Nutritional status of adults in Northwest Argentina: an observational study

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Background: Northwestern Argentina (NWA) is a region with geographic, ethnic, socioeconomic, and cultural characteristics that set it apart from the rest of the country. The present study aimed to analyze both the anthropometry and nutritional status of adults in this region and establish its recent secular trend.

Methods: This was an observational cross-sectional study that utilized the National Risk Factor Survey (NRFS) 2018. We calculated the body mass index (BMI), waist-to-height ratio (WHtR), and relative fat mass (RFM) by sex in the six provinces that comprise the NWA region based on the weight, height, and waist circumference data of 3,283 individuals. We also calculated the prevalence of underweight, overweight, and obesity. Furthermore, we evaluated the correlation and correspondence between measurements and anthropometric indexes. Joinpoint regression analyses were performed to identify trend changes, which were then compared with that established for the rest of the country.

Results: The regional population presented a heterogeneous distribution of anthropometric variables, in which the Andean provinces of Salta and Jujuy presented the lowest height and weight and highest percentage of body fat. These anthropometric differences were not evident in the prevalence of nutritional status determined by the BMI, which did not exhibit significant variations between the region and the rest of the country. Excess body weight, as measured by any of the indexes, reached over 65% of the population, and the prevalence of obesity in both sexes was higher than that established for Argentina overall. The secular trend in obesity was positive and higher in some provinces compared to the region and the rest of the country. These differences are interpreted according to the geographic, ethnic, socioeconomic, and cultural characteristics of the region.

Conclusions: The anthropometric variables registered in some provinces vary significantly compared to those of the country as a whole, and these differences are not captured by the traditionally used obesity indices.

Keywords: Obesity; Northwestern Argentina (NWA); body mass index (BMI); relative fat mass (RFM)

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Introduction

Northwestern Argentina (NWA) is a large region that covers 559,524 km^2 and extends from the High Andes in the west of the country to the Chaco region in the east. It includes the provinces of Jujuy, Salta, Tucumán, Catamarca, Santiago del Estero, and La Rioja (*Figure 1*). Its population is 4,911,412 people, of which 60% are over 20 years old. Due to its location in the Andes, the following

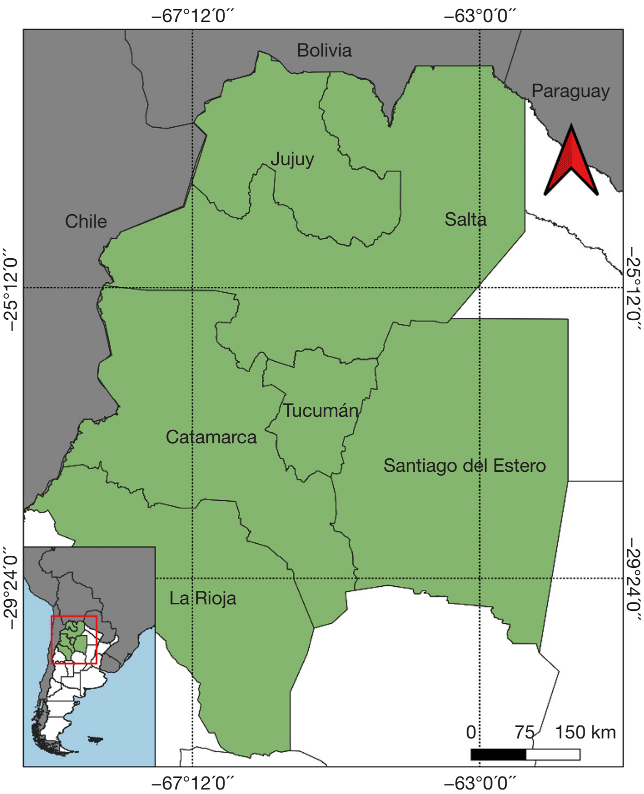

Figure 1 Northwestern Argentinian map. The map was made with shapefiles obtained from the National Geographic Institute (NGI) Link: Capas SIG | Instituto Geográfico Nacional (ign.gob.ar), available publicly.

geological provinces are identified from west to east: Western Cordillera, Puna, Eastern Cordillera, Subandean System, Santa Bárbara System, and Chaco Plains (1). This rugged orography determines the settlement of part of the population in high-altitude environments (>2,000 masl).

In addition to these geological and geographical traits, demographic (2,3), historic (4), ethnohistoric (5), and cultural (6) characteristics contribute to the uniqueness of the region. The original populations of the NWA covered two main cultural areas: the Andean area and the Southern Chaco area (7). The Andean area was the most important in the country during pre-colonial times and had greater significance in the development of the current population, owing to both its numerical importance and the resistance posed to the process of denaturalization initiated with the conquest (7,8).

Molecular and genomic studies have shown that the native continental genetic component is prevalent in the genomes of the NWA populations (>60%) and that the less miscegenated populations are located in the highlands (>2,000 masl) (9-14).

From a socio-economic perspective, the NWA is the poorest and least developed region of Argentina, with higher percentages of unsatisfied basic needs (UBN) and infant mortality rates than the rest of the country (15). Moreover, the region scores lowest in the Quality of Life Index, which measures fundamental aspects of the population's living conditions, such as housing, health, and education (16).

Studies on adult nutrition and health in the NWA region are scarce (17-24). Since 2005, the INDEC (National Institute of Statistics and Censuses) carries out the National Risk Factor Survey (NRFS) every 4–5 years to epidemiologically monitor chronic non-communicable diseases. This survey uses a population-based probability sample that includes socio-demographic and health information about the country's adult population. For the first time, the 2018 NRFS included anthropometric measurements of the surveyed individuals instead of the self-reported data that was reported in previous surveys (25).

The present study aimed to analyze the anthropometric characteristics and nutritional status of adults from the NWA region based on the information provided by the NRFS to establish its recent trend, compare it with the rest of the country, and contrast it with the information available in the literature. We present the following article in accordance with the STROBE reporting checklist (available at https://jphe.amegroups.com/article/view/10.21037/jphe-22-38/rc).

Methods

This was an observational cross-sectional study based on data collected by the NRFS carried out by the Ministry of Health of Argentina and the National Institute of Statistics and Censuses (INDEC). The purpose of this survey was to provide valid, reliable, and timely information regarding risk factors, healthcare processes, and the prevalence of chronic non-communicable diseases (hypertension, diabetes, obesity, etc.) in the population aged >18 years old residing in private homes in urban areas of ≥5,000 inhabitants. The survey was performed by trained interviewers that carried out face-to-face questionnaires in each home; it represented a probability sample, and the selection of respondents was made using the Kisch selection table (26). Cases with missing data were eliminated.

We analyzed the following anthropometric measurements from the NRFS 2018 data: weight (kg), height (cm), and waist circumference (cm). We calculated the following indexes: body mass index (BMI) (kg/m^2) and waist-to-height ratio (WHtR). To analyze the anthropometric nutritional status, we used the criteria proposed by the World Health Organization (WHO) (27), which applies specific BMI cut-offs points for an adult population to define the nutritional phenotypes: thinness (BMI <18.5 kg/m^2), normal (BMI =18.5–24.9 kg/m^2), overweight (BMI =25.0–29.9 kg/m^2), class I obesity (BMI =30.0–34.9 kg/m^2), class II obesity (BMI =35.0–39.9 kg/m^2), and class III or extreme obesity (BMI ≥40 kg/m^2). Abdominal obesity was assessed using waist circumference (WC) and WHtR. Based on the WC, participants were divided into abdominally obese, when the WC was ≥102 cm for men and ≥88 cm for women, or non-abdominally obese, when the WC was <102 cm for men and <88 cm for women (NHLBI, 1998). Finally, subjects were classified as abdominally obese or non-abdominally obese using a WHtR cut-off point of 0.50 (28).

The relative fat mass (RFM) was used to estimate whole-body fat percentage according to the following equations: 76 [−20 × (height/waist)] and 64 [−20 × (height/waist)] for women and men, respectively (29), where height and waist (circumference) are expressed in meters. To define obesity based on body fat percentage, we used the cut-points proposed by Deurenberg (30): ≥35% for women and ≥25% for men.

We used the NRFS data from 2005, 2009, 2013, and 2018 (31-34) to analyze the secular trend of obesity prevalence. Given the self-reporting nature of the data from the first three years, they could only be used to calculate the evolution of the prevalence of excess weight and thinness.

The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). Our article was written using secondary databases published by the INDEC. As these databases are public and anonymous, this work did not require the approval of an Ethics Committee, and informed consent was not requested.

Statistical analysis

We calculated the measures of central tendency (mean) and dispersion (standard deviation) for the anthropometric measurements and indexes. We performed an independent t-test to examine the differences in indexes and metrics between provinces versus the region and country. Statistical significance was established at the 5% level.

We also calculated the prevalence of the different nutritional phenotypes by sex and province, and differences were evaluated using the Chi-square test. Scatter plots were drawn in SPSS v.26 software (IBM Corp.: Armonk, New York, USA) using the previously defined obesity cut-off points to analyze the relationship between BMI and the other indicators (WC, WHtR, and RFM). A Pearson test was conducted to establish the correlation between the variables and anthropometric indices, and the concordance of the different estimates of obesity was tested using the Kappa test. The agreement categories were established according to Landis and Koch (35).

The secular trends for the prevalence of obesity (BMI >30 Kg/m^2) and thinness (BMI <18.5 Kg/m^2) at the provincial and regional levels were calculated using the Joinpoint regression model. The annual percentage change (APC), confidence intervals for the prevalence of obesity and thinness, and the statistically significant differences for each trend phase were calculated using the National Cancer Institute (NCI) Joinpoint regression program software v. 4.9 (36).

Results

The final sample comprised 3,283 individuals (1,855 women and 1,428 men). In general, statistically significant differences were observed in all anthropometric variables and indexes (except for BMI) when comparing each province with the NWA region and the whole country (*Table 1*). The provinces of Jujuy and Salta displayed markedly lower average weights and heights for both sexes compared to Argentina as a whole and the NWA region. No statistically significant differences were observed in the average WC of both sexes in the NWA region compared to the entire country, but the provinces of Jujuy and Salta showed a higher WC than the NWA and the country, which was significant in all cases except for men in Salta. The NWA average RFM was considerably higher in both sexes compared to Argentina. Also, the provinces of Jujuy, Salta, and Santiago del Estero exhibited substantially higher average RFM in both sexes compared to the NWA and the whole country. Only the women from Santiago del Estero presented an average BMI that was significantly higher than the NWA and countrywide averages. The average WHtR values were markedly higher in the NWA populations of both sexes compared to the country as a whole. Women from Jujuy, Salta, Tucumán, and Santiago del Estero presented mean WHtR values that were statistically

Table 1 Mean ($\bar{x}$) ± SD of the anthropometric variables and indices by provinces, NWA, and Argentina

Measures and indices	Jujuy	Salta	Tucumán	Catamarca	Santiago del Estero	La Rioja	NWA	Argentina
Women								
N	367	374	355	304	223	232	1,855	9,333
Weight (kg)	67.4±14.1*•	68.9±13.9*	71.1±15.2	70.3±15.8	72.6±15.8*•	70.5±14.4	69.9±14.9	70.4±15.1
Height (m)	155.3±7.2*•	156.4±7.1*•	158.6±6.7•	159.5±7.2*•	158.5±6.1	159.1±6.2•	157.7±7.0*	158.7±7.0
WC (cm)	90.4*±13.5	91.8±13.9*•	84.1±15.4*•	89.9±15.9	93.1±14.9*•	89.1±14.1	89.6±14.9	88.9±15.6
BMI	28.0±5.7	28.2±5.4	28.3±5.9	27.6±5.8	28.9±6.3*•	27.9±5.5	28.1±5.7	28.0±5.9
WHtR	0.6±0.1*•	0.6±0.1*•	0.5±0.1*•	0.6±0.1	0.6±0.1*•	0.5±0.1	0.6±0.1*	0.6±0.1
RFM	40.8±5.5*•	41.1±5.9*•	37±7.5*•	39.4±6.6	41±6.2*•	39.4±6.1	39.8±6.5*	39.2±6.8
Men								
N	265	340	224	259	165	175	1,428	6,916
Weight (kg)	80.6±15.5*	79.9±16.0*	82.3±16.6	82.0±14.5	83.9±17.6	84.1±17.1	81.8±16.1	82.6±15.9
Height (m)	168.4±8.0*•	169.5±7.8*•	171.2±6.8	172.4±7.0•	172.1±7.3•	171.5±7.2	170.6±7.5*	171.7±7.7
WC (cm)	97.2±12.7*	96.3±13.8	90.4±17.6*•	94.8±13.4	98.3±14.1*•	96.6±14.2	95.6±14.5	95.2±14.6
BMI	28.3±4.7	27.8±5.1	28.0±5.3	27.6±4.7	28.3±5.1	28.5±5.2	28.0±5.0	28.0±5.0
WHtR	0.6±0.1*•	0.6±0.1*	0.5±0.1*•	0.5±0.1	0.6±0.1*•	0.6±0.1*	0.6±0.1*	0.5±0.1
RFM	28.8±4.6*•	28.1±5.6*	25±6.7*•	26.9±5.4	28.3±5.1*	27.7±5.4	27.5±5.6*	27.1±5.8

*, significant statistical differences with respect to Argentina; •, significant statistical differences with respect to NWA. SD, standard deviation; NWA, Northwestern Argentina; WC, waist circumference; BMI, body mass index; WHtR, waist-to-height ratio; RFM, relative fat mass.

different from those of the NWA and the country. The same pattern was observed in men, except for the province of Salta.

The prevalence of different nutritional categories according to BMI was homogeneously distributed among the provinces, the NWA, and Argentina (*Figure 2*). The BMI prevalence by sex and 95% confidence interval (CI) are presented in the Supplementary file (Table S1, Figure S1). According to the classification of nutritional status by WC, WHtR, and RFM, the provinces of Jujuy, Salta, and Santiago del Estero generally showed a notably higher prevalence than those of the NWA and Argentina (*Figure 3*).

The correlations between variables and anthropometric indexes were statistically significant (*Table 2*). Both sexes displayed negative values when height was correlated with BMI, WC, WHtR, and RFM, except for the correlation between height and WC in men, although this value was close to 0. The remaining correlations were positive, higher than 0.5, and similar for each pair of variables and indices in both sexes. WC showed the best correlation with BMI for both sexes (r=0.816 and 0.813 for men and women, respectively), followed by RFM and WHtR. The highest correlation of RFM was that with WHtR in both sexes, followed by WC and BMI.

The concordances of the prevalence of obesity (BMI >30 kg/m^2) were statistically significant in all categories and the total sample for both sexes. When the obesity categorization of WC, WHtR, and RFM *vs.* BMI >30 kg/m^2 was analyzed, low Cohen's Kappa values (<0.4) were generally observed, except for WC, whose values were moderate (between 0.41 and 0.60) (*Table 3*).

Figure 4 displays the scatter plots of BMI *vs.* WC, WHtR, and RFM. The BMI *vs.* WC combination exhibited the best concordance in women (kappa =0.541, P<0.0001) and men (kappa =0.657, P<0.0001) as well as the highest proportion of true positives and negatives.

In all provinces and the NWA region, the prevalence of obesity had a positive secular trend, which was statistically significant for Argentina, the NWA, and all

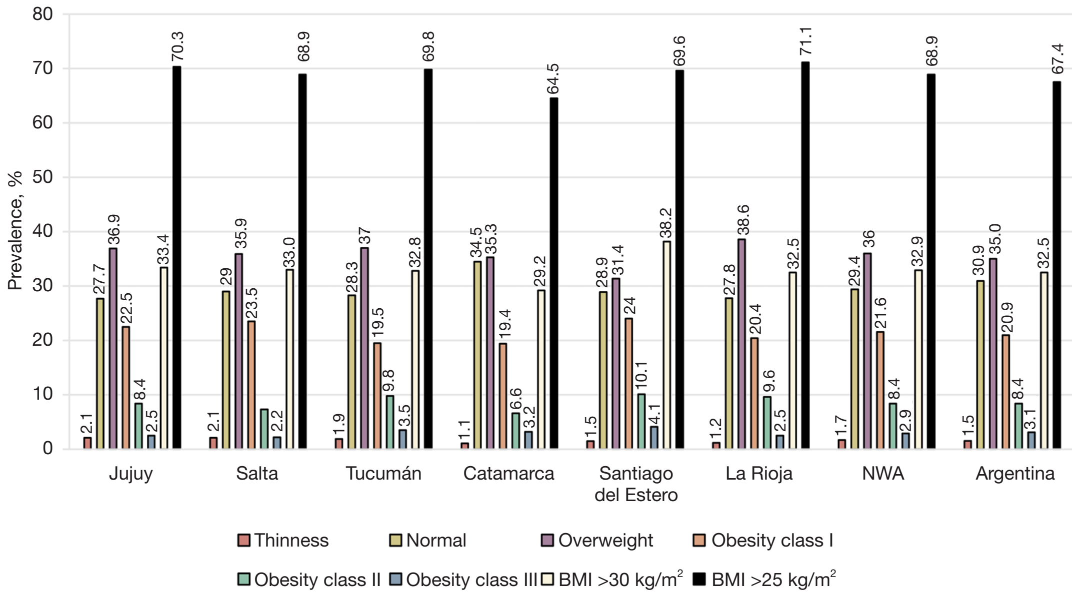

Figure 2 Nutritional status by BMI according to WHO criteria. NWA, Northwestern Argentina; BMI, body mass index.

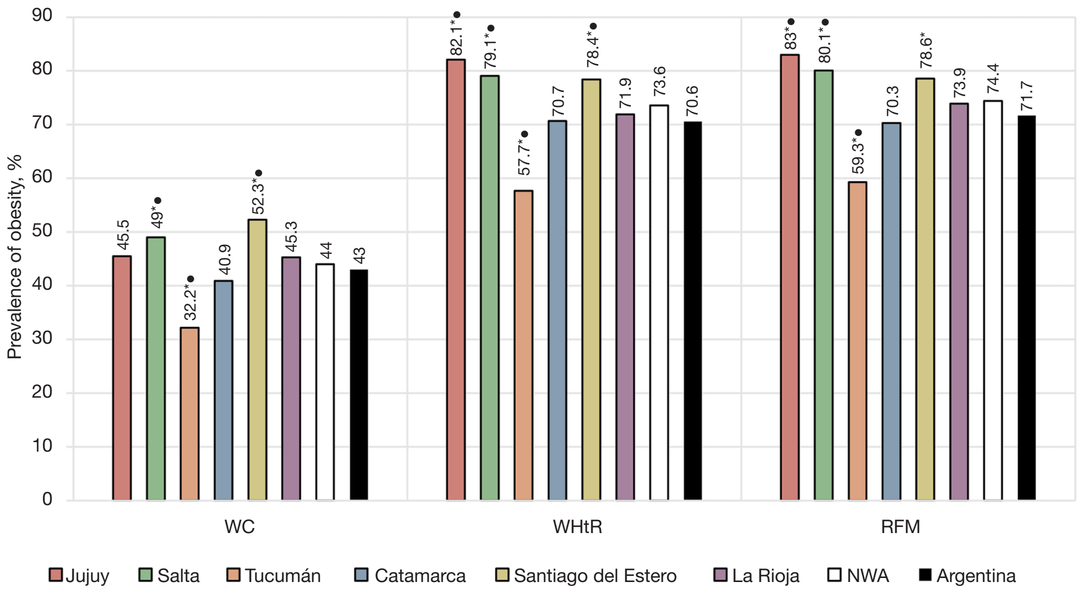

Figure 3 Obesity prevalence according to WC, WHtR and RFM criteria. *, significant statistical differences compared to Argentina; •, significant statistical differences compared to NWA. WC, waist circumference; WHtR, waist-to-height ratio; RFM, relative fat mass; NWA, Northwestern Argentina.

provinces, except for Catamarca, La Rioja, and Santiago del Estero (*Figure 5*). The provinces of Jujuy and Salta exhibited the highest APCs. On the other hand, thinness showed a negative secular trend in all provinces, which was statistically insignificant in the provinces of Jujuy, Catamarca, Santiago del Estero, and La Rioja.

Discussion

Except for those carried out for sports purposes, there is a paucity of anthropometric studies on contemporary healthy Argentine adults, which do not always include the NWA regional populations (37-43). The present study discusses

Table 2 Correlations of variables and anthropometric indices by sex

Variables	Women					
	Weight	Height	BMI	WC	WHtR	RFM
Men						
Weight	1	0.265**	0.908**	0.764**	0.563**	0.641**
Height	0.395**	1	−0.153**	−0.073**	−0.276**	−0.311**
BMI	0.886**	−0.068**	1	0.813**	0.696**	0.786**
WC	0.795**	0.093**	0.816**	1	0.968**	0.941**
WHtR	0.541**	−0.176**	0.675**	0.956**	1	0.969**
RFM	0.646**	−0.199**	0.800**	0.928**	0.971**	1

**, P<0.001. BMI, body mass index; WC, waist circumference; WHtR, waist-to-height ratio; RFM, relative fat mass.

Table 3 Concordance of the prevalence of obesity by BMI *vs.* WC, WHtR and RFM

Sex	N	BMI (>30 kg/m^2) *vs.* WC		BMI (>30 kg/m^2) *vs.* WHtR		BMI (>30 kg/m^2) *vs.* RFM	
		Kappa	P	Kappa	P	Kappa	P
All	3,252	0.589	<0.001	0.273	<0.001	0.280	<0.001
Women	1,833	0.541	<0.001	0.312	<0.001	0.266	<0.001
Men	1,419	0.657	<0.001	0.242	<0.001	0.282	<0.001

BMI, body mass index; WC, waist circumference; WHtR, waist-to-height ratio; RFM, relative fat mass.

the anthropometric characteristics and nutritional status of the adult population of the NWA region in terms of the obesity pandemic for the first time. The results obtained are valid for individuals aged between 18 and 84 years.

Significant variations in anthropometric measurements between provinces, especially height, did not reflect marked differences in the prevalence of nutritional status, particularly the prevalence of obesity (as estimated by the BMI). These results indicate that the adult populations of Jujuy and Salta are notably shorter and less heavy than those of the NWA region and Argentina, while the populations of Catamarca and La Rioja exhibit the opposite pattern. As adult height reflects the interaction between genetic factors and a changing social, economic, and cultural environment throughout an individual's life, the populations of Jujuy and Salta appear to be the least favored of the NWA regions in this aspect. Indeed, these differences are consistent with socioeconomic indicators, such as UBN (44), which rank Jujuy and Salta as the provinces with the greatest structural poverty in the NWA region. Genetically, the populations of Jujuy and Salta are the least miscegenated in the NWA region, with greater participation of the native component in their genome (9,13,14). From an environmental point of view, these provinces are in the Andes and some of their populations live at altitudes higher than 2,000 meters above sea level. The analysis carried out by Bejarano *et al.* (45) on the secular trend of height in 48,589 conscripts born in Jujuy between 1870 and 1960 provides information on the variation of this indicator in terms of geographical altitude and surnames as indicators of ethnicity. Regardless of the drafting year, individuals bearing foreign surnames were significantly taller than those who had a native surname and lived in the highlands (45). Average height exhibited a reverse relationship to geographical altitude, regardless of the ethnic group. On the other hand, the taller heights registered in the provinces of Catamarca and La Rioja may be due to the interaction between a higher genetic admixture of Spanish and African populations (9) as well as a better socioeconomic situation (44) than the one observed in the northern provinces.

WC is a simple and convenient way of measuring abdominal or central obesity and constitutes the main criterion for the diagnosis and definition of metabolic syndrome (46). Although the average WC of men and

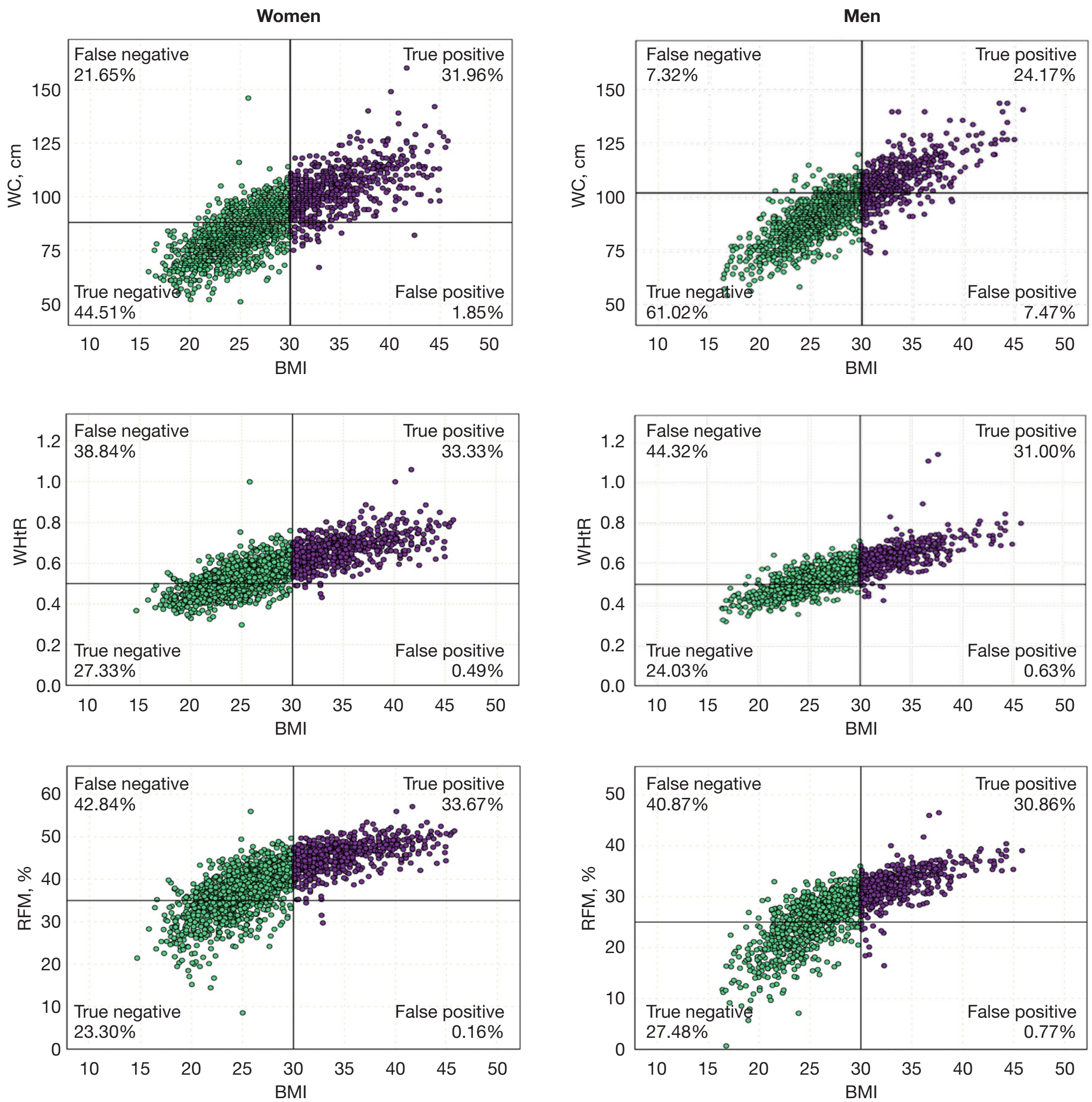

Figure 4 Scatterplot of BMI *vs.* WC, WHtR and RFM. BMI, body mass index; WC, waist circumference; WHtR, waist-to-height ratio; RFM, relative fat mass.

women from the NWA does not differ significantly from that of Argentina as a whole, women from Salta and Santiago del Estero and men from Jujuy and Santiago del Estero have significantly higher WCs than the averages for NWA and Argentina. This situation may lead to a higher risk of developing some of the components of metabolic syndrome. The average value of WHtR in some provinces and the NWA exceeds the proposed 0.5 and is close to the lower limits of the 95% CI, thus moving away from the health recommendation "keep your waist circumference to less than half your height" (47,48).

The average BMIs of the provinces and the NWA region were compared with those of Argentina as well as the global BMI according to the data provided by the NCD Risk Factor Collaboration (NCD-RisC) (49) from 2014. The average BMI of women and men from the NWA region is higher than the global BMI and is not included in the 95% CI. Only men from the NWA have a higher BMI than the one reported for Argentina by the NCD-RisC (49). These discrepancies could be due to the time elapsed between the data collection of this study in relation to the NCD-RisC (49) as well as the

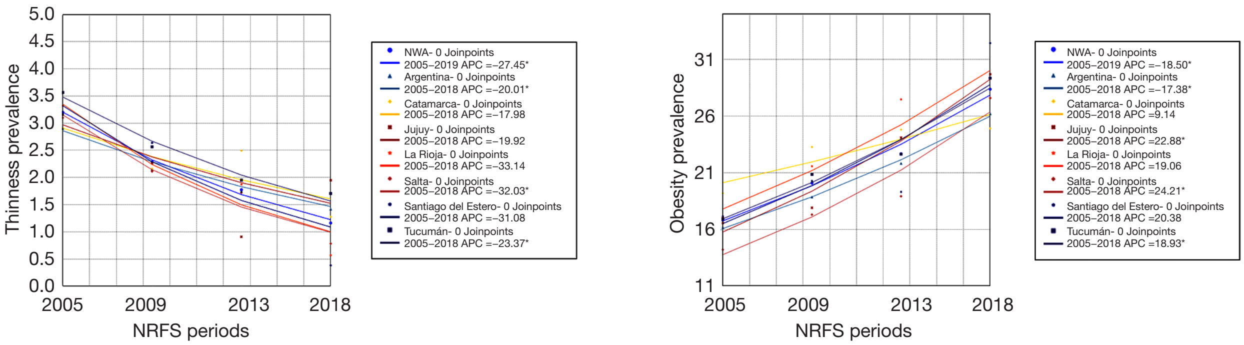

Figure 5 Joinpoint regression curves of thinness and obesity prevalence by BMI. *, P<0.05. NRFS, National Risk Factor Survey; NWA, Northwestern Argentina; APC, annual percentage change; BMI, body mass index.

effect of the secular trend and the inter-population ethnic, environmental, and cultural differences (50).

A previous anthropometric study carried out on NWA regional populations analyzed the weight, height, perimeters (arm, thigh, leg, waist), and folds (triceps, subscapular) of 881 healthy individuals (526 women; 355 men; aged 20–60 years old) from different localities of Catamarca and Jujuy (18). The results were compared with anthropometric data from US adults of Mexican origin. Overall, NWA adults displayed significantly lower values than those measured in the reference population for all anthropometric variables in both sexes and all age groups.

The RFM averages for all provinces, the NWA region, and Argentina as a whole exceed the arbitrarily defined body fat percentage [measured by dual energy X-ray absorptiometry (DXA)] cut-off points for women (≥.9%) and men (≥22.8%), which constitute the technical resource of excellence to assess adiposity (29).

The prevalence of overweight and obesity is increasing at an alarming rate in developed and developing countries worldwide. According to Chooi *et al.* (51), the prevalence of overweight increased from 45.3% to 64.2%, and that of obesity increased from 12.9% to 28.3% between 1980 and 2015 in the Americas. Although the secular trend of obesity in the NWA region was calculated using self-reported anthropometric data from the NRFS [2005, 2009, and 2013 (INDEC 2019)], the same pattern is observed. The provinces of Jujuy and Salta, with average heights and weights lower than the NWA region and Argentina, presented the highest APCs of the secular trend in the region. Inversely to the increase in the secular trend of overnutrition, there is a decrease in undernutrition evidenced by a negative secular trend of thinness, indicating a shift to the right in the distribution of adiposity in adults of NWA. Christine *et al.* (52) reported that Argentine women with a low socioeconomic position had a higher and increasing BMI relative to their counterparts of higher socioeconomic status based on the 2005 and 2009 NRFS data. In addition, changes in provincial economic development during the study period were marginally associated with annual increases in mean BMI in both men and women.

This study highlights that the anthropometric differences of the NWA provinces compared to the region and the country are not captured by the BMI, an index universally used to assess nutritional status and, in particular, obesity. Other indicators such as WHtR showed a significantly higher prevalence of abdominal obesity in the provinces of Jujuy and Salta, with lower height and higher WC averages than the regional and national averages in some cases. A study conducted by Ashwell *et al.* (48) including over 300,000 adults from various ethnic groups, demonstrated the superiority of WHtR over WC and BMI for detecting cardiometabolic risk factors in both sexes.

Despite the high reliability of indirect methods of body composition assessment (computed tomography scan, magnetic resonance imaging, DXA, and plethysmography), these cannot be massively applied in nutritional epidemiology studies due to their high financial costs. Since BMI is easy to determine and has a high correlation with adiposity, it is recommended by the WHO as a simple marker to determine the total amount of body fat. However, the usefulness of BMI to estimate adiposity can be questioned because it does not differentiate between fat and lean mass and its distribution, in addition to being a poor predictor of body fat (53). On the other hand, the relationship between the BMI, the percentage of body fat, and its distribution are dependent on the gender, age, and ethnic origin of the populations (51). In this context, the observations of the correlations, concordance, and scatterplot of the BMI distribution must be interpreted considering other additional measurements that take the distribution of body fat into account.

Both the correlation and the concordance of the WC *vs.* BMI combination were high and significant. This is particularly important since it is the only combination that is free of collinearity, as RFM and WHtR are calculated based on height and/or waist circumference. The categorization of obesity by BMI and WC is contrasted in a scatterplot, and the percentage of WC hits to BMI (false and true positives) is shown as complementary graphic information to the concordance analysis. For both sexes, the percentage of obese people captured by the WC but not by the BMI was high. Thus, the use of the WC as a complement to the BMI for the identification of obesity in NWA populations could be more useful in epidemiological studies.

The current obesity epidemic is the result of a multifactorial interaction between the environment, genetic susceptibility, and human behavior. Environmental factors, excess intake of energy-dense foods, and reduced physical activity are likely to be the main drivers of the increase in obesity (54). Based on a nutritional survey carried out on a representative sample of rural high-altitude populations of the NWA, Bassett *et al.* (19) concluded that these populations are undergoing the early stages of the nutritional transition. On the other hand, a study performed by Mesa *et al.* (21) analyzed adult populations living in urban areas of Jujuy and Catamarca who could have completed the nutritional transition. Both studies agree that there is little diversity in the foods consumed, including the high intake of carbohydrates (potatoes, rice, pasta, and flours) as well as ultra-processed foods and beverages, a variable consumption of vegetables, meat, and dairy, and an absence of other products such as fish. Therefore, we assume that the NWA region could present a heterogeneous nutritional transition with similar dietary patterns but with differences related to geographic altitude. However, the interpretation of these results must delve deeper into the metabolic characteristics and eating habits of these populations, which are still insufficiently explored and understood.

Conclusions

The adult populations of the NWA exhibit a high prevalence of obesity with an increasing trend. The anthropometric variables registered in some provinces, such as weight, height, and WC, vary significantly compared to the whole country, and these differences are not captured by the traditionally used obesity indices (BMI). According to Chooi *et al.* (51), BMI and other double indirect anthropometric methods used to estimate adiposity (WC, WHtR) cannot accurately convey the magnitude of health risk when used alone, not only in studies of different ethnic populations but also for certain subgroups within the same population. For this reason, more than one obesity index should be used simultaneously when studying these populations.

Strengths and limitations

The main limitations of this study were that the anthropometric measurements collected by the NRFS are insufficient to reflect intra-population variations in the NWA region. On the other hand, the anthropometric analysis could not be extended to the previous NRFS (2003/2009/2013) because height and weight were self-reported rather than objectively measured. Although the anthropometric data collected by the NRFS presents these limitations, the analyses performed in this study could allow for a global approximation of the intra-population nutritional status by incorporating additional measurements to estimate obesity.

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Footnote

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Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at https://jphe.

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Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). Our article was written using secondary databases published by the National Institute of Statistics and Censuses (INDEC). As these databases are public and anonymous, this work did not require the approval of an Ethics Committee, and informed consent was not requested.

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Supplementary

Table S1 Nutritional status by WHO, WC, WHtR and RFM criteria

		Jujuy			Salta			Tucumán			Catamarca			Santiago del Estero			La Rioja			NWA			Argentina		
		N	%	95% CI	N	%	95% CI	N	%	95% CI	N	%	95% CI	N	%	95% CI	N	%	95% CI	N	%	95% CI	N	%	95% CI
Woman																									
OMS BMI	TH	9	2.5	(1.2–4.4)	6	1.6	(0.7–3.3)	7	2	(0.9–3.8)	6	2	(0.8–4)	4	1.8	(0.6–4.2)	4	1.7	(0.6–4)	36	1.9	(1.4–2.6)	170	1.8	(1.6–2.1)
	NO	116	31.6	(27–36.5)	113	30.2	(25.7–35)	103	29	(24.5–33.9)	111	36.5	(31.2–42)	66	29.6	(23.9–35.8)	70	30.2	(24.5–36.3)	579	31.2	(29.1–33.3)	3117	33.4	(32.4–34.4)
	OW	123	33.5	(28.8–38.5)	124	33.2	(28.5–38)	125	35.2	(30.4–40.3)	91	29.9	(25–35.3)	63	28.3	(22.7–34.4)	89	38.4	(32.3–44.7)	615	33.2	(31–35.3)	2940	31.5	(30.6–32.4)
	O tipe I	73	19.9	(16.1–24.2)	93	24.9	(20.7–29.4)	70	19.7	(15.8–24.1)	58	19.1	(15–23.8)	50	22.4	(17.3–28.2)	43	18.5	(13.9–23.9)	387	20.9	(19.1–22.8)	1882	20.2	(19.4–21)
	O tipe II	32	8.7	(6.2–11.9)	28	7.5	(5.1–10.5)	34	9.6	(6.8–13)	26	8.6	(5.8–12.1)	28	12.6	(8.7–17.4)	20	8.6	(5.5–12.7)	168	9.1	(7.8–10.4)	844	9	(8.5–9.6)
	O tipe III	14	3.8	(2.2–6.1)	10	2.7	(1.4–4.7)	16	4.5	(2.7–7)	12	3.9	(2.2–6.6)	12	5.4	(3–8.9)	6	2.6	(1.1–5.3)	70	3.8	(3–4.7)	380	4.1	(3.7–4.5)
	O I-III	119	32.4	(27.8–37.3)	131	35	(30.3–40)	120	33.8	(29–38.8)	96	31.6	(26.5–37)	90	40.4	(34.1–46.9)	69	29.7	(24.1–35.8)	625	33.7	(31.6–35.9)	3106	33.3	(32.3–34.2)
	EX	242	65.9	(61–70.6)	255	68.2	(63.3–72.7)	245	69	(64.1–73.7)	187	61.5	(56–66.9)	153	68.6	(62.3–74.4)	158	68.1	(61.9–73.8)	1240	66.8	(64.7–69)	6046	64.8	(63.8–65.7)
WC	O	244	66.5	(61.5–71.2)	217	58.2	(53.1–63.1)	253	73.8	(68.9–78.2)	195	65	(59.5–70.2)	121	54.3	(47.7–60.7)	147	64.8	(58.4–70.8)	1177	64.2	(62–66.4)	6044	65.4	(64.5–66.4)
	Not O	123	33.5	(28.8–38.5)	156	41.8	(36.9–46.9)	90	26.2	(21.8–31.1)	105	35	(29.8–40.5)	102	45.7	(39.3–52.3)	80	35.2	(29.2–41.6)	656	35.8	(33.6–38)	3191	34.6	(33.6–35.5)
WHtR	NA	75	20.4	(16.6–24.8)	73	19.6	(15.8–23.8)	148	43.1	(38–48.4)	93	31	(26–36.4)	51	22.9	(17.7–28.7)	70	30.8	(25.1–37.1)	510	27.80	(25.8–29.9)	2841	30.80	(29.8–31.7)
	A	292	79.6	(75.2–83.4)	300	80.4	(76.2–84.2)	195	56.9	(51.6–62)	207	69	(63.6–74)	172	77.1	(71.3–82.3)	157	69.2	(62.9–74.9)	1323	72.20	(70.1–74.2)	6394	69.20	(68.3–70.2)
RFM	O	309	84.20	(80.2–87.7)	314	84.20	(80.2–87.6)	212	61.80	(56.6–66.8)	216	72.20	(67–77.1)	181	81.20	(75.7–85.9)	170	74.90	(69–80.2)	1402	76.50	(74.5–78.4)	6828	74.00	(73.1–74.8)
	Not O	58	15.80	(12.3–19.8)	59	15.80	(12.4–19.8)	131	38.20	(33.2–43.4)	83	27.80	(22.9–33)	42	18.80	(14.1–24.3)	57	25.10	(19.8–31)	430	23.50	(21.6–25.5)	2404	26.00	(25.2–26.9)
Man																									
OMS BMI	TH	4	1.5	(0.5–3.5)	9	2.6	(1.3–4.8)	4	1.8	(0.6–4.2)	0	0	(–)	2	1.2	(0.3–3.8)	1	0.6	(0.1–2.6)	20	1.4	(0.9–2.1)	81	1.2	(0.9–1.4)
	NO	59	22.3	(17.6–27.6)	94	27.6	(23.1–32.6)	61	27.2	(21.7–33.3)	83	32	(26.6–37.9)	46	27.9	(21.5–35.1)	43	24.6	(18.6–31.3)	386	27	(24.8–29.4)	1908	27.6	(26.5–28.6)
	OW	110	41.5	(35.7–47.5)	132	38.8	(33.8–44.1)	89	39.7	(33.5–46.2)	108	41.7	(35.8–47.8)	59	35.8	(28.7–43.3)	68	38.9	(31.9–46.2)	566	39.6	(37.1–42.2)	2751	39.8	(38.6–40.9)
	O tipe I	69	26	(21–31.6)	75	22.1	(17.9–26.7)	43	19.2	(14.5–24.7)	51	19.7	(15.2–24.9)	43	26.1	(19.8–33.1)	40	22.9	(17.1–29.5)	321	22.5	(20.4–24.7)	1530	22.1	(21.1–23.1)
	O tipe II	21	7.9	(5.1–11.6)	24	7.1	(4.7–10.1)	23	10.3	(6.8–14.8)	11	4.2	(2.3–7.2)	11	6.7	(3.6–11.2)	19	10.9	(6.9–16.1)	109	7.6	(6.3–9.1)	522	7.5	(6.9–8.2)
	O tipe III	2	0.8	(0.2–2.4)	6	1.8	(0.7–3.6)	4	1.8	(0.6–4.2)	6	2.3	(1–4.7)	4	2.4	(0.8–5.7)	4	2.3	(0.8–5.3)	26	1.8	(1.2–2.6)	127	1.8	(1.5–2.2)
	O I-III	92	34.7	(29.2–40.6)	105	30.9	(26.1–35.9)	70	31.3	(25.5–37.5)	68	26.3	(21.2–31.9)	58	35.2	(28.2–42.6)	63	36	(29.2–43.3)	456	31.9	(29.6–34.4)	2179	31.5	(30.4–32.6)
	EX	202	76.2	(70.8–81)	237	69.7	(64.7–74.4)	159	71	(64.8–76.6)	176	68	(62.1–73.4)	117	70.9	(63.7–77.4)	131	74.9	(68.1–80.8)	1022	71.6	(69.2–73.9)	4930	71.3	(70.2–72.3)
WC	O	118	44.7	(38.8–50.7)	160	47.2	(41.9–52.5)	129	58.9	(52.3–65.3)	132	51.4	(45.3–57.4)	79	47.9	(40.3–55.5)	86	49.1	(41.8–56.5)	704	49.6	(47–52.2)	3486	50.9	(49.7–52.1)
	Not O	146	55.3	(49.3–61.2)	179	52.8	(47.5–58.1)	90	41.1	(34.7–47.7)	125	48.6	(42.6–54.7)	86	52.1	(44.5–59.7)	89	50.9	(43.5–58.2)	715	50.4	(47.8–53)	3363	49.1	(47.9–50.3)
WHtR	NA	38	14.4	(10.6–19)	76	22.4	(18.2–27.1)	90	41.1	(34.7–47.7)	70	27.2	(22.1–32.9)	33	20	(14.4–26.6)	43	24.6	(18.6–31.3)	350	24.70	(22.5–27)	1881	27.50	(26.4–28.5)
	A	226	85.6	(81–89.4)	263	77.6	(72.9–81.8)	129	58.9	(52.3–65.3)	187	72.8	(67.1–77.9)	132	80	(73.4–85.6)	132	75.4	(68.7–81.4)	1069	75.30	(73–77.5)	4968	72.50	(71.5–73.6)
RFM	O	215	81.40	(76.4–85.8)	256	75.50	(70.7–79.9)	121	55.30	(48.6–61.7)	175	68.10	(62.2–73.6)	124	75.20	(68.2–81.3)	127	72.60	(65.6–78.8)	1018	71.70	(69.4–74)	4699	68.60	(67.5–69.7)
	Not O	49	18.60	(14.2–23.6)	83	24.50	(20.1–29.3)	98	44.70	(38.3–51.4)	82	31.90	(26.4–37.8)	41	24.80	(18.7–31.8)	48	27.40	(21.2–34.4)	401	28.30	(26–30.6)	2149	31.40	(30.3–32.5)

TH, thinness; NO, normal; OW, overweight; O, obesity; EX, overweight + obesity; O tipe I, obesity tipe I; O tipe II, obesity tipe II; O tipe III, obesity tipe III; O I–III, obesity I–III; NA, no abdominal; A, abdominal.

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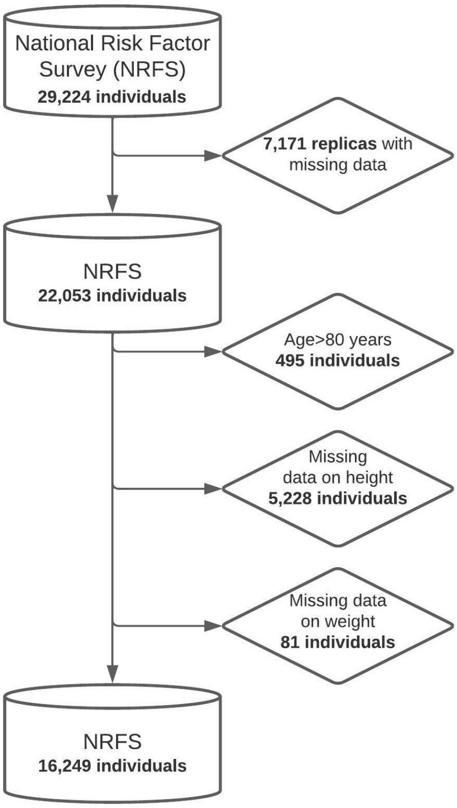

Figure S1 Flow chart of the database cleaning.

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