than those exhibited by the Aymara children of the commune of Arica, referring to values of 127 cm for their 8-year-old male population. The result is similar in the female sex.

When analyzing the cephalic perimeter, no evidence was found of previous studies from the locality that would allow a comparative analysis with the results of the present investigation, however, in research published in Anthropometry of the Andean populations, the mesocephaly classification of the Aymaras inhabitants in the Altiplano (highlands) are highlighted. In the study carried out by Gavilán and Álvarez (1984), it is emphasized that the increase in the cephalic perimeter varies proportionally regarding age, and that variations of this variable are very discrete between 8 and 10 years of age.

The results of the perimeter of the thorax in Aymaras boys and girls shows higher values than that presented by Gómez et al. in 2012 in its study with 955 boys and girls from Peru (Arequipa)

In the results of waist measurements, percentiles rather than absolute waist perimetervalues have been used to compensate for variations in child development and ethnic origin.

Waist circumference is associated with the central fat distribution and is a simple tool that allows the identification of children at greater risk of developing cardiovascular disease. In the present study, it was possible to verify that the child population studied had waist perimeter values above those collected by the international literature.

When comparing children from 8 to 10 years of Zulia, it was possible to verify that the perimeter of waist in our study it was above 56.7 cm, 60.2 cm and 64.6 cm, shown by the male population of 8-10 years of Zulia (Vargas et al. 2011).

In another study presented by Benjumea et al. (2008) in the Colombian study, children aged 7 to 9 years showed a waist perimeter of 57.2 cm and children aged 10 to 12 years showed values of 59.9 cm. The result in the assessment of girls, also the Colombian girls showed values below those shown in this study, they behaved with values of 56.0 cm for the group of 7 to 9 years and 58.4 cm in girls from 10 to 12 years.

However, in the study by Bruneau et al. (2015), who's studied comparatively waist perimeter in children of 10- to 13-year-olds of the

Mapuche and non-Mapuche ethnic groups in the commune of Temuco were able to verify that the values were 62.7 cm and 65.5 cm respectively; showing these results, inferior to those of the in this study.

For its part, in a study carried out by Díanz and Espinoza (2012) in children of 10 years the waist perimeter was observed in boys was 65.1 cm, while in girls this figure was 67.5 cm.

In the hip perimeter, it was verified that the Aymara children showed values higher than those shown in the Bruneau et al. (2015) in Mapuches and non- Mapuches children 10- to 13-year-olds from the region of Temuco, presenting 10-year-old Mapuche children with a hip perimeter of 64.3 cm.

Díaz and Espinoza in their study in 2012, presented values of 76.5 cm in children of 10 years and 79.1cm for women of the same age. This is similar regarding gender analysis, since girl's exhibit greater hip perimeter than boys.

The result of the body mass index (BMI), is a widely used indicator for the diagnosis of obesity and overweight. This is the indicator referred to by the World Health Organization for the classification of obesity.

In the year 2012, Díaz and Espinoza concluded that the BMI records of children aged 10 to 13 years of Arica-Chile, showed that there was no risk of overweight in this child population, which does not coincide with the findings obtained in our research. The researchers consider that, when evaluating this variable, it has been possible to verify that the Aymaras children of both genders are found in the majority between the percentiles 85 and 95, and they are being classified as overweight.

A comparative analysis of the different age groups studied showed that the percentage of fat mass increased in parallel with age, being higher in girls than in boys. Similar results have been observed in the literature, such as the study carried out by Lizana et al. (2012), who evaluated Chilean girls and boys concluding that the girls presented a higher fat mass percent than males in values of 31.6, while the males studied showed values of 24.6 percent.

The behavior of the somatotype in the Aymara children of the commune of Arica was analyzed in relation to other investigations carried out, among them the one carried out by Bruneau et al. (2015) concluded that the 10-year-old children presented an Endomesomorphic Somome-

sotype. In both studies, a trend towards Endomorphy was observed.

Another study to be considered was the one conducted by Martínez et al. (2012), in which 993 adolescents of both genders, between 6 and 14 years of age, were evaluated. In their results it was observed that the men were more Mesomorphic than women, whereas in the female the predominance of the Endomorphy was visualized, coinciding these results with those evidenced in this research.

Arcay and Del Río (1995), in their study of students of Huilliche descent in the coastal sector of Osorno, could observe that in both genders was present a Mesomorphic somatotype, with weak tendencies to Endomorphism in women and Ectomorphism in men.

CONCLUSION

The variables weight, height, percentage of fat mass, folds, perimeters, circumferences, showed slightly higher results in the girls compared to the Aymara boys. In the same way, it was possible to verify the increase of these variables with age. A BMI is shown indicating that the children studied are classified as overweight.

As for the evaluation of the somatotype, it was concluded that the boys presented a Mesoendomorphic somatotype, while the girls showed an Endomesomorphic somatotype. The population under study has overweight and obesity traits, with higher values in girls, compared to boys.

RECOMMENDATIONS

- ◆ Conduct similar studies in the population that inhabits the highlands, to make comparisons about geographic influence.
- ◆ Emphasize the rescue of nutritional habits of our aboriginal cultures that contribute to an adequate nutritional status.
- ◆ Carry out similar studies in other age groups.

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