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Nutritional Status and Body Composition in an Industrially Exposed Population: Sex-Specific Anthropometric Patterns in Chilean Adults

Estado Nutricional y Composición Corporal en una Población Expuesta Industrialmente: Patrones Antropométricos Específicos por Sexo en Adultos Chilenos

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SUMMARY: Understanding body composition through advanced anthropometric indicators provides critical insight into nutritional status and cardiometabolic risk, particularly in vulnerable populations. Traditional metrics like body mass index (BMI) often misclassify health status by failing to differentiate fat from lean mass. Chile lacks population-based studies incorporating body composition indices (Fat Mass Index [FMI], Fat-Free Mass Index [FFMI], Skeletal Muscle Index [SMI], Fat-to-Muscle Ratio), especially in industrial-exposed areas like Quintero. This cross-sectional study assessed 2709 adults (1906 women, 803 men) living in Quintero using multifrequency bioelectrical impedance analysis (InBody®). Variables included BMI, percent body fat (PBF), fat-free mass (FFM), skeletal muscle mass (SMM), and derived indices (FMI, FFMI, SMI, Fat-to-Muscle Ratio). Data were stratified by sex/age and analyzed using t-tests and Pearson correlations. Men showed higher FFM (63.8±7.3 kg), SMM (36.4±4.3 kg), and FFMI (24.0±4.9), while women had significantly greater PBF (39.9±7.5 %) and FMI (11.5±4.8). The fat-to-muscle ratio was 2.1 higher in women (1.25±0.38 *vs.* 0.59±0.31). Overall, 46.5 % had obesity based on PBF (50.7 % women). Age correlated positively with PBF (men: r=0.36; women: r=0.20) and negatively with %SMM (men: r =-0.38; women: r=-0.22). The Quintero population exhibits high adiposity rates with age-related muscle decline, suggesting sarcopenic obesity features. Advanced indices provided more accurate risk stratification than BMI alone, underscoring their utility for public health surveillance in environmentally vulnerable communities.

KEY WORDS: Adiposity; Anthropometry; Body composition; Lean body mass; Nutritional status; Skinfold thickness.

INTRODUCTION

The study of nutritional status and anthropometric characteristics in specific populations is a fundamental tool for public health surveillance and the identification of risk factors associated with chronic non-communicable diseases (NCD) such as obesity, type 2 diabetes, and cardiovascular diseases (Bhuiyan *et al*., 2024). In Chile, data from the 2016–2017 National Health Survey already warned of a high prevalence of excess weight, with 74.2 % of the adult population being overweight or obese (Ministerio de Salud, 2017), and an increasing trend in recent decades.

Anthropometry has historically been a key tool in nutritional diagnosis, given its accessibility, low cost, and ability to indirectly estimate body composition. Its

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widespread use in both clinical and public health contexts has enabled the monitoring of nutritional status across diverse populations, especially in low-resource settings (Wells & Fewtrell, 2006). Despite its limitations, anthropometry remains the foundation of global nutritional surveillance systems, supported by organizations such as the World Health Organization (World Health Organization, 2008), due to its practicality and adaptability across age groups and settings. Traditionally, body mass index (BMI) has been the most widely used parameter for classifying nutritional status and establishing risks for chronic non-communicable diseases. However, its predictive capacity has been questioned because it does not distinguish between fat mass and fat-free mass, which has led to the development and adoption of new indicators that offer a more specific and functional assessment (Wells & Fewtrell, 2006). For this reason, other complementary indices have been developed and validated, such as the fat mass index (FMI), the fat-free mass index (FFMI), the skeletal muscle mass index (SMI) and the fat/muscle index, which allow for a more accurate characterization of metabolic and functional risk in different age groups and by sex (Romero-Corral *et al*., 2008; AlMasud *et al*., 2025). Among these, the Fat Mass Index (FMI) stands out, as it enables the estimation of body fat adjusted for height, thereby overcoming the limitations of BMI in individuals with high muscle mass or in clinical contexts where body fat is a critical risk factor (Kelly *et al*., 2009). Recent studies have shown that FMI more accurately predicts cardiometabolic risk than BMI, especially in women and older adults (Srdic *et al*., 2012). The fat-free mass index (FFMI) assesses the lean component of the body (muscles, bones, and organs) and is useful for detecting conditions such as sarcopenia or protein-calorie malnutrition in clinical and geriatric populations (Kyle *et al*., 2004). Low FFMI levels have been observed to be associated with a worse prognosis in patients with cancer, COPD, and cardiovascular disease (van Vugt *et al*., 2018). On the other hand, skeletal muscle mass index (SMI) has been widely used in the diagnosis of sarcopenia, demonstrating robust correlations with physical function, grip strength, and risk of falls in older adults (Cruz-Jentoft *et al*., 2019). Furthermore, it is considered a key predictor of functional dependence and mortality in hospital and community settings (Janssen *et al*., 2002). Finally, the Fat-to-Muscle Index seeks to integrate the relationship between key body compartments. Studies suggest that the imbalance between fat mass and muscle mass, rather than excess weight itself is a more accurate predictor of metabolic risk, systemic inflammation, and frailty (Yu *et al*., 2022; He *et al*., 2023). These indicators have been validated in various clinical and population contexts, demonstrating greater sensitivity in identifying sarcopenic obesity, a phenotype associated with increased risk in ageing (Zamboni *et al*., 2008; Barbat-Artigas *et al*., 2012). In addition, they have been proposed as alternative markers for monitoring changes induced by interventions in public health and nutrition programs (Laviano *et al*., 2015). In Latin America, the systematic use of these indices in population studies is still in its infancy. However, recent research in Brazil, Mexico, and Chile is beginning to incorporate them as part of more complex risk analysis and epidemiological surveillance (Lera *et al*., 2017). In Chile, the use of segmental bioimpedance in population studies enables a reliable estimation of these components, which is crucial for understanding differences by sex, age, and socioeconomic status. The availability of reference values and specific percentiles by sex and age remains a significant limitation. Therefore, studies describing and analyzing advanced anthropometric indices in local populations are essential for establishing clinically significant thresholds and contextualizing risk within sociocultural and environmental frameworks. At the same time, scientific literature has shown that ageing leads to a redistribution of body composition, characterized by a progressive increase in fat mass and a reduction in muscle mass, a process known as sarcopenia (Cruz-Jentoft *et al*., 2019). This trend manifests itself differently in men and women and is often influenced by hormonal, behavioral and socio-environmental factors. The municipality of Quintero, in Valparaíso (Chile), has several environmental and social characteristics that warrant special analysis. Its history of exposure to industrial pollutants has been the subject of health and media concern over the last decade. However, few studies have comprehensively characterized the body composition of its adult population. The present study aims to describe the anthropometric profile and nutritional status of adults living in Quintero, disaggregating the results by sex and age groups, through the analysis of classic and advanced body composition indicators. This information will allow the establishment of local reference patterns that contribute to the design of more effective public health and NCD prevention interventions.

MATERIAL AND METHOD

Participants. This cross-sectional study included 2709 adults (1906 women, 803 men) aged ≥18 years living in the industrial-exposed community of Quintero, Valparaiso, Chile. Participants were recruited through various means such as social networks, open calls and email, between March 2020 and April 2025. Inclusion criteria included permanent residence in Quintero and willingness to undergo anthropometric and body composition assessments. Exclusion criteria included pregnancy, implanted electronic medical devices (due to bioimpedance contraindications), or severe physical disabilities preventing accurate measurements.

Ethical Considerations. All participants provided written informed consent prior to participation confirming their voluntary agreement to join the study. Researchers explained the study objectives and measurement protocols to participants beforehand. The investigation adhered to ethical standards of the Declaration of Helsinki for human research. The study was approved by the ethics committee of the Quintero Physical Fitness Assessment Laboratory (code 2025-002).

Bioelectrical Impedance. Measurements were conducted in a controlled environment (20 °C, 70 % humidity) following standardized protocols published elsewhere (Yañez-Sepúlveda *et al*., 2024). Participants abstained from exercise, alcohol, and diuretics for 48 hours prior to testing and arrived after a 4-hour fast with confirmed urinary/ bladder emptying. Evaluations were performed in a standing position wearing light clothing, all jewelry removed and skin contact surfaces cleaned with 70 % isopropyl alcohol. Height was measured to ±0.5 cm precision using a SECA® 213 portable stadiometer. Body composition was assessed via validated octopolar multifrequency bioelectrical impedance analysis (InBody® 270, 20-100 kHz). Data were automatically processed through LookinBody® software (InBody®), recording weight, height, BMI, adipose tissue (%/kg), muscle tissue (%/kg), fat-free mass, total body water (TBW), body fat mass (BFM), skeletal muscle mass (SMM), waist-hip ratio (WHR), skeletal muscle index (SMI), fat mass index (FMI), fat-free mass index (FFMI), and basal metabolic rate (BMR).

Body Mass Index (BMI). The BMI was determined by calculating the ratio of body weight in kilograms to the square of height in meters (kg/m^2) (Eknoyan, 2008).

Table I. Anthropometric characteristics and body composition parameters by sex.

Variable	Male		Female		*p*-value
	Mean	SD	Mean	SD	
Height (cm)	165.01	14.12	165.52	14.37	0.392
Age (years)	36.72	11.28	38.14	11.74	0.003
Weight (kg)	85.33	14.55	75.46	15.44	<0.001
TBW (L)	46.77	5.31	32.65	4.41	<0.001
Protein (kg)	12.72	1.45	8.81	1.2	<0.001
Minerals (kg)	4.35	0.58	3.09	0.41	<0.001
BFM (kg)	21.49	11.28	30.91	11.46	<0.001
FFM (kg)	63.84	7.31	44.55	5.99	<0.001
SMM (kg)	36.36	4.34	24.58	3.61	<0.001
SMM (%)	43.18	4.95	33.13	4.12	<0.001
BMI (kg/m^2)	27.76	5.19	29.9	6.08	<0.001
PBF (%)	24.16	8.63	39.85	7.52	<0.001
FFM (RA)	3.78	0.53	2.48	0.48	<0.001
FFM (LA)	3.72	0.53	2.46	0.48	<0.001
FFM (Trunk)	28.93	3.13	21.11	2.93	<0.001
FFM (RL)	9.68	1.21	6.57	0.93	<0.001
FFM (LL)	9.6	1.2	6.52	0.93	<0.001
BFM (RA)	1.41	1.39	2.6	1.57	<0.001
BFM (LA)	1.44	1.38	2.62	1.57	<0.001
BFM (Trunk)	11.59	5.95	15.82	5.46	<0.001
BFM (RL)	2.89	1.28	4.29	1.45	<0.001
BFM (LL)	2.86	1.26	4.27	1.43	<0.001
BMR (kcal/day)	1748.95	158.01	1332.32	129.39	<0.001
WHR	0.94	0.09	0.97	0.08	<0.001
SMI	8.65	0.69	7.11	0.82	<0.001
RCI (kcal/day)	2625.12	332.95	1739.24	224.5	<0.001
FFMI	23.95	4.87	16.62	3.63	<0.001
FMI	8.06	4.54	11.54	4.76	<0.001
SMI	13.64	2.81	9.17	2.07	<0.001
Fat/Muscle Index	0.59	0.31	1.25	0.38	<0.001

Abbreviations: BMI: Body Mass Index; BFM: Body Fat Mass; BMR: Basal Metabolic Rate; FFM: Fat-Free Mass; FMI: Fat Mass Index; FFMI: Fat-Free Mass Index; LA: Left Arm; LL: Left Leg; PBF: Percent Body Fat; RA: Right Arm; RCI: Recommended Calorie Intake; RL: Right Leg; SD: Standard Deviation; SMM: Skeletal Muscle Mass; SMI: Skeletal Muscle Index; TBW: Total Body Water; WHR: Waist-to-Hip Ratio.

Skeletal Muscle Index (SMI). The absolute muscle mass (kg) was normalized for height (muscle mass (kg)/height (m^2) to calculate the Skeletal Muscle Index (SMI) (Janssen *et al*., 2002).

Status Nutritional. Nutritional status classification based on adiposity was performed using the percent body fat (PBF) cut-off points proposed by Gallagher *et al.* (2000). These reference values, stratified by sex and age ranges (20–39, 40–59, and 60–79 years), were selected for their ability to predict metabolic health risks independently of BMI. Participants were categorized into underfat, normal weight, overweight, and obese groups by applying specific thresholds corresponding to their age decade and sex, thus allowing for the adjustment of physiological changes in body composition associated with aging.

Fat Mass Index (FMI). FMI was derived by dividing individual fat mass values (in kilograms) by the square of height (in meters), expressed as kg/m^2 (Liu *et al*., 2013).

Fat-Free Mass Index (FFMI). The FFMI was obtained by first dividing fat-free mass (kg) by height squared (m^2), followed by application of a height correction factor [6.3 × (1.75 m - actual height)], as described in prior body composition literature (Kouri *et al*., 1995).

Statistical Analyses. Data were analyzed using IBM SPSS 23 (IBM Corp., Armonk, NY, USA). Normality distribution was confirmed with Shapiro-Wilk tests. Independent t-tests compared sexes; Pearson correlations were used to assess age and body composition relationships. Obesity prevalence used PBF cutoffs (men ≥25 %, women ≥35 %). Mean and standard deviation were used to present the results; $p<0.05$ was defined as significant.

Table II. Body fat classification distribution by sex.

Classification	Men	Women	Total
Underweight	0.5 % (4)	0.7 % (14)	0.7 % (18)
Normal	43.0 % (346)	18.8 % (359)	26.0 % (705)
Overweight	19.6 % (157)	29.8 % (568)	26.8 % (725)
Obese	36.9 % (296)	50.7 % (965)	46.5 % (1261)
Total	100.0 % (803)	100.0 % (1906)	100.0 % (2709)

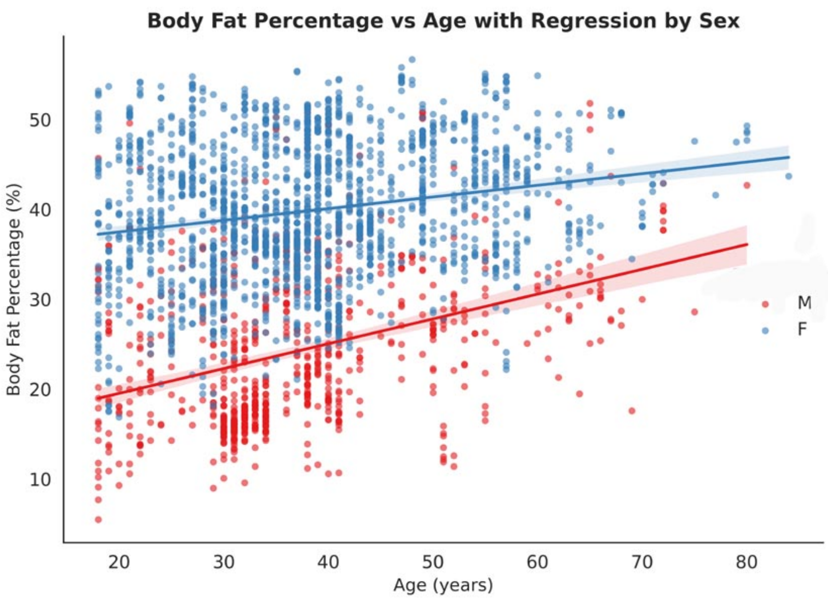

Fig. 1. Relationship between body fat percentage and age.

Table III. Mean bodyfat percentage and age-related increment by decade.

Sex	Age group	Mean BF (%)	Decadal increase
Female	10.0	34.87	—
	20.0	38.9	4.03
	30.0	39.09	0.19
	40.0	40.72	1.63
	50.0	42.21	1.49
	60.0	43.29	1.08
	70.0	41.94	-1.35
	80.0	47.58	5.64
Male	10.0	21.64	—
	20.0	23.61	1.97
	30.0	22.15	-1.46
	40.0	27.84	5.69
	50.0	25.58	-2.25
	60.0	31.18	5.59
	70.0	37.3	6.12
	80.0	42.7	5.4

Note: BF=body fat.

RESULTS

The analysis revealed significant sex differences in body composition (all $p<0.001$). Men had higher lean mass measures (FFM: 63.8 vs 44.6 kg; SMM: 36.4 *vs* 24.6 kg), while women showed greater adiposity (PBF: 39.9 % vs 24.2 %; FMI: 11.5 *vs* 8.1 kg/m^2). The fat-to-muscle ratio was 2.1-fold higher in women (1.25 *vs* 0.59). Metabolic rates differed substantially (BMR: 1749 *vs* 1332 kcal/day) (Table I).

Table II shows the body fat classification distribution by sex, revealing significant disparities. Women showed higher obesity prevalence (50,7 %, n=965) compared to men (36.9 %, n=296). In contrast, more men fell into the normal weight category (43.0 % men *vs* 18.8 % women). The overall population exhibited high obesity rates (46.5 %, n=1261), with minimal underweight representation (0.7 %, n=18). Distribution of body fat percentage by age is presented in Figure 1.

Men exhibited a moderate positive correlation ($r=0.3609$, $p<0.001$) between body fat percentage and age, while women displayed a weak positive correlation ($r=0.2024$, $p<0.001$).

Table III shows a 4.03 % increase in body fat percentage (BF %) between ages 10-20 years, with another peak increase of 5.64 % between 70-80 years. Overall, the decade-by-decade increase was gradual and constant (~1-2 %). Men exhibited marked increases during their 40s (+5.69 %), 60s (+5.59 %), and 70s (+6.12 %). Correlations between muscle mass percentage by age and sex are presented in Figure 2.

Muscle mass percentage showed inverse correlations with age in both sexes, though the strength of association differed by sex. Men exhibited a moderate negative

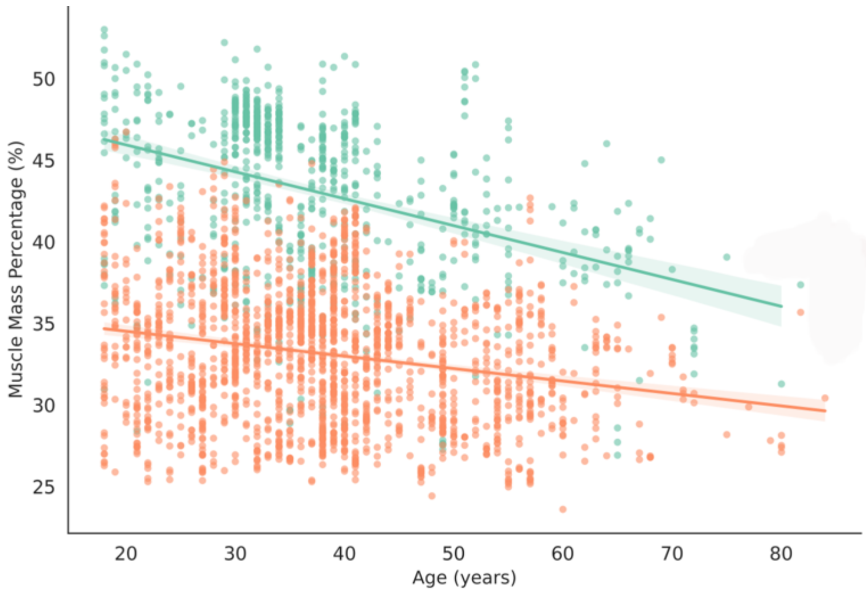

Fig. 2. Correlation between muscle mass percentage and age by sex.

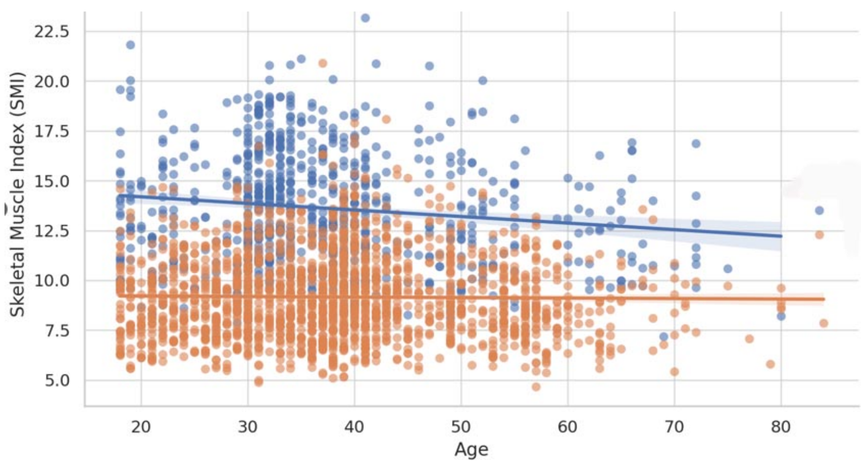

Fig. 3. Correlation between skeletal muscle mass percentage and age by sex.

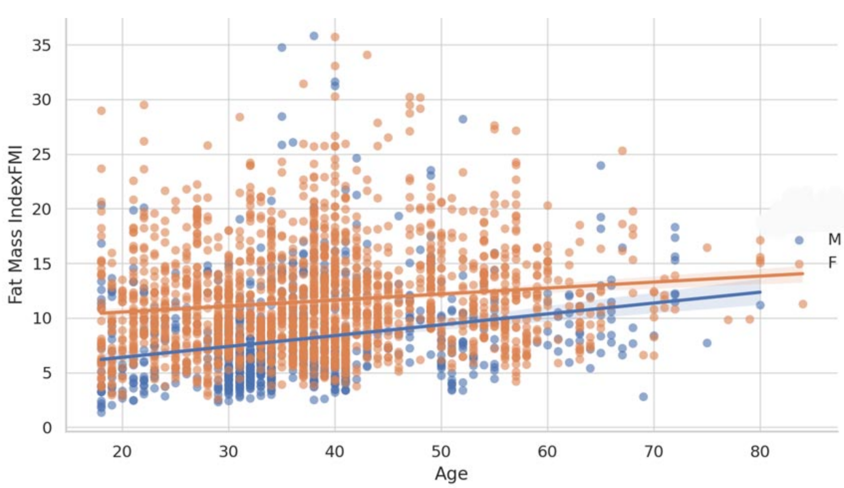

Fig. 4. Relationship between fat mass index and age by sex.

correlation (*r*=-0.376, *p*<0.001), while women demonstrated a weaker but still significant negative association (*r*=-0.217, *p*<0.001). Correlations between skeletal muscle mass percentage by age and sex are presented in Figure 3.

Age-related changes showed sex-specific patterns (Figs. 3 to 6). Skeletal muscle mass percentage declined with age in both sexes (men: *r*=-0.38; women: *r*=-0.22; *p*<0.001). FMI increased with age, particularly in men (Fig. 4). FFMI trajectories differed significantly by sex (Figs. 5 and 6), with men exhibiting steeper declines (interaction *p*<0.001).

Age showed weak negative correlations with FFMI/SMI in men (*p*<0.001) but not women. Both sexes had weak positive FMI-age associations (men *r*=0.247, women *r*=0.135; *p*<0.001). The fat-to-muscle ratio increased moderately with age in men (*r*=0.347) versus weakly in women (*r*=0.197), indicating sex-specific body composition changes (Table IV).

Table V presents sex-stratified percentiles for body composition parameters. Women showed substantially higher adiposity measures (median PBF: 39.6 % vs 22.4 % in men; Fat-to-Muscle Ratio: 1.19 vs 0.50). Men maintained greater lean mass (FFMI: 23.63 vs 16.23) and skeletal muscle indices. Both sexes exhibited wide variability across percentiles, particularly in FMI (men P5-P95: 3.4-15.96; women: 5.55-20.39).

DISCUSSION

The results of this study show marked and statistically significant differences between men and women in virtually all components of body composition. As previously reported in the literature, men had higher skeletal

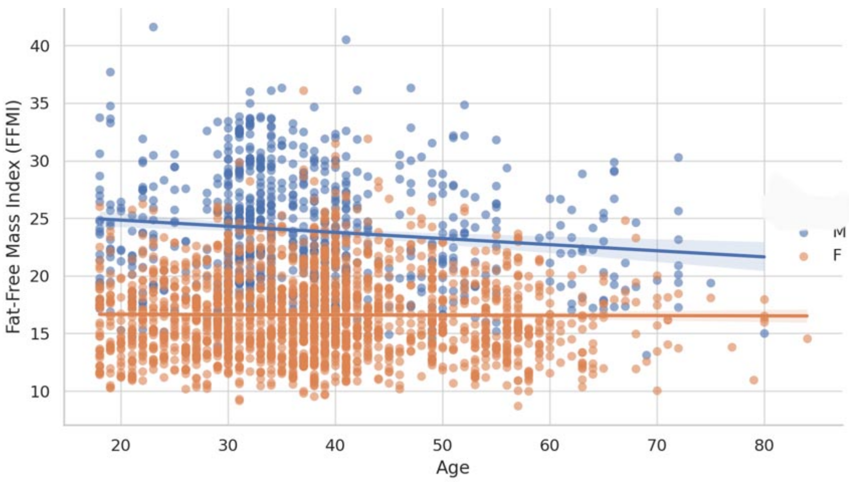

Fig. 5. Relationship between fat-free mass index and age by sex.

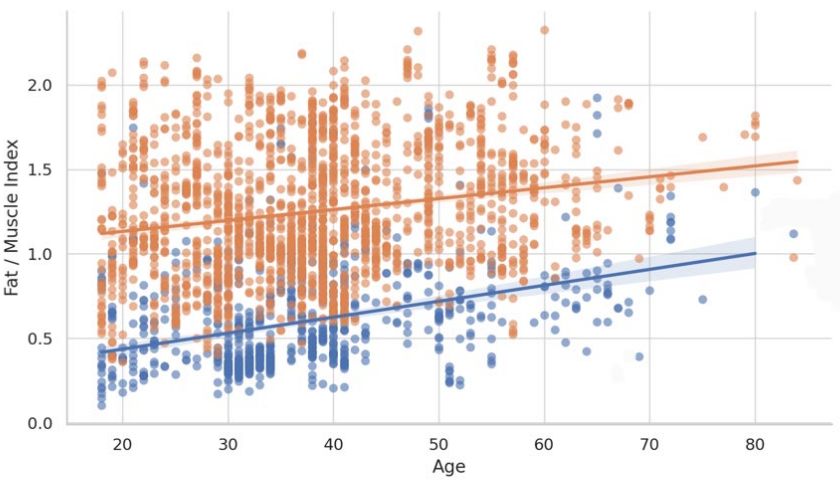

Fig. 6. Relationship between fat-free mass index and age stratified by sex.

Table IV. Correlation between age and body composition variables by sex.

Variable	Sex	Correlation (*r*)	*p*-value	Classification
FFMI	Male	-0.123	<0.001	Weak
	Female	-0.007	0.762	Very weak
FMI	Male	0.247	0.001	Weak
	Female	0.135	0.001	Weak
SMI	Male	-0.132	<0.001	Weak
	Female	-0.014	0.532	Very weak
Fat /Muscle Index	Male	0.347	0.001	Moderate
	Female	0.197	0.001	Weak

Abbreviations: FMI: Fat Mass Index; FFMI: Fat-Free Mass Index; SMI: Skeletal Muscle Index

muscle mass (SMM), fat-free mass (FFM) and fat-free mass index (FFMI). In contrast, women had a higher percentage of fat mass (PBF), a higher fat mass index (FMI), and a higher fat-to-muscle index. These differences are partly due to hormonal, metabolic, and factors related to fat and muscle distribution, which have been widely documented in clinical and epidemiological studies (Wells & Fewtrell, 2006; Srdic *et al*., 2012). According to the data obtained, 46.5 % of participants are obese, with this condition being significantly more prevalent in women (50.7 %) than in men (36.9 %). This high prevalence not only exceeds the national averages reported in the latest Chilean National Health Survey but also reflects a global trend documented by the World Health Organization, which has warned of the sustained increase in overweight and obesity as a silent pandemic. This condition is closely associated with an increased risk of chronic non-communicable diseases, such as type 2 diabetes, high blood pressure, dyslipidemia, sleep apnea and cardiovascular diseases (Hruby & Hu, 2015).

From a physiological perspective, the results show significant differences by sex in all body variables evaluated (p<0.001). While men have higher levels of lean mass, total body water, and skeletal muscle mass (SMM: 36.36 kg in men vs. 24.58 kg in women), women exhibit higher values of total body fat (BFM) and body fat percentage (%PBF: 39.85 % in women vs. 24.16 % in men). These differences are partly due to hormonal and genetic determinants, as well as sex-differentiated cultural, behavioral, and physical activity patterns (Kyle *et al*., 2004; Wells & Fewtrell, 2006). This finding reinforces the need to supplement BMI with indicators such as the IMF or the fat/muscle index for a more accurate nutritional classification (He *et al*., 2023).

A key finding of the study is the inverse relationship between age and muscle mass. In men, the percentage of muscle mass (% MM) exhibits a significant negative correlation with age (r=-0.376, p=0.001). In contrast, in women, this relationship is also negative but of lesser magnitude (r=-0.217, p=0.001). This phenomenon reflects the physiological process of sarcopenia, defined as the progressive loss of muscle mass, strength and function associated with ageing (Cruz-Jentoft *et al*., 2019). This condition not only impacts on the functionality and autonomy of older people, but also

Table V. Sex-stratified percentiles.

Sex	Variable	P5	P10	P25	P50	P75	P90	P95
Male	PBF	13.8	15.2	17.2	22.4	30.35	35.4	38.79
	BMI	22.1	23.0	23.8	26.5	30.3	34.38	38.0
	FFM	51.91	54.0	59.1	63.7	68.6	72.16	75.1
	FFMI	17.13	17.81	20.02	23.63	27.27	30.55	32.61
	FMI	3.4	3.86	4.9	6.74	10.14	13.99	15.96
	SMI	7.7	7.9	8.2	8.6	9.0	9.5	10.0
	SMI	9.68	10.12	11.4	13.43	15.6	17.47	18.56
	Fat/Muscle Index	0.28	0.32	0.36	0.5	0.77	0.96	1.13
Female	PBF	27.2	29.9	34.8	39.6	45.7	50.0	51.4
	BMI	21.9	23.35	25.6	28.8	33.5	37.0	41.6
	FFM	35.72	37.4	40.42	43.9	47.98	52.8	54.8
	FFMI	11.54	12.31	13.92	16.23	18.85	21.57	23.1
	FMI	5.55	6.32	8.02	10.69	14.01	18.03	20.39
	SMI	5.8	6.1	6.6	7.1	7.6	8.1	8.5
	SMI	6.3	6.72	7.64	8.93	10.43	11.97	12.93
	Fat/Muscle Index	0.68	0.77	0.97	1.19	1.53	1.8	1.91

Abbreviations: PBF (Percent Body Fat), BMI (Body Mass Index), FFM (Fat-Free Mass), FFMI (Fat-Free Mass Index), FMI (Fat Mass Index), SMI (Skeletal Muscle Index), Fat-to-Muscle Ratio.

increases the risk of falls, fractures and premature mortality (Hamilton *et al*., 2024). Furthermore, analyses by decade reveal a clear trend toward increased body fat and reduced muscle mass with age. In women, PBF reaches its highest point in the eighth decade (47.6 %), while in men it increases progressively until the age of 80 (42.7 %). This evolution coincides with multiple studies that describe a progressive redistribution of body composition associated with ageing, characterized by sarcopenia and central adiposity, both conditions associated with an increase in morbidity and mortality (Zamboni *et al*., 2008; Cruz-Jentoft *et al*., 2019).

The positive correlation between age and PBF was stronger in men (r=0.36) than in women (r=0.20), a finding also observed in studies conducted on Chilean and Latin American adults (Lera *et al*., 2017). In contrast, muscle mass showed a negative correlation with age, which was more pronounced in men (r=-0.38), suggesting that the risk of sarcopenia may be higher in men, even when total body mass index (BMI) does not indicate weight loss. Composite indices, such as the SMI and the fat-to-muscle index, proved to be particularly sensitive in detecting this imbalance. In men, the fat-to-muscle index showed a moderate positive correlation with age (r=0.347), indicating that, despite maintaining a relatively stable BMI, the relative proportion of fat to muscle increases, a condition described as sarcopenic obesity (Zamboni *et al*., 2008). This condition has been associated with an increased risk of diabetes, frailty and poorer clinical outcomes in older adults (Yu *et al*., 2022).

Another noteworthy aspect of the study is the high prevalence of obesity due to PBF (more than 60 % of the total sample), particularly in women (69.2 %), which exceeds thenational figures reported in the National Health Survey (Ministerio de Salud, 2017). This may be related to specific environmental and social factors in the municipality of Quintero, including conditions of vulnerability and exposure to pollutants, factors that have also been associated with metabolic disorders (Husaini *et al*., 2022).

Finally, the percentile distribution of the different anthropometric indicators provides valuable input for the creation of local reference values, which is currently underdeveloped in Chile. As proposed in other contexts (Kelly *et al*., 2009), using percentiles by sex and age enables a more accurate classification of nutritional and functional status, which is beneficial in both clinical practice and public health

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Practical applications. The results show that BMI alone underestimates risk in a large part of the population, especially in women with obesity due to excess fat and in men with progressive loss of muscle mass. It is recommended that accessible methods, such as segmental bioimpedance, be incorporated into primary healthcare check-ups, which would enable the earlier detection of conditions like sarcopenic obesity, cardiometabolic risk, and functional malnutrition. Given that the study identified distinct patterns of fat gain and muscle loss between men and women, it is recommended that specific health promotion strategies be developed.

Characterization using percentiles by sex and age allows reference ranges to be established for the Chilean adult population. These values could serve as a basis for updating diagnostic cut-off points for nutritional status in national clinical contexts, thereby overcoming the limitations of BMI and adapting guidelines to the epidemiological reality in Chile.

The sustained decrease in muscle mass with age observed in the study warns of the increasing risk of frailty and dependence. It is crucial to implement community interventions aimed at preserving functionality in older adults, promoting structured physical activity and nutritional supplementation, especially in communities with environmentally vulnerable conditions such as Quintero. The fat/muscle index and the FFMI/FMI indices are proposed as sensitive and easy-to-apply indicators for monitoring nutritional and physical activity interventions. Their use can be incorporated into programs such as Elige Vivir Sano (Choose to Live Healthy) or Chile Crece Contigo (Chile Grows with You) to monitor the longitudinal impact on at-risk groups.

CONCLUSION

This study highlights marked sex-related disparities in body composition among Chilean adults residing in an area impacted by industrial exposure. Women were characterized by significantly elevated fat accumulation and unfavorable fat-to-muscle proportions, whereas men exhibited more robust markers of muscularity. Distinct age-related trajectories emerged, with men experiencing more pronounced declines in muscle metrics over time, while adiposity increased with age across both sexes. The widespread presence of obesity, in tandem with age-associated muscle loss, signals a growing risk of sarcopenic obesity within this at-risk population. These outcomes emphasize the necessity of incorporating nuanced body composition parameters, beyond traditional BMI, for a more precise evaluation of metabolic vulnerability in environmentally burdened communities. Tailored public health interventions should account for these sex- and age-specific patterns to effectively address evolving health risks.

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RESUMEN: El entendimiento de la composición corporal a través de indicadores antropométricos avanzados proporciona información crítica sobre el estado nutricional y el riesgo cardiometabólico, particularmente en poblaciones vulnerables. Métricas tradicionales como el índice de masa corporal (IMC) a menudo clasifican erróneamente el estado de salud al no diferenciar entre grasa y masa magra. Chile carece de estudios basados en la población que incorporen índices de composición corporal (Índice de Masa Grasa [FMI], Índice de Masa Libre de Grasa [FFMI], Índice de Masa Muscular Esquelética [SMI], Relación Grasa-Músculo), especialmente en áreas expuestas industrialmente como Quintero. Este estudio transversal evaluó a 2709 adultos (1906 mujeres, 803 hombres) residentes en Quintero utilizando análisis de impedancia bioeléctrica multifrecuencia (InBody®). Las variables incluyeron IMC, porcentaje de grasa corporal (PBF), masa libre de grasa (FFM), masa muscular esquelética (SMM) e índices derivados (FMI, FFMI, SMI, Relación grasa-músculo). Los datos se estratificaron por sexo/edad y se analizaron mediante pruebas t y correlaciones de Pearson. Los hombres mostraron mayores valores de FFM (63,8±7,3 kg), SMM (36,4±4,3 kg) y FFMI (24,0±4,9), mientras que las mujeres tuvieron significativamente mayor PBF (39,9±7,5 %) y FMI (11,5±4,8). La relación grasa-músculo fue 2,1 veces mayor en mujeres (1,25±0,38 *vs.* 0,59±0,31). Globalmente, el 46,5 % presentó obesidad basada en PBF (50,7 % mujeres). La edad se correlacionó positivamente con PBF (hombres: r=0,36; mujeres: r=0,20) y negativamente con %SMM (hombres: r=-0,38; mujeres: r=-0,22). La población de Quintero exhibe altas tasas de adiposidad con declive muscular relacionado a la edad, sugiriendo características de obesidad sarcopénica. Los índices avanzados proporcionaron una estratificación de riesgo más precisa que el IMC solo, subrayando su utilidad para la vigilancia en salud pública en comunidades ambientalmente vulnerables.

PALABRAS CLAVE: Adiposidad; Antropometría; Composición corporal; Estado nutricional; Masa corporal magra; Pliegue cutáneo.

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