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CHANGES IN ANTHROPOMETRIC MEASUREMENTS AND BODY MASS INDEX AMONG CHILEAN ELDERLY

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Abstract: *Objectives:* Compare the anthropometric measurements, body mass index (BMI), and nutritional status of the Chilean Elderly from the years 2003 and 2010, and see if there are differences between age groups and by sex. *Design, settings, and participants:* Data was obtained from the Chilean National Health Survey (ChNHS), of the years 2003 and 2010. These are two cross-sectional studies. The weight, height, abdominal circumference, and BMI were analyzed for a representative sample of Chileans. *Main Outcome Measures:* Anthropometric measurements, BMI, and the prevalence of underweight, normal, overweight, and obese population of the elderly of Chile, grouped by age (65-74 years, and ≥ 75 years) and sex, when comparing elderly within both periods, as well as comparing them to the rest of the population. *Conclusion:* There were significant changes in the weight, abdominal circumference, and BMI in the elderly since the years 2003 and 2010. The weight and height of those ≥ 75 years tends to be significantly lower than the rest of the population. We can also appreciate a noticeable increase in the abdominal circumference from the younger adults to those ≥ 65 years. Through the years, there is an increasing trend towards being overweight and obese. Also, the highest prevalence of underweight individuals was seen in those older than 75 years, and within this group, it was mainly composed by women.

Key words: Elderly, anthropometric measurements, body mass index, nutritional status, Chileans.

Introduction

In these last years, we have observed a marked demographic increase in the elderly population in Chile. Today, one out of ten Chileans, is a senior citizen (≥ 65 years), and for the year 2025, this relationship will change to be one out of five. The mean survival age for women is 83 years, while for men is 77 years (1). The process of aging in our population will bring medical-social challenges at different levels in society (2, 3). In the health related area, this implies changing a previous model that gave priority to maternal-infant wellbeing, to one that will have to concentrate in the attention given to the elderly (2-5).

The nutritional status of a person has an important impact over their health. In older people, there is a higher risk of dying when one is underweight, in relation to a person with normal BMI (6). On the other hand, there is controversial information about how being overweight or obese can affect the longevity of an aged person (7-12). There seems to be a U shaped relationship between body weight and mortality, where the very lean and very heavy, have higher risk of dying (13, 14). There is also a higher prevalence of frailty in obese elderly, followed by those who are overweight and underweight (15-17).

Due to the importance that the nutritional situation has over a person's health, we decided to evaluate and describe the trends and changes in the anthropometric measurements, BMI, and nutritional status in the Chilean elderly, from the years 2003 and 2010, compare between sexes, and to the rest of the population.

Materials and Methods

Studied Population

The Chilean National Health Survey, from now on referred to as ChNHS, is a cross-sectional, observational, and analytic study, with multiple selection stages, that uses expansion factors, constructed according to the representation that the individuals have of the demographic region of residence, age, and sex. The ChNHS is a voluntary health exam, done to a representative population of Chile. Only 4.6% of the Chilean population is considered to belong to ethnic groups (Mapuche, Aymara, Atacameño, Quechua,

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Rapanui, Colla, Alacalufe, Yámana), while the rest belong to white and white Amerindians (a mixture of European descendants and Chilean indigenous groups) (18). There are two surveys, to this day, from the years 2003 and 2010. The 2003 survey included 3600 individuals, of which 904 were older than 65. On the other hand, the 2010 survey interviewed more than 5000 people, of which 707 belonged to this age group. The survey represents Chilean men and women of different ages (starting from those ≥ 17 and ≥ 15 years of age, in the ChNHS 2003 and ChNHS 2010, respectively), socioeconomic status, education levels, and urban and rural areas of the country.

The sample of the ChNHS 2010 was based on the 2002 census. From this later study, 7549 individuals were selected and 5058 accepted to participate in the ChNHS 2010. Communes were first selected from all the regions of Chile, based on the proportion of the size of the population older than 15 years of age. Each commune was then further segmented, based on a geographic division and proportional to the number of occupied homes at the moment of the census. There was a random selection of homes within each selected segment. Finally, people within the homes were randomly chosen, doubling the chance of selecting a person who was ≥65 years. Elderly living in nursing homes, pregnant women, and people who manifested violent conduct once the interviewer was in the house, were excluded.

The sample of the ChNHS 2003, on the other hand was based on the individuals who responded the Quality of Life Survey (QLS), conducted by the Chilean Ministry of Health (MINSAL), from the year 2000. A subpopulation of 3600 individuals were selected to participate in the ChNHS 2003, of the 6228 who participated in the QLS. The subjects from the QLS were chosen in a similar manner as the ChNHS 2010, with the differences that the sample was based on the 1992 Chilean census and the chance of selecting an elderly was not doubled.

Both surveys were conducted by the Public Health Department of the Pontificia Universidad Católica de Chile, entrusted by the MINSAL. The design and methodology of those studies are described in more detail in the website (19).

In this paper, only individuals of 17 years of age or more were selected. Those who were <65 years, were considered as the younger adults, which combines young and middle aged adults, while those ≥65 years were defined as elderly. Comparative analysis was also done within the later group: subdividing it into those between 65-74 and ≥75 years.

Anthropometric Measurements

Weight, height, and abdominal circumference (at the level of the waist), were measured in both ChNHS. The members of the teams in charge of the field work were trained and capacitated. Weight was measured with a portable, electronic, and digital scale, with a sensibility of 100 grams and a maximum capacity of 150 kilograms. Individuals were weighed in their interior garments, pants, and a single shirt. The height was measured with a metal measuring tape, while the individual was standing, with no shoes, arms at the sides, legs well stretched, and with the back and heels touching the wall. The abdominal circumference was measured with a flexible measuring tape, in exhalation, in the intermediate point between the inferior border of the last rib and the iliac crest, at the level of the mid axilary line, while the individual was standing, with the clothes removed from the abdominal area. The same devices were used in all participants for both surveys.

Definition of Obesity, Overweight, and Underweight

The parameters used for the diagnosis of the nutritional status of the individual correspond to those defined by the World Health Organization (WHO) [20]. Underweight, overweight, and obese individuals were defined as those with a body mass index of (BMI) < 18.5, between ≥ 25 and < 30, and ≥ 30, respectively. BMI was calculated by dividing the weight in kilograms by the square of the height in meters.

Statistical Analysis

Due to the fact that the ChNHS uses expansion factors, these were used in all of the analysis of this study. Categorical variables were presented as number of cases and percentages, while the numeric variables were presented as means, with a 95% confidence interval. The $\chi 2$ test was used to compare proportions, and Student's t test and analysis of variance (ANOVA) were used to compare the means of independent samples. All p-values less or equal to 0.05 were considered statistically significant. Statistical program SPSS 17 was used for statistical analysis.

Results

There was a significant difference in the mean weight of the elderly between periods, with an mean of 70.6 (CI: 68.9 – 71.3) kg, for the year 2003, and 72.7 (CI: 72.0 – 73.4) kg, for the year 2010 ($p < 0.001$). Women tend to have lower weights than men, in all age groups. The mean weight of those ≥ 75 years is statistically significantly lower than that of other age groups, in both periods, being 64.1(CI: 61.6 – 66.6) kg and 70.9 (70.2 – 71.7) kg, in the year 2003, and 66.5(63.9 – 69.1) kg and 73 (72.3 – 73.9) kg, in the year 2010, for the very elderly and younger adults, respectively ($p < 0.001$). This difference in weight

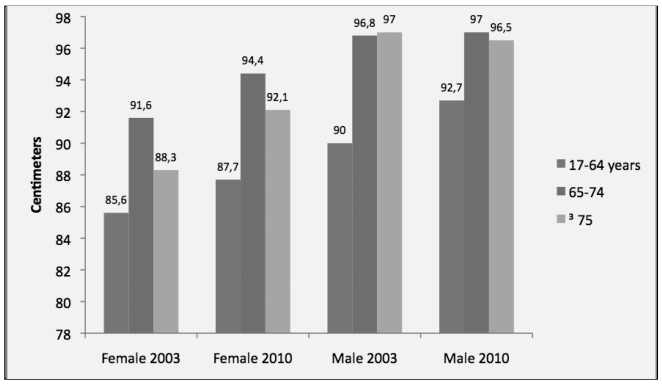
Table 1
Mean Weight, Height, Abdominal Circumference, and BMI, separated by age group and sex

Age (years)	Total Population	ChNHS 2003 17-64 years	65-74 years	≥ 75 years
Weight (kgs)	70.6 (69.9-71.3)	70.9 (70.2-71.7)	70.1 (68.5-71.7)	64.1 (61.6-66.6)
Female	65.8 (64.9-66.6)	66.1 (65.2-67.1)	66.0 (64.1-68.0)	58.8 (56.1-61.6)
Male	75.6 (74.6-76.6)	75.7 (74.6-76.8)	75.1 (72.9-77.5)	73.4 (70.8-76.0)
Height (cms)	162.1 (161.7-162.7)	162.9 (162.4-163.5)	157.5 (156.4-158.6)	154.0 (152.4-155.6)
Female	155.5 (155.0-156.0)	156.2 (155.7-156-8)	151.8 (150.5-153.0)	148.8 (147.5-150.2)
Male	169.1 (168.6-169.7)	169.6 (169.0-170.2)	164.7 (163.6-165.8)	163.1 (161.5-164.7)
Circumference (cms)	88.4 (87.7-89.0)	87.8 (87.1-88.5)	93.9 (92.4-95.4)	91.5 (89.3-93.6)
Female	86.2 (85.3-87.1)	85.6 (84.7-86.6)	91.6 (89.5-93.7)	88.3 (85.7-91.0)
Male	90.7 (89.7-91.6)	90.0 (89.0-91.1)	96.8 (94.9-98.7)	97.0 (94.2-99.7)
Average BMI	26.8 (26.6-27.1)	26.7 (26.5-27.0)	28.2 (27.7-28.8)	26.9 (26.1-27.8)
Female	27.2 (26.9-27.6)	27.2 (26.8-27.6)	28.7 (27.9-29.5)	26.5 (25.4-27.7)
Male	26.4 (26.1-26.7)	26.3 (26.0-26.6)	27.7 (27.0-28.4)	27.7 (26.4-28.9)
Age (years)	**Total Population**	**ChNHS 2010 17-64 years**	**65-74 years**	**≥ 75 years**
Weight (kgs)	72.7 (71.9-73.4)	73.0 (72.3-73.9)	71.6 (69.8-73.5)	66.5 (63.9-69.1)
Female	67.7 (66.8-68.6)	67.9 (66.9-68.9)	68.4 (66.2-70.5)	62.8 (60.0-65.7)
Male	78.0 (77.0-79.0)	78.4 (77.3-79.5)	75.7 (72.9-78.5)	72.0 (67.1-77.0)
Height (cms)	162.7 (162.1-163.3)	163.4 (162.8-164.0)	158.3 (156.9-159.6)	155.1 (153.6-156.7)
Female	156.1 (155.5-156.7)	156.7 (156.0-157.4)	152.8 (151.6-153.9)	149.9 (148.6-151.2)
Male	169.7 (169.1-170.3)	170.3 (169.7-170.9)	165.1 (163.5-166.7)	163.2 (160.8-165.5)
Circumference (cms)	90.7 (90.1-91.4)	90.2 (89.5 - 90.9)	95.5 (93.9-97.2)	93.8 (91.6-96.1)
Female	88.4 (87.5-89.3)	87.7 (86.7-88.7)	94.4 (92.1-96.7)	92.1 (89.5-94.6)
Male	93.1 (92.3-94.0)	92.7 (91.8-93.7)	97.0 (94.8-99.2)	96.5 (92.4-100.6)
Mean BMI	27.5 (27.2-27.9)	27.4 (27.0-27.8)	28.7 (28.0 -29.4)	27.6 (26.6-28.5)
Female	27.9 (27.3-28.6)	27.8 (27.1-28.5)	29.4 (28.4-30,4)	28.0 (26.8-29.1)
Male	27.1 (26.8-27.4)	27.1 (26.7-27.4)	27.7 (26.8-28.7)	27.0 (25.5-28.5)

Means are presented with 95% confidence interval in parentheses.

is not perceived between the younger adults and those between 65-74 years (p = 0.349, for year 2003, and p = 0.168, for year 2010) (Table 1).

Figure 1
Mean Abdominal Circumference grouped by sex, age, and period



There were no significant differences in the height between the years 2003 and 2010 in the elderly population (mean height 162.2 (CI: 161.7 – 162.7) cm and 162.6 (CI: 162.1 – 163.2) cm, respectively, with p = 0.09). Women tend to be shorter than men. There is a marked difference in the height of the elderly, when compared to the younger adult group. The height difference is significant (p < 0.001 for both years, when we compare the younger adults to those between 65- 74 years), and diminishes progressive as the population gets older (Table 1).

The mean abdominal circumference for elderly is 88.4 (CI: 87.7 – 89.0) cm in the year 2003 and 90.7 (CI: 90.1 – 91.4) cm in the year 2010 (p < 0.001). As opposed to the weight and height, the abdominal circumference increases as the person ages (p < 0.001, for both years, when comparing younger adults to those between 65 – 74 years, and p = 0.002, for both years, when comparing younger adults to those ≥ 75 years). There was no significant difference in the waist size between 65 – 74 years and ≥ 75 years, for any of the two surveys. Elderly women tend to be thinner than men (Figure 1).

There is an increase in the BMI in all age groups between periods. There was a significant increase in the mean BMI in those ≥ 65 years. The BMI for the year 2003 was 26.8 (CI: 26.6 – 27.1) and for the year 2010 was 27.5

(CI: 27.2 – 27.9), with p = 0.001. In both years, we can also appreciate a higher BMI in those between 65 – 74 years, with respect to the younger adults (p < 0.001, for year 2003, and p = 0.003, for year 2010). There is no significant difference between the BMI of younger adults and elderly ≥ 75 years (Figure 2).

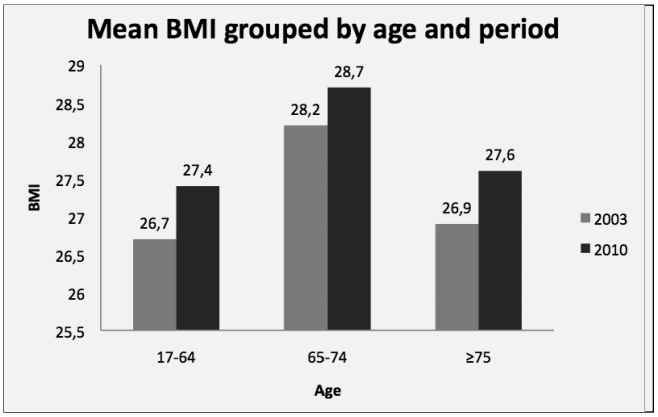
Table 2
Prevalence of underweight, normal, overweight and obese population, grouped by age and sex

	Age (years)	underweight IMC <18.5	normal IMC 18.5 – 24.9	overweight IMC 25 – 29.9	Obese ≥ 30
2003	17-64	0.7	39.6	37.2	22.5
	Women	0.9	40.9	31.6	26.6
	Men	0.6	38.3	42.8	18.4
2010	17-64	1.2	34.2	39.4	25.2
	Women	1.9	35.2	32.2	30.7
	Men	0.4	33.1	47.0	19.4
2003	65-74	1.5	21.3	43.7	33.5
	Women	1.7	21.0	37.9	39.4
	Men	1.2	21.6	51.1	26.1
2010	65-74	1.4	19.8	46.5	32.3
	Women	2.4	16.0	43.1	38.5
	Men	0.1	24.6	50.7	24.6
2003	≥ 75	2.2	33.9	40.4	23.5
	Women	3.2	35.7	41.9	19.2
	Men	0.3	30.7	37.8	31.2
2010	≥ 75	2.3	32.4	35.4	30.0
	Women	3.5	27.4	35.4	33.7
	Men	0.4	39.9	35.3	24.4

**Prevalence are presented as percentages

There is a small prevalence of elderly that are underweight, being 1.7% for both years. As can be appreciated in the graph, the highest prevalence is composed by those ≥ 75 years, being significantly higher in women, than in men (p = 0.008 for the year 2003, and p = 0.007 for the year 2010) (Figure 3).

Figure 2
Mean BMI grouped by age and period



There is a high prevalence of elderly that are obese, being 29.9% in the year 2003, and 31.5%, in the year 2010 (p = 0.641 between periods). In the year 2003, 72.4% of the elderly have a BMI ≥ 25, and for the year 2010, the prevalence is 73.9% (p = 0.656) (Table 3).

Figure 3
Prevalence of Underweight (BMI < 18.5) by age, sex, and period

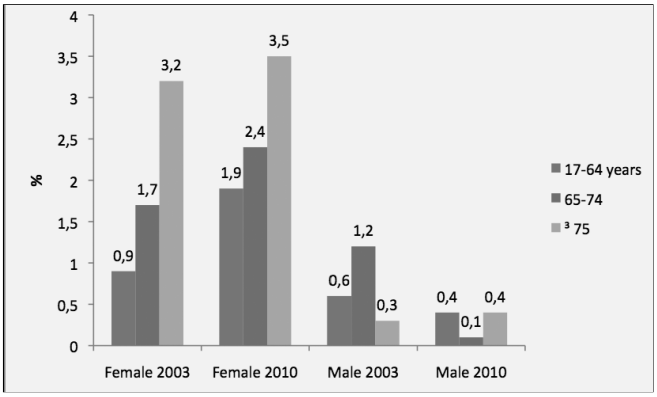


Table 3
Overweight and Obese Population

		IMC ≥ 25	IMC ≥ 30
≥ 17 years	2003	61.1% (0.013)[1]	23.3% (0.087)[3]
	2010	65.7% (0.013)[1]	25.9% (0.087)[3]
17-64 years	2003	59.7% (0.016)[2]	22.5% (0.105)[4]
	2010	64.6% (0.016)[2]	25.2% (0.105)[4]
≥ 65	2003	72.4% (0.656)[2]	29.9% (0.641)[4]
	2010	73.9% (0.656)[2]	31.5% (0.641)[4]

In parentheses, the P value for 1overweight and obese (IMC ≥ 25) grouped by period, for overall population, 2 overweight and obese (IMC ≥ 25) grouped by period, segregated by age group (17-64 years and ≥ 65), 3obesity (IMC ≥ 30) grouped by period, for total population, 4 obesity (IMC ≥ 30) grouped by period, segregated by age group (17-64 years and ≥ 65)

Discussion

The number of elderly people has increased, and by the year 2025, it is projected that in Chile, one out of five people shall be ≥ 65 years. People that constitute this group are heterogeneous in their financial wellbeing, social situation, and health. It is therefore important that we can well categorize this group so as to be prepared to receive this growing population, with all their special needs, which has been one of the aims of our study, and greatly aided by the fact that the ChNHS is a survey that is representative of the Chilean population, and uses expansion factors.

There is a world-wide campaign to educate and prevent obesity due to the fact that it has been associated with a great number of diseases, including cardiovascular and cerebrovascular diseases, which increases mortality and contributes to physical limitations. When we analyze the number of people who are overweight and obese, it constitutes a great percentage in younger people,

that will someday be old, and on the other hand, although the prevalence of obesity has not increased in the elderly, it has neither diminished, in spite of the multiple campaigns against obesity that have been conducted. It calls our attention that 31.5% of those ≥ 65 years are obese (2010), number that translates to approximately 540,000 people. When we observe the change in BMI, we can see that there is a sharp increase in the BMI from the younger adults to those between 65 – 74 years, and then, the BMI tends to diminish once again, in the ≥ 75 year group, being very similar in values to the younger adult population. This fact supports the hypothesis that being obese increases mortality, due to the fact that those that survive, tend to have lower BMI, but on the other hand, when we see that almost 1/3 of those ≥ 75 years, are obese in the year 2010, it makes us question if it is all that bad to have extra body fat, for how can we explain the great number of older elderly that are obese? Of course, this study does not permit us validate or discard one or the other hypothesis, due to the fact that we do not have the causes of mortality in the population, and neither is it the objective of this study to do so.

The elderly tend to be heavier and have bigger abdominal circumference in later years, probably due to multiple factors, such as an improvement in the overall country's economic wellbeing, which translates to better health policies that benefit the elderly, giving them nutritional supplements, greater access to food, amongst other positive changes. Those ≥ 75 years, persistently are shown to be the group that have the lowest weights, heights, abdominal circumference, and BMI. This is consistent with the fact that this also tends to be the most fragile group.

Although we could also observe an increase in the BMI between periods, this did not translate into a significant increase in the prevalence of overweight and obese population. The prevalence of underweight elderly remained stable amongst both periods. Overall, the highest prevalence of underweight individuals was seen in those older than 75 years, in both periods. Females composed the highest percentage in this group.

The limitations of our study is that the population studied in the year 2010 are not necessarily the same ones as the ones studied in the year 2003. There was a higher chance of selecting an elderly in the 2010 survey, but this was not the same for the 2003 ChNHS.

Conclusion

Elderly in the year 2010 tend to be heavier, have bigger waists, and similar heights, compared to the year 2003. That is to say, they have a higher BMI. In the Chilean population, those between 65 – 74 years tend to have the highest abdominal circumference and BMI. Although there was no significant increase in the overweight and obese elderly population, there is an increasing trend. The prevalence of underweight elderly did not change, but the highest percentage is composed by those older than 75 years, and within this group, it was mainly composed by women.

Ethical Standards: This study complies with the current laws of Chile. The study was approved by the ethical committee of the Pontificia Universidad Católica de Chile and the Chilean Health Ministry.

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