ISSN: 2753-7919
British Journal of Healthcare and Medical Research; Vol. 13 No. 03 (2026) (128-141)
https://doi.org/10.14738/bjhr.1303.10819

Prevalence of Underweight, Normal Weight, Overweight and Obesity from 1999 to 2023 in Subjects Undergoing their First Endocrinological Examination in Liguria: A Retrospective Cross-Sectional Study

Massimo Giusti

1. Endocrine Unit, Priamar Clinical Diagnostic Centre, Savona, Italy and Department of Internal Medicine, University of Genoa, Genoa, Italy

Abstract: Background: The combined burden of underweight and obesity has increased in most countries. No studies of this phenomenon in Liguria have been published. Aim. We evaluated the prevalence of underweight, normal weight, overweight and obesity in adults undergoing their first endocrinological examination in the district of Savona (Italy). Methods: From 1999 to 2023, 7038 subjects (1429 males; 5619 females) were evaluated. Body mass index (BMI) and some covariates were recorded. Records were grouped into five 5-year periods, and the prevalence of weight groups in each period was evaluated. Results: The prevalence of normal weight was higher in females than in males, while that of overweight/obesity was higher in males than in females. The prevalence of underweight increased slightly (P=0.05) in females but not in males. Overall, no significant trends in the prevalence of normal weight, overweight and obesity emerged in either sex over the 5-year periods. When BMI was corrected for age, the prevalence of obesity displayed a significant decreasing trend in 18-44-year-old subjects of both sexes (P<0.001, P=0.03) and a significant increasing trend in those aged ≥65 years (P<0.0001, P=0.03). On multivariate analysis, BMI remained positively related with age in the 5-year periods. Conclusions: Our subjects undergoing their first endocrinological evaluation constituted a representative sample of the population of the Savona district. More females than males were of normal weight. Overweight and obesity affected a large part of the population. Overall, the prevalence of weight classes did not change significantly over the 25 years. The greatest change in BMI was age-dependent in both genders.

Keywords: BMI, weight groups, prevalence, trends, adult subjects, 25-year period, regional area.

INTRODUCTION

Italian legislation recently classified obesity as a complex, relapsing, chronic disease [1] requiring continuous integrated intervention, including lifestyle and dietary changes and drug therapy. This health alert stems from several surveys, which have shown that the burden of overweight and obesity is a worldwide problem [2, 3]. From 1990 to 2022, the prevalence of obesity in the USA more than doubled in both young [3, 4] and adult populations [3, 5], and statistical spatial-temporal regression suggests that the current trend in overweight and obesity may continue to increase up to 2050 in the USA [3, 6]. More recently, however, the expectation of a 3% reduction in the prevalence of obesity in the USA has arisen from an uptick in the use of glucagon-like receptor agonists [7], but this hope needs worldwide confirmation.

In a cross-sectional study aimed at evaluating long-term trends in obesity and overweight among individuals aged 5-85 years living in private households in England, it was observed that the probability of being obese increased faster between 1992 and 2001 and in the younger generation [8]. By contrast, in an old study conducted on a sample of 2932 adults interviewed by the Doxa (from Greek δόξα, opinion) Institute in 2004 in 20 Italian regions, and from self-reported data from a survey by the National Institute of Statistic (ISTAT; 1999 to 2003), the prevalence of obesity was seen to have remained around 8-9% over 20 years [9]. Subsequently, the same authors, in a study with the same design [10], analysed survey data on 14135 adults (≥18 years old) from 2006 to 2010; they did not find unfavourable trends in overweight and obesity, although a higher prevalence emerged among adults from Southern Italy and those with a lower educational level. Moreover, in the CUORE Project, which analysed survey data from 1998 to 2019 on individuals (cumulatively about 6200 males and females; 35-75 years old) randomly selected from the resident population in Italy, the overall trend of overweight and obesity appeared substantially stable [11]. More recently, in a study conducted by general practitioners in a primary setting involving more than 1 million of adults (≥18 years old) in Italy [12], the estimated prevalence of obesity rose from 10.2% to 11.2% in males and from 11.2% to 11.8% in females from 2013 to 2022; this slight but significant increasing trend was not observed in overweight subjects. The inclusion of Ligurian subjects in the cohorts involved in Italian studies of the prevalence of overweight and obesity [9, 10, 12, 13] has not generally been reported. Indeed, only the study by Defrancesco et al. [11] reported the involvement of the Ligurian population, and in that study regional data were analysed cumulatively with data from other northern Italian regions. In two studies, northern Italian regions displayed a better weight-class distribution than southern regions [10, 11]. Several reports released by the Italian National Institute of Health (ISS) are available online. According to the 2023-2024 PASSI (Progressi delle Aziende Sanitarie per la Salute in Italia) survey, which collected data from a sample of adults aged 18-69 years by means of telephone interviews (about 35000 in each period), the prevalence of overweight was lower in Liguria (29.8%) than in the cumulative Italian sample (32.6%), with obesity displaying less difference (Liguria 9.5%; Italy 10.4%) [14]. Nevertheless, these figures were higher than those reported in the 2011-2014 survey (overweight 27.7%; obesity 8.0%) in Liguria [14]. However, data from the 2023 Report of the Osservatorio Nazionale Sulla Salute nelle Regioni Italiane [15] indicated an increase in overweight (31.5-35.7%) and obesity (6.9-11.1%) in Ligurian adults in the period 2007-2022; these values do not match the stable linear trend in overweight and the increasing trend in obesity observed in the general Italian population.

The aim of the present study was to evaluate the prevalence of underweight, normal weight, overweight and obesity in adults (>18 years) undergoing their first endocrinological examination from 1999 to 2023 in the district of Savona, which is located in the west of the Ligurian Riviera (Italy). To do so, we analysed cross-sectional information collected in an out-patient setting, in which age, gender, weight, height and some other variables were well controlled. In this way, the errors associated with telephone surveys, self-reported data and differences in ethnicity were avoided. We hypothesized that individuals examined in this 25-year period constituted a large sample (about 2%) of the population living in the Savona district during this period [16].

MATERIALS AND METHODS

Overview

In this cross-sectional, retrospective, single-centre study, we estimated the prevalence of underweight, normal weight, overweight and obesity in adults (≥ 18 years), subdivided by sex, from 1999 to 2023 in the district of Savona (Liguria, Italy) and nearby districts. Cross-sectional data were extracted anonymously from the medical files of the Endocrine Unit of the Priamar Centre, a secondary private clinical-diagnostic medical facility located in Savona. Only data concerning the first examination were collected and analysed.

Outcome Variables

Recorded weight in kilograms (kg) and height in meters (m) were used to calculate the body mass index (BMI; kg/m^2). We categorized BMI into one of the following categories: normal weight (BMI 18.5-24.9 kg/m^2), overweight (BMI 25.0-29.9 kg/m^2) and obesity (BMI ≥ 30 kg/m^2) for males and females separately. A separate analysis was made in subjects classified as being underweight (BMI <18.5 kg/m^2). Using weight status, we grouped single survey years into 5-year periods (from 1999-2003 to 2019-2023), as is frequently done in age-period cohort models [8, 17]. Covariates were: age (as a continuous variable), reason for the first endocrinological examination (metabolic/weight vs other reasons), subjective nutritional approach (diet "no" vs diet "yes"), smoking habits (no smoking vs previous or current smoking) and thyroid function (normal vs abnormal).

Data Source

Weight and height were measured during the first in-person endocrinological examination. Clothes, socks and stockings were not removed. Self-reported measurements of weight and height were discarded. Although BMI has its limitations as a measure of adiposity [3, 18], it is strongly associated with numerous health outcomes. It is also the most commonly used metric for population assessment and provides the most extensive data. The first endocrinological examination was requested mainly for thyroid, metabolic and pituitary-gonadal or adrenal health problems, or during endocrinological screening. All records collected from 1999 to 2023 were individually reviewed in order to ensure that the subjects met our inclusion criteria. In this period of time, medical records on 6923 females and 1894 males were anonymously evaluated. Exclusion criteria were: incomplete records, age <18 years, pregnancy, non-Caucasian ethnicity, and "other reasons" (impossibility or refusal of physical examination, transgender, only video consultation). The final study sample comprised 1429 records on males and 5619 records on females (Figures 1a, 1b). In each 5-year period, evaluable records ranged between 526 (1999-2003) and 1313 (2009-2013) in females and between 166 (1999-2003) and 388 (2019-2023) in males.

Statistical Analysis

For each 5-year period, the prevalence of each class of BMI was calculated by dividing the number of cases by the total population, and then multiplying by 100. Prevalence was compared by means of Chi-square test for trend across 5-year periods. To compare

continuous data, the Kruskal-Wallis non-parametric analysis of variance (ANOVA), followed by post-ANOVA Dunn's multiple comparison test, was used. To compare BMI with age and binary covariates, the univariate Spearman test was used, followed by a multiple linear regression (least squares). Examinations were subdivided into non-weight/metabolic-related (n=0) and weight/metabolic-related (n=1) reasons. The subjective approach to diet (none=0, present=1) was also evaluated. Thyroid function (normal=0, abnormal=1) was evaluated, abnormality being assigned if TSH was outside our current reference intervals [19] and/or thyroid drugs were ongoing (levo-thyroxine, methimazole). Metabolic conditions (e.g. prediabetes/diabetes, hypercholesterolaemia, hypertriglyceridaemia, gout) were cumulatively evaluated (absent=0, present=1) according to the following criteria: anti-diabetic drugs or glycaemia ($\geq$100 mg/dl) and/or glycosylated haemoglobin ($\geq$5.7%); anti-dyslipidaemia drugs or total cholesterol ($\geq$200 mg/dl) and/or LDL cholesterol ($\geq$130 mg/dl); fibrate drugs or triglycerides ($\geq$150 mg/dl). Smoking habits (0=non-smoker; 1=former or current smoker) were recorded. Significance was set at $P \leq 0.05$. Statistical analysis was performed by means of GraphPad 10 software (GraphPad, San Diego, CA, USA). Data are reported as mean ± standard deviation (SD), median, and confidence interval (Cl) of median percentiles, when appropriate.

Ethical Approval

Owing to the retrospective nature of data collection, no further formal approval from the Liguria Ethics Committee was required. A waiver of informed consent was granted because the research involved no risk to patients. Before their examination at the Priamar Clinical Diagnostic Centre, all patients had provided written informed consent to the management of data collected from their medical files and had agreed to their use for scientific purposes. Data were managed anonymously. Data collection and subsequent analysis were performed in compliance with the Helsinki Declaration.

RESULTS

Some clinical data recorded in males and females involved in the 25-year survey are reported in tables 1a and 1b. The mean age of subjects at their first endocrinological examination significantly increased in each 5-year period in both males (<0.0001) and females (<0.0001). This phenomenon is in accordance with a significant decreasing trend in the number of males (P<0.0001) and females (P<0.0001) aged 18-44 years, together with a significant increasing trend in the number of males (P<0.0001) and females (P<0.0001) aged $\geq$65 years requesting their first endocrinological examination (Tables 1a, 1b). The main reason for endocrinological examination was thyroid screening, in accordance with the prevalence of thyroid disease managed in a tertiary setting. Fewer examinations were requested for metabolic reasons (prediabetes and overt diabetes, under-nutrition or over-nutrition, dyslipidaemia, hyperuricemia) or for other internal medicine reasons. There were no significant changes in the reasons (metabolic *vs* non-metabolic; thyroidal *vs* non-thyroidal) for endocrinological examinations in the 25-year period in either sex (Table 1a, 1b). The prevalence of females on a self-reported controlled diet increased (P=0.002) from 12.5% in 1999-2003 to 18.3% in 2019-2023; this improvement was not seen in males (Tables 1a, 1b). The percentage of non-smokers increased significantly over time among both

females (P=0.0002) and males (P=0.02), with a corresponding decrease in smoking (current or former) (Table 1a, 1b).

The general prevalence values of underweight, normal weight, overweight and obesity among males and females in the 5-year period from 1999 to 2023 are reported in Tables 2a and 2b, respectively. The prevalence of underweight was higher in females (range of 5-year median values: 2.3% - 4.4%) than in males (0.0% - 2.3%). The prevalence of normal weight was higher in females (46.3% - 58.2%) than in males (30.4% - 37.9%), while that of overweight/obesity was higher in males (61.8% - 66.2%) than in females (40.4% - 51.9%) (Tables 2a, 2b). From 1999 to 2013, there was a slightly (P=0.05) increasing trend of underweight in the whole group of females, but not in males (Table 1b). Overall, no significant trends in the prevalence of normal weight, overweight and obesity were discerned in either males or females over the 5-year periods (Table 2a, 2b).

When BMI was corrected for age, no significant trend in the prevalence of underweight and normal-weight emerged in male subjects. In overweight subjects, a slight non-significant (P=0.06) decrease was noted in the 18-44-year age-group, while a slightly significant (P=005) increase was observed in the $\geq$ 65-year group. A similar, but more evident, phenomenon was observed in the obesity group, with a decrease (P<0.0001) in the 18-44-year age-group and an increase (P=0.002) among subjects aged $\geq$ 65 years (Table 2a).

Regarding females, when BMI was corrected for age, no significant trends in prevalence were observed in underweight subjects, while in all other groups there was a significant decreasing trend in 18-44-year-old subjects (normal weight group P<0.0001, overweight group P=0.03, obesity group P=0.03) and a significant increasing trend in $\geq$65-year-old subjects (normal weight group P=0.001, overweight group P=0.03, obesity group P=0.03). In 45-64-year-old subjects, no significant changes in the prevalence of normal weight, overweight and obesity were observed over the 25-year period (Table 2b). Table 3 reports the correlation between BMI and several other variables. Except for males in the period 1999-2003, BMI was always positively related to age in both males and females. BMI remained related to age in the multivariate linear correlation in the majority of periods (males: 2009-2013 P=0.003, 2014-2018 and 2019-2023 P=0.01; females: from 2004-2008 to 2019-2023 P<0.0001). In the majority of the 5-year periods, a significant correlation between BMI and metabolic reasons for the first endocrinological examination was seen in both sexes (Table 3). This correlation was confirmed on multivariate analysis in males in the period 1999-2003 (P=0.002) and in females from 2004-2008 to 2019-2023 (P<0.0001). On multivariate analysis, a significant correlation between BMI and nutritional approach was confirmed in males in two 5-year periods (2004-2008 P=0.0002; 2014-2019 P=0.006) and in females in three 5-year periods (2009-2013 P=0.01, 2014-2018 and 2019-2023 P<0.0001). A relation between BMI and smoking was confirmed on multivariate analysis in males in the periods 2009-2013 (P=0.03) and 2014-2018 (P=0.04) and in females in 2009-2013 (P=0.05). A correlation between BMI and thyroid abnormalities was found only in females in the period 2019-2023 (P=0.01) on univariate, but not on multivariate, analysis (Table 3).

DISCUSSION

Recent studies have predicted a worldwide increase in the prevalence of overweight and obesity from 2022 to 2050 in all age-groups [2, 3], with a forecasted scenario in which

approximately 1 in 3 adults over the age of 25 years is expected to experience obesity [3]; about a quarter of these will be over the age of 65 years [3]. This increase is predominantly expected in the USA, Asia and sub-Saharan Africa [2, 3, 4, 5, 6].

In high-income countries, the rise in obesity is coupled with an ageing population and a low fertility rate [3, 20]. Liguria is the Italian region with the highest median population age (almost 50 years) - about 3 years higher than the general Italian population (ISTAT). In our 25-year cross-sectional study, we observed an increasing trend in age among individuals requiring endocrinological examination. While we did not investigate the income of people requiring examinations, it can be hypothesized that this remained unchanged or increased over time. Moreover, we observed a higher prevalence of overweight and obesity in males than in females over the 25 years of study, but not a general increase in overweight and obesity in either males or females. This trend is also reported by other researchers in Italy [9-11, 13]. Indeed, only the recent analysis of data collected by general practitioners reported a slight but significant increasing trend in obesity from 2013 to 2022 [12]. The difference between these results could be due to differences in the study models implemented (data from medical records collected in the same centre vs data from several general practitioners; regional population *vs* nationwide population; specified *vs* unspecified reasons for medical examination). In the latest worldwide study [3], which analysed both self-reported and measured BMI, the prevalence of overweight and obesity in Italy increased in males from 46% (CI 46-48%) in 1990 to 60% (CI 57-64%) in 2022, with a forecast of 71% (CI 67-75%) in 2050. In the same period, overweight and obesity in females rose from 34% (CI 32-37%) to 46% (CI 43-49%), with a forecast of 58% (CI 52-63%) [3].

Interestingly, our data documented a slight increasing trend in underweight in females (1999-2003 CI 1.6-5.1% vs 2019-2023 CI 3.3-5.4%), which was probably due to greater attention to eating disorders [21].

In our population, normal weight was more frequently observed in females than in males, without a significant trend among the 5-year intervals. The prevalence and trend of normal weight have not been reported in most studies, as the outcomes were overweight and obesity. However, a higher prevalence of normal weight in Italian females than males has been reported in some studies [10, 11]. In another study [8] the prevalence of normal weight (without distinction between the sexes) decreased slightly from 74% to 69% from 1992 to 2016. The importance of ethnicity in weight distribution [3, 22] has been confirmed by a study conducted on a small population recruited from electoral registers in a Mediterranean country (Libya), in which normal weight was recorded in 19% of females and 34% of males [23].

In our cross-sectional study, as in others conducted in Italy [9, 10, 13] and worldwide [3, 6, 8], the main determinant of increased BMI was age, both in males and in females. In 188 countries, the age-standardized prevalence of obesity in adults increased from 1990 to 2022 in both women and men, and in some countries the increase in obesity/overweight was seen to be coupled with a decrease in underweight [2]. In our “scenario”, however, this was not the case, probably on account of the Mediterranean diet and the consumption of healthier foods.

We observed a significant correlation between BMI and age in all 5-year periods on both univariate and multivariate analyses. After correction for age, only the prevalence of underweight did not show significant trends. Regarding the prevalence of normal weight,

significant changes in some variables were recorded in females but not in males. In general, our data on Caucasian individuals living in Liguria and requiring endocrinological examination documented an unsafe increase in BMI only in aged ≥65 males and females. By contrast, in young adults (18-44 years old) overweight/obesity remained stable or decreased over time. This latter phenomenon could be due to a bias in subject selection. However, it may also indicate an increasing awareness of a healthier lifestyle (diet and/or physical activity) among young adults, as constantly recommended by physicians/dieticians and the media. The hypothesised impact of new drugs on changes in the prevalence of overweight and obesity [7] is not relevant in our study, as the use of these drugs has increased only in the last 2-3 years in our region, unlike in the USA [24]. The age-related increase in BMI might be due to biological and life-dependent causes [25]. In our study, unlike other Italian studies [9, 10, 13-15], education, social status and family origin were not considered.

It is well known that thyroid abnormalities [26] and smoking can influence weight [27]. In a previous study, in which we evaluated TSH reference intervals in a Ligurian population by collecting cross-sectional data from 2014-2023, we did not find a correlation between TSH and BMI or smoking status in either males or females [19]. Although thyroid evaluation was a common reason for endocrinological examination, the correlation with BMI was weak or absent, probably because few of the patients involved had overt thyroid dysfunction. A correlation between smoking status and BMI, however, was more frequently noted. This is not surprising, as former smokers, who constituted a substantial portion of our study group, frequently gain weight after giving up smoking [27]. Indeed, another Italian study reported that obesity was more frequent among adult male and female ex-smokers [10], and a study conducted in Israel found that the rate of smoking was low in normal-weight young subjects, but considerably higher in obese subjects [28]. While age, thyroid function and lifestyle can influence BMI, an unexplained weight gain in subjects on a (self-reported) diet frequently prompts the request for endocrinological examination. It is therefore not surprising that we observed a correlation between BMI and metabolic reasons for endocrinological examination (mainly dyslipidaemia) and self-reported diet. To our knowledge, these aspects have not been previously investigated in Italian surveys on the prevalence of overweight and obesity.

The present study has several limitations: a) our definition of weight class was based on BMI, which is easy to calculate but less indicative of adiposity in comparison with waist measurements and instrumental techniques; nevertheless, these methods do not greatly improve the evaluation of overweight/obesity [29]; b) this was a single-centre cross-sectional study, as no other private or public centres in the district of Savona were available for data collection; c) some variables were not considered (income, family status, education) or were incomplete (smoking); d) relatively few subjects were involved; however, given the population of the district [16], it was thought that the individuals involved in the 25-year study represented about 2% of the general population; e) data collected during the first endocrinological examination might not be representative of the general population of our district.

In conclusion, the data from our study depict the distribution of weight classes over a 25-year period in the Savona district. Indeed, our subjects, who were undergoing their first endocrinological evaluation, constituted a representative sample of the local population. The study utilised standardized in-office measurements of height and weight, thus avoiding the limitation of self-reported information, whereby height may be

overestimated and weight underestimated [3, 10, 13, 14]. A large part of the population proved to be overweight or obese, with more females than males being of normal weight. The overall prevalence of weight classes did not change significantly over the 25 years, and the greatest change in BMI was age-dependent in both genders. This study indicates a relatively favourable trend in our district in terms of the prevalence of overweight and obesity, which contrasts with the worrying scenario recently reported in the USA between 1990 and 2021 with a rising trend up to 2050 [3]. In the Savona district, however, there is still a need for obesity prevention, as promoted by recent Italian legislation [1]. Although new-generation anti-obesity medications appear promising [7], the prevention and management of overweight and obesity are important, especially in children and adolescents [30], in whom they are increasing worldwide and threatening to result in widespread obesity in adulthood [2, 4].

(*) This study was presented at the Joint Congress of ESPE and ESE 2025, Copenhagen, Denmark, 10-13 May 2025.

Acknowledgements

We thank Bernard Patrick for revising the language of the paper.

REFERENCES

1. Legge 3 ottobre 2025, n 149. Disposizioni per la prevenzione e la cura dell'obesità. Gazzetta Ufficiale della Repubblica Italiana Serie Generale n. 235, Accessed 9 October 2025, pp 1-2.
2. NCD Risk Factor Collaboration (NCD-RisC) (2024) Worldwide trends in underweight and obesity from 1990 to 2022: a pooled analysis of 3663 population-representative studies with 222 million children, adolescents, and adults. Lancet, 403:1027–1050. https://doi.org/10.1016/S0140-6736(23)02750-2
3. GBD 2021 Adult BMI Collaborators (2025). Global, regional, and national prevalence of adult overweight and obesity, 1990-2021, with forecasts to 2050: a forecasting study for the Global Burden of Disease Study 2021. Lancet 405:813-838. doi:10.1016/S0140-6736(25)00355-1
4. Hu K, Staiano A E (2022) Trends in obesity prevalence among children and adolescents aged 2 to 19 years in the US from 2011 to 2020. JAMA pediatr 176:1037–1039. https://doi.org/10.1001/jamapediatrics.2022.2052
5. Emmerich SD, Fryar CD, Stierman B, Ogden CL (2024) Obesity and severe obesity prevalence in adults: United States, August 2021-August 2023. NCHS Data Brief 508:10.15620/cdc/159281. https://doi:10.15620/cdc/159281
6. GBD 2021 US Obesity Forecasting Collaborators (2024) National-level and state-level prevalence of overweight and obesity among children, adolescents, and adults in the USA, 1990-2021, and forecasts up to 2050. Lancet 404:2278-2298. https://doi:10.1016/S0140-6736(24)01548-4
7. Schweitzer K (2026) What to know about the WHO's new GLP-1 drug guideline. JAMA. Published online January 9, E1-E3. https://doi:10.1001/jama.2025.25208
8. Opazo Breton M, Gray LA (2023) An age-period-cohort approach to studying long-term trends in obesity and overweight in England (1992-2019). Obesity (Silver Spring) 31:823–831. https://doi.org/10.1002/oby.23657

9. Gallus S, Colombo P, Scarpino V, Zuccaro, P, Negri, E, Apolone G, et al C (2006) Overweight and obesity in Italian adults 2004, and an overview of trends since 1983. Eur J Clin Nutr 60:1174-1179. https://doi:10.1038/sj.ejcn.1602433
10. Gallus S, Odone A, Lugo A., Bosetti C, Colombo P, Zuccaro P, et al (2013) Overweight and obesity prevalence and determinants in Italy: an update to 2010. Eur J Nutr 52:677–685. https://doi.org/10.1007/s00394-012-0372-y
11. Donfrancesco C, Profumo E, Lo Noce C, Minutoli D, Di Lonardo A, Buttari B, et al (2022) Trends of overweight, obesity and anthropometric measurements among the adult population in Italy: The CUORE Project health examination surveys 1998, 2008, and 2018. PLoS One 17:e0264778. https://doi:10.1371/journal.pone.0264778
12. Lapi F, Marconi E, Medea G, Grattagliano I, Rossi A, Cricelli C (2025) Epidemiology and yearly trend of obesity and overweight in primary care in Italy. Intern Emerg Med 20:625–628. https://doi.org/10.1007/s11739-025-03870-1
13. Micciolo R, Di Francesco V, Fantin F, Canal L, Harris TB, Bosello O, et al (2010) Prevalence of overweight and obesity in Italy (2001-2008): is there a rising obesity epidemic? Ann Epidemiol 20:258–264. https://doi.org/10.1016/j.annepidem.2010.01.006
14. ISS Sorvglianza PASSI. EpiCentro-L'epidemiologo per la sanità pubblica https://www.epicentro.iss.it/en/
15. Osservatorio Nazionale sulla Salute nelle Regioni Italiane 2023 Rapporto Osservasalute 2023 - Trend Regionali. https://osservatoriosullasalute.it/
16. Tuttitalia.it (2024) Popolazione della provincia di Savona 2001-2024: grafici statistici su dati ISTAT. https://www.tuttitalia.it/liguria/provincia-di-savona/statistiche/popolazione-andamento-demografico/
17. Reither EN, Masters RK, Yang YC, Powers DA, Zheng H, Land KC (2015) Should age-period-cohort studies return to the methodologies of the 1970s? Soc Sci Med 128:356-365. https://doi:10.1016/j.socscimed.2015.01.011
18. Adab P, Pallan M, Whincup PH (2018) Is BMI the best measure of obesity? BMJ 360:k1274. https://doi:10.1136/bmj.k1274
19. Giusti M, Sidoti M (2025) Evaluation of subclinical thyroidal dysfunction with gender- and age-specific serum TSH reference intervals derived from a 2014-2023 Ligurian population. British Journal of Healthcare and Medical Research *12;* 226–241. https://doi.org/10.14738/bjhr.1204.19217
20. Okunogbe A, Nugent R, Spencer G, Powis J, Ralston J, Wilding J (2022) Economic impacts of overweight and obesity: current and future estimates for 161 countries. BMJ Glob Health. 7:e009773. https://doi:10.1136/bmjgh-2022-009773
21. Garrido-Miguel M, Martínez-Vizcaíno V, Oliveira A, Martínez-Andrés M, Sequí-Domínguez I, Hernández-Castillejo LE, et al (2021) Prevalence and trends of underweight in European children and adolescents: a systematic review and meta-analysis. Eur J Nutr 60:3611–3624. https://doi.org/10.1007/s00394-021-02540-0
22. Lo JC, Parikh RV, Tan TC, Alexeeff SE, Ambrosy AP, Howick CK, et al (2025) Differential obesity trends in Asian and native Hawaiian or other Pacific islander US Adults. JAMA 334:912–915. https://doi.org/10.1001/jama.2025.9901
23. Lemamsha H, Randhawa G, Papadopoulos C (2019) Prevalence of overweight and obesity among Libyan men and women. Biomed Res Int 2019:8531360. https://doi:10.1155/2019/8531360

24. Berning P, Adhikari R, Schroer AE, Jelwan YA, Razavi AC, Blaha MJ, et al (2025) Longitudinal analysis of obesity drug use and public awareness. JAMA Netw Open 8:e2457232. https://doi:10.1001/jamanetworkopen.2024.5723

25. Kanter R, Caballero B (2012) Global gender disparities in obesity: a review. Adv Nutr 3:491–498. https://doi.org/10.3945/an.112.002063

26. Jonklaas J (2025) The complexity of the relationship between thyroid disease and body weight. Nat Rev Endocrinol. Published online October 14, 2025. https://doi:10.1038/s41574-025-01190-0

27. Golden A, Davis JM (2025) Smoking, obesity, and post-cessation weight gain: neurobiological intersection and treatment recommendations. J Multidiscip Healthc 18:2889-2900. https://doi:10.2147/JMDH.S509971

28. Zimlichman E, Kochba I, Mimouni FB, Shochat T, Grotto I, Kreiss Y, et al. (2005). Smoking habits and obesity in young adults. Addiction100:1021-1025. http://doi:10.1111/j.1360-0443.2005.01103.x

29. Aragaki AK, Manson JE, LeBlanc ES, Chlebowski RT, Tinker LF, Allison MA, et al (2025) Development and validation of body mass index-specific waist circumference thresholds in postmenopausal women: A prospective cohort study. Ann Intern Med 17: 1073–1084. https://doi.org/10.7326/ANNALS-24-00713

30. Hampl SE, Hassink SG, Skinner AC, Armstrong SC, Barlow SE, Bolling CF, et al (2023) Clinical practice guideline for the evaluation and treatment of children and adolescents with obesity. Pediatrics 151:e2022060640. https://doi.org/10.1542/peds.2022-060640

Declarations

- Ethical approval and consent to participate: All procedures were carried out in accordance with the ethical standards of the institution and with the 1975 Helsinki Declaration, as revised in 2008. Informed consent was obtained from all participants.
- Availability of data and materials: The datasets used and/or analysed in the present study are available from the corresponding author on reasonable request.
- Author Disclosure Statement: No competing financial interests exist.
- Funding information: No funding was received.
- Author Contribution: M.G. carried out this research, was responsible for data collection, wrote the manuscript, and reviewed and approved the final version of the manuscript.

Table 1a: Some clinical data on males. Significance: a) by Kruskal-Wallis test, followed by Dunn's multiple comparison tests: 1999-2003 vs 2009-2013 p=0.16; 1999-2003 vs 2019-2013 p<0.0001; 2004-2008 vs 2019-2023 p=0.03; 2009-2013 vs 2019-2023 p=0.03; 2014-2018 vs 2019-2023 p=0.003; b) by Chi-square test for trend; c) Smoking habits were evaluable in only 799 medical files.

		5-year interval					P values
		1999-2003	2004-2008	2009-2013	2014-2018	2019-2023	
		(n = 166)	(n = 228)	(n = 323)	(n = 324)	(n = 388)	
Age (years)	mean ± SD	47.5 ± 15.6	52.1 ± 15.9	52.4 ± 15.9	51.7 ± 16.1	56.1 ± 16.3	<0.0001 (a)
	18-44	73 (43.98%)	74 (32.45%)	96 (29.72%)	99 (30.55%)	89 (22.93%)	<0.0001 (b)
Age-class (years)	45-64	69 (41.56%)	94 (41.23%)	145 (44.89%)	149 (45.98%)	163 (42.01%)	0.65 (b)
	>65	24 (14.46%)	60 (26.32%)	79 (24.45%)	76 (23.45%)	136 (35.04%)	<0.0001 (b)
	metabolic	22 (13.25%)	38 (16.66%)	34 (10.53%)	33 (10.19%)	61 (15.72%)	
Reason for examination							0.91 (b)
	non-metabolic	144 (86.75%)	190 (83.34%)	289 (89.47%)	291 (89.81%)	327 (84.28%)	
	diet free	142 (85.54%)	196 (85.96%)	282 (87.30%)	291 (89.81%)	317 (81.70%)	
Self-reported food-intake							0.28(b)
	diet controlled	24 (14.46%)	32 (14.03%)	41 (12.69%)	33 (10.19%	71 (18.30%)	
	non-smokers	20 (26.67)%)	49 (36.29%)	103 (38.01%)	100 (45.45%	122 (41.22%)	
Smoking habit (c)							0.02 (b)
	smokers	55 (73.33%)	86 (63.70%)	168 (61.995)	120 (54.55%)	174 (58.78%)	
	normal	98 (59.04%)	134 (58.77%)	192 (59.44%)	204 (62.96%)	243 (62.63%)	
Thyroid (screening, diseases)							0.19 (b)
	abnormal	68 (40.96%)	94 (41.23%)	131 (40.56%)	120 (37.04%)	145(37.37%)	

Table 1b: Some clinical data on females. Significance: a) by Kruskal-Wallis test, followed by Dunn's multiple comparison tests: 1999-2003 vs 2014-2018 p=0.003; 1999-2003 vs 2019-2013 p<0.0001; 2004-2008 vs 2014-2018 p<0.0001; 2009-2013 vs 2019-2023 p<0.0001; 2014-2018 vs 2019-2023 p=0.02; b) by Chi-square test for trend; c) Smoking habits were evaluable in only 3314 medical files.

		5-year intervals					P values
		1999-2003	2004-2008	2009-2013	2014-2018	2019-2023	
		(n = 526)	(n = 1288)	(n = 1313)	(n = 1224)	(n = 1268)	
Age (years)	mean ± SD	46.7±15.1	48.5±15.3	49.1±16.5	49.9±16.9	51.9±16.8	<0.0001 (a)
	18-44	244 (46.4%)	555 (43.1%)	542 (41.3%)	469 (38.3%)	407 (32.1%)	<0.0001 (b)
Age-class (years)	45-64	207 (39.4%)	511 (39.7%)	511 (38.9%)	490 (40.0%)	545 (43.0%)	0.08 (b)
	>65	75 (14.2%)	222 (17.2%)	260 (19.8%)	265 (21.7%)	316 (24.9%)	<0.0001 (b)
	metabolic	47 (8.9%)	181 (14.0%)	138 (10.5%)	121 (9.9%)	126 (9.9%)	
Reason for examination							0.06 (b)
	non-metabolic	479 (91.1%)	1107 (86%)	1175 (89.5%)	1103 (90.1%)	1142 (90.1%)	
	diet free	460 (87.5%)	1107 (85.9%)	1151 (87.7%)	1070 (87.4%)	1035 (81.7%)	
Self-reported food-intake							0.002 (b)
	diet controlled	66 (12.5%)	181 (14.1%)	162 (12.3%)	154 (12.6%)	233 (18.3%)	
	non- smokers	69 (46.6%)	273 (54.3%)	607 (61.7%)	438 (57.9%)	586 (63.4%)	
Smoking habit (c)							0.0002 (b)
	smokers	79 (53.4%)	230 (45.7%)	376 (38.3%)	318 (42.1%)	338 (36.5%)	
	no	152 (28.9%)	460 (35.7%)	437 (33.3%	354 (28.9%)	369 (29.1%)	
Thyroid (screening, diseases)							0.08 (b)
	yes	374 (71.1%)	828 (64.35)	876 (66.7%)	870 (71.1%)	899 (70.9%)	

Table 2a: Median prevalence of underweight, normal weight, overweight and obesity in males from 1999-2003 to 2019-2023. Age-adjusted prevalence in the four weight groups of males: 18-44, 45-64 and ≥65-year intervals. Data are reported in percentages; in brackets, 95% CI. Exact P value was determined by Chi-square test for trend.

		5-year intervals					P values
		1999-2003	2004-2008	2009-2013	2014-2018	2019-2023	
	underweight	0.0 (0.0-4.5)	2.3 (0.0-4.0)	1.7 (0.0-3.38)	0.0 (0.0-3.5)	1.3 (0.0-1.4)	0.40
	normal weight	30.4 (18.2-36.8)	33.9 (23.3-37.5)	36.1 (23.7-38.5)	37.9 (27.5-40.0)	35.4 (30.3-38.2)	0.34
Weight groups							
	overweight	42.0 (39.4-52.2)	40.9 (10.0-53.4)	40.0 (38.5-47.6)	46.2 (32.8-51.3)	39.2 (38.2-42.3)	0.55
	obesity	23.7 (17.4-31.8)	20.9 (15.0-36.0)	23.3 (13.9-25.4)	20.0 (12.9-25.9)	23.6 (16.9-27.4)	0.91
	18-44 years	0.0 (0.0-4.5)	1.8 (0.0-2.5)	1.7 (0.0-3.1)	0.0 (0.0-1.7)	0.0 (0.0-1.4)	0.21
Underweight group	45-64 years	1.0 (0.0-0.0)	0.0 (0.0-4.0)	0.0 (0.0-1.7)	0.0 (0.0-0.0)	0.0 (0.0-0.0)	0.35
	≥65 years	0.0 (0.0-0.0)	0.0 (0.0-0.0)	0.0 (0.0-0.0)	0.0 (0.0-1.7)	0.0 (0.0-1.7)	0.24
	18-44 years	14.2 (0.0-26.3)	8.9 (5.0-17.2)	15.4 (5.1-22.9)	15.5 (7.5-15.7)	10.9 (10.5-13.7)	0.20
Normal-weight group	45-64 years	10.5 (9.1-18.0)	10.0 (2.3-16.1)	9.8 (6.4-18.5)	14.3 (12.5-19.2)	14.6 (6.9-18.6)	0.26
	≥65 years	4.0 (0.0-9.1)	7.8 (7.1-9.3)	3.3 (1.5-16.7)	6.3 (3.4-9.4)	9.2 (6.2-12.7)	0.09
	18-44 years	15.8 (8.9-22.7)	9.1 (2.0-26.1)	8.5 (4.6-10.3l	11.5 (6.9-16.2)	9.2 (5.3-11.3)	0.06
Overweight group	45-64 years	15.8 (13.6-34.8)	31.6 (8.0-47.8)	23.1 (14.1-27.1)	20.3 (17.2-28.6)	16.8 (15.5-19.7)	0.55
	≥65 years	6.1 (5.3-9.1)	13.6 (4.0-39.4)	13.1 (5.0-16.9)	7.8 (5.2-17.6)	15.1 (11.3-16.8)	0.05
	18-44 years	12.0 (4.3-18.2)	8.0 (2.3-15.0)	4.9 (3.1-6.8)	3.13 (1.3-6.7)	1.8 (1.4-4.0)	<0.0001
Obesity group	45-64 years	9.1 (4.0-15.8)	10.9 (0.0-16.0)	11.5 (6.2-16.4)	8.57 (5.8-11.3)	10.5 (7.0-14.5)	0.74
	≥65 years	4.4 (0.0-6.1)	6.0 (0.0-12.0)	5.1 (3.3-6.67)	5.0 (0.0-12.1)	9.6 (5.6-12.4)	0.002

Table 2b: Median prevalence of underweight, normal weight, overweight and obesity in females from 1999-2003 to 2019-2023. Age-adjusted prevalence in the four weight groups of females: 18-44, 45-64 and ≥65-year intervals. Data are reported as percentages; in brackets, 95% CI. Exact P value was determined by Chi-square test for trend.

		5-year intervals					P values
		1999-2003	2004-2008	2009-2013	2014-2018	2019-2023	
	underweight	4.1 (1.6-5.1)	2.3 (1.3-3.8)	4.2 (3.9-4.8)	3.6 (2.0-5.8)	4.4 (3.3-5.4)	0.05
	normal weight	58.2 (46.7-60.6)	46.3 (43.0-48.8)	49.0 (45.2-50.5)	47.3 (45.2-49.3)	49.6 (41.9-53.1)	0.66
Weight groups							
	overweight	26.1 (22.2-28.6)	26.6 (20.3-26.9)	28.5 (25.3-32.2)	28.0 (20.8-30.9)	24.2 (18.8-35.0)	0.84
	obesity	14.3 (11.1-22.1)	25.3 (22.9-28.0)	15.8 (12.4-26.2)	22.4 (12.1-27.3)	20.8 (14.6-25.7)	0.96
	18-44 years	2.0 (0.0-4.3)	1.8 (0.7-3.4)	3.1 (2.6-3.5)	2.8 (1.6-5.4	2.8 (1.8-4.4)	0.08
Underweight group	45-64 years	1.0 (0.0-2.0)	0.5 (0.4-0.7)	0.7 (0.3-1.9)	0.4 (0.0-0.6)	0.7 (0.0-1.1)	0.54
	≥65 years	0.0 (0.0-1.0)	0.0 (0.0-0.0)	0.3 (0.0-0.9)	0.0 (0.0-0.8)	0.81 (0.3-1.1)	0.07
	18-44 years	28.6 (26.5-30.6)	24.9 (18.9-29.2)	23.5 (20.0-24.6)	21.2 (16.3-25.6)	18.7 (13.4-20.9)	<0.0001
Normal-weight group	45-64 years	20.4 (9.1-28.1)	14.6 (12.6-22.2)	19.1 (14.1-20.9)	18.1 (16.8-21.2)	20.3 (16.2-21.2)	0.001
	≥65 years	8.5 (0.0-11.1)	5.9 (2.4-6.5)	6.9 (3.5-10.0)	6.4 (5.8-9.8)	9.7 (7.9-11.8)	0.001
	18-44 years	8.2 (6.0-11.1)	7.6 (5.3-10.0)	9.4 (7.0-10.5)	7.3 (5.3-9.9)	6.6 (5.4-6.9)	0.03
Overweight group	45-64 years	12.0 (8.0-18.4)	11.3 (10.3-15.8)	11.6 (9.1-45.2)	10.8 (10.2-13.5)	11.9 (9.3-15.0)	0.26
	≥65 years	5.1 (2.0-4.5)	5.4 (3.9-6.3)	6.5 (5.7-10.5)	7.3 (4.9-10.3)	7.3 (5.2-9.6)	0.03
	18-44 years	4.3 (0.0-8.0)	8.2 (7.1-10.0)	4.8 (3.8-8.1)	6.4 (4.5-8.2)	3.7 (3.4-7.4)	0.03
Obesity group	45-64 years	8.2 (5.1-11.6)	10.9 (9.0-13.0)	7.8 (4.3-9.7)	9.2 (5.8-10.6)	9.3 (5.5-11.7)	0.54
	≥65 years	2.5 (1.1-4.1)	5.9 (3.5-7.1)	4.3 (1.3-9.3)	6.5 (1.8-8.6)	5.5 (4.5-8.9)	0.002

Table 3: Univariate correlation in males and females in each 5-year period between BMI and several covariates: age (years), smoking habits (0=no smoking, 1=previous or current smoking), reason for the first endocrinological examination (0=other reasons, 1=metabolic/weight reasons), approach to nutrition (0=no diet; 1= on diet), and thyroid abnormalities (0=no; 1=yes). Thyroid abnormalities were: out-of-range biochemical data, ongoing thyroid therapies, presence of positive autoimmunity and evidence of structural alteration on clinical or instrumental examinations.

			1999-2003	2004-2008	2009-2013	2014-2018	2019-2023
Age (years)	Males	rS	0.14	0.13	0.20	0.18	0.24
		P	0.06	0.05	0.0003	0.001	<0.0001
	Females	rS	0.27	0.26	0.25	0.27	0.24
		P	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Smoking habit	Males	rS	0.06	0.18	0.18	0.23	0.05
		P	0.58	0.04	0.004	0.0006	0.37
	Females	rS	0.06	-0.03	-0.06	0.04	0.00
		P	0.49	0.54	0.04	0.31	0.98
Reason for medical examination	Males	rS	0.24	0.23	0.14	-0.04	0.13
		P	0.002	0.0004	0.01	0.49	0.009
	Females	P	0.13	0.23	0.19	0.25	0.14
		rS	0.003	<0.0001	<0.0001	<0.0001	<0.0001
Approach to nutrition	Males	rS	0.08	0.30	0.14	0.16	0.07
		P	0.31	<0.0001	0.01	0.005	0.16
	Females	rS	0.15	0.19	0.16	020	0.21
		P	0.001	<0.0001	<0.0001	<0.0001	<0.0001
Thyroid abnormalities	Males	rS	-0.06	-0.06	-0.04	0.08	-0.06
		P	0.43	0.37	0.46	0.13	0.22
	Females	rS	-0.02	-0.00	0.01	0.01	0.08
		P	0.68	0.90	0.74	0.84	0.01

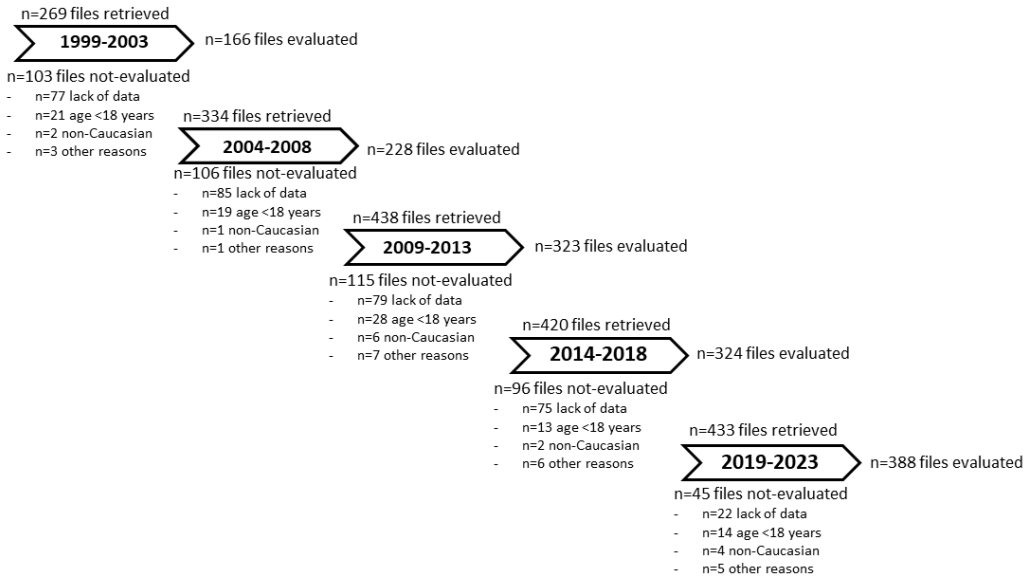

Figure 1a: Flowchart of the study (male subjects).

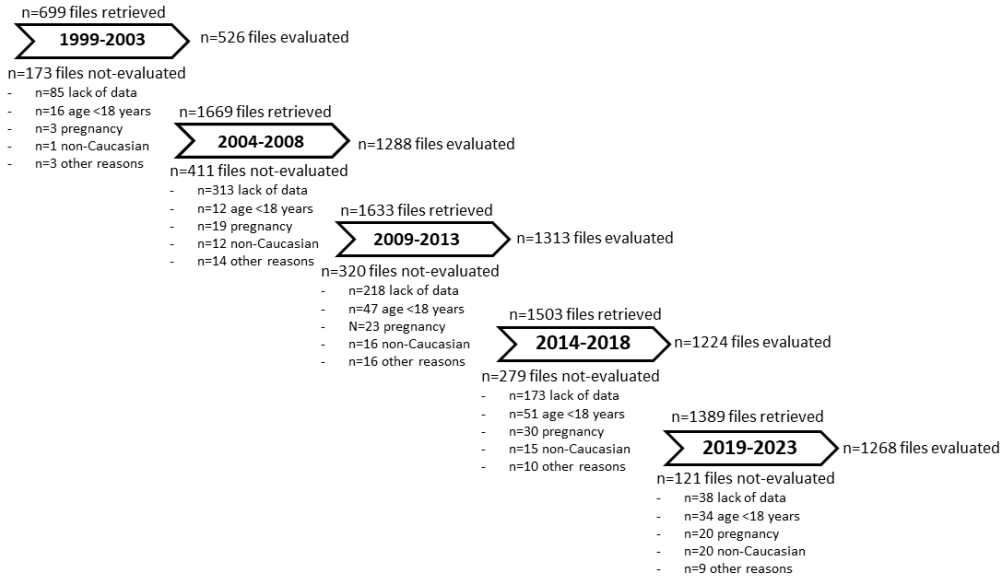

Figure 1b: Flow chart of the study (female subjects).