

The weight of the Italians: application of the Gaussian curve to the body mass index

Giacchino de Candia

Independent Reasercher, Via Salgari, 6, 70038 Terlizzi (BA), Italy. E-mail: gioacchino.decandia@fastwebnet.it

Citation: Giacchino de Candia. 2014. The weight of the Italians: application of the Gaussian curve to the body mass index. Human Biology Review, 3 (1), 95-104.

ABSTRACT

The body mass index (BMI) is from about two centuries one of the main indicators of human health and is used in this sense in almost every country in the world. The purpose of this research is to analyze this indicator, based on the Gaussian distribution (or normal curve) in the time period 1994-2005, in order to provide a point estimate of the Italians in the condition of being overweight, according to the classification given by WHO. The report also provides forecasts to 2020 on the extent of BMI for overweight people, in order to assess the effects on the health of not only Italians, but also for the possible effects on the national health system.

Keywords: *overweight, obesity, body mass index, normal curve, health*

1 INTRODUCTION

Health is always a major concern of man since ancient times. *Mens sana in corpore sano* is a motto of Latin origin, is still in vogue not only in Italy, but all over the world.

A healthy body means a fair and balanced way of life, which is expressed in a proper nutrition and, more generally, in a sober approach to everyday life.

Conversely, a poor diet can cause or aggravate some diseases: obesity or leanness, increased cholesterol and/or triglycerides, increased blood sugar or diabetes, increased blood pressure, lower the body's defenses against disease, food allergies, cancer, anemia, diseases of the circulatory system, gastro - intestinal, liver, lung and bone - articulate.

The characteristics that have an impact on the proper/improper eating habits are many: family background, social context, socio – economic level, personal factors and genetics.

Consequently, a constant and careful control of its own weight, in addition to periodic clinical analysis, improve the level of life and health.

In this research, we will analyze the variable “weight”, in relation to the variable “height”, derived from the multipurpose ISTAT called *Condizione di salute e ricorso ai servizi sanitari*, created in 1994, 1999-2000 and 2004 – 2005 (ISTAT 1994, 2000, 2005).

The subjects studied as part of the investigation are: health conditions (perception of health status, presence of chronic diseases, etc.), The presence of disability, lifestyle (smoking habits, physical activity, etc.) the prevention, the use of health services, the use of drugs or unconventional therapies and the path of motherhood from pregnancy to breastfeeding.

In order to minimize the effect of seasonal phenomena, of particular relevance to the issues of health, the survey was conducted on a quarterly basis in the months of March, June, September and December on the resident population in Italy, net of the permanent members of cohabitation.

Every three months, was interviewed a quarter of the total sample.

The sample has two stages with stratification of the units of the first stage (Towns). The sample size has been expanded over time, with the assistance of the National Health Fund mandated by the State-Regions Conference to allow regional and sub-regional estimates. The information was collected through direct interview for a part of the questions. In cases where the individual was not

available to interview for particular reasons, the information was provided by another member of the family. For another part of the questions has been provided as auto.

The survey unit is constituted by the family of fact (FF) associated with the family registry (FA) sampled. The family is in fact defined as the set of people who usually live in the same dwelling and are related by kinship, affinity, affection or friendship.

Note that for the detection of a FF are more important than the concepts of “home” and “usual residence”, which is not the actual birth registration of individuals living together.

Within each FF can be detected none, one or more families. The definition of family is more restrictive than that of the family. In fact, per household means:

1. married or cohabiting couple without children or with children never married nor cohabiting or having children of their own;
2. a single parent with one or more children never married nor cohabiting or having children of their own.

The members of the family that do not meet the above requirements shall be considered as “isolated members”. For each survey, it was decided to extrapolate the variables related to the weight and height of individuals.

The survey, now no longer in existence, was used in this research to the body of the sample, in addition to the presence of multiple variables related to health conditions, as well as lifestyle.

The samples were stratified by age, 18 years and over, in addition to weight and height.

From the relationship between “weight” and “stature” was obtained the body mass index (BMI) which is focused on the analysis carried out in the research.

2 MATERIALS AND METHODS

As stated in the introduction, the main source of data comes from ISTAT - Multipurpose Survey of Households - *Condizione di salute e ricorso ai servizi sanitari*.

The analysis was conducted for people (male and female, 18 years and over) which have a weight not less 30 kg.

The sample sizes are summarized in Table 1:

Tab. 1: Sample Size

Years	Sample units
1994	49,677
1999 – 2000	115,018
2004 - 2005	105,844

Source: Source: Based on data from ISTAT – Multipurpose Survey families - *Condizione di salute e ricorso ai servizi sanitari*

The variable “weight”, was processed in a timely manner, so as not to lose any information on the distribution of the sample.

The distribution of the weight classes has been shown to have Gaussian shape to the three surveys, as well as displayed in Figures 1, 2 and 3.

Fig. 1: Distribution of weight and curve fitting. 1994

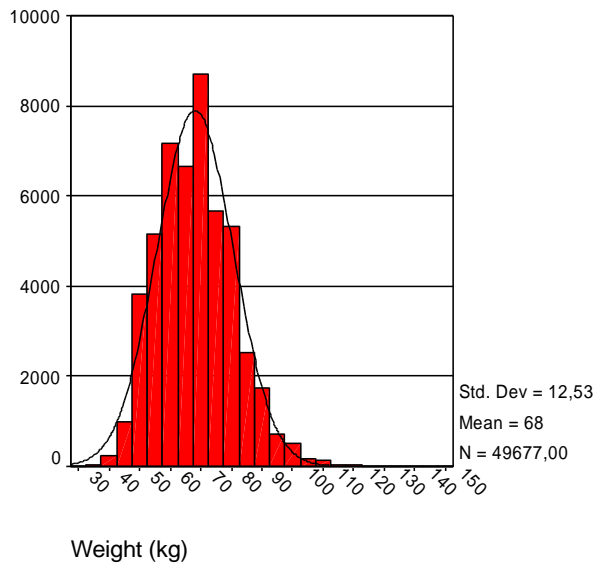


Fig. 2: Distribution of weight and curve fitting. 2000

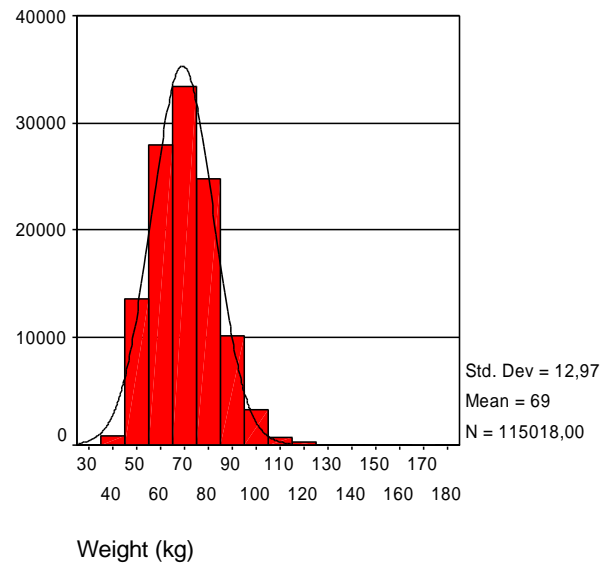
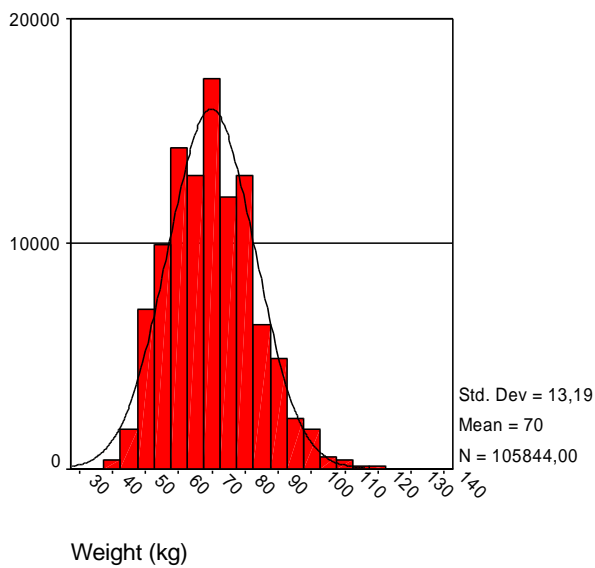


Fig. 3: Distribution of weight and curve fitting. 2005



Source: Based on data from ISTAT – Multipurpose Survey families – *Condizione di salute e ricorso ai servizi sanitari*

Similarly for the variable “height”, as it appears from Figures 4, 5 and 6.

Fig. 4: Distribution of stature and curve fitting. 1994

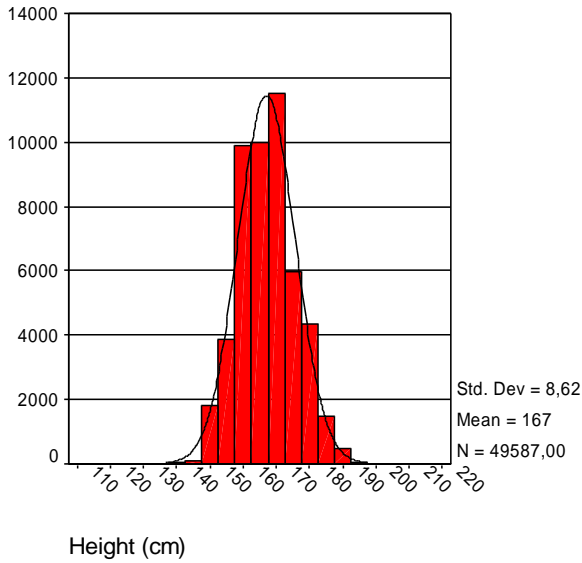


Fig. 5: Distribution of stature and curve fitting. 2000

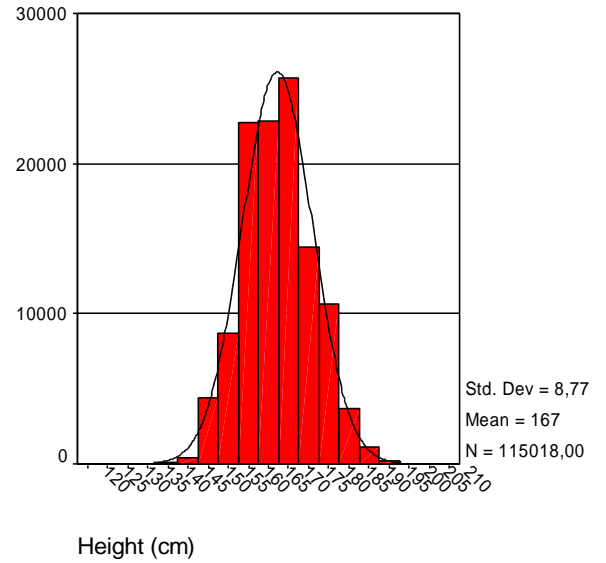
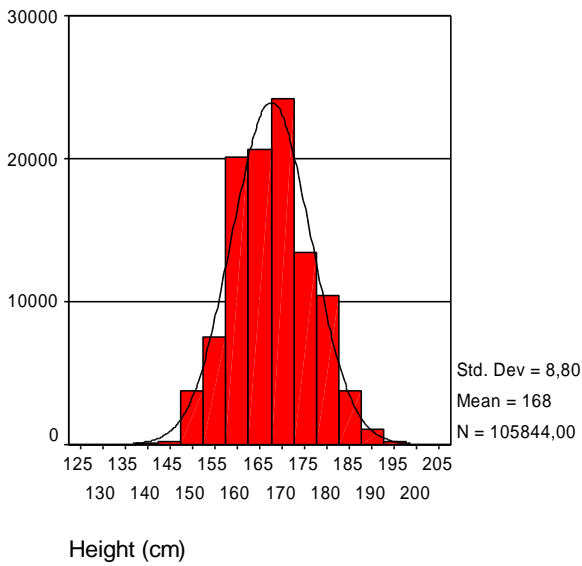


Fig. 6: Distribution of stature and curve fitting. 2005



Source: Based on data from ISTAT – Multipurpose Survey families – *Condizione di salute e ricorso ai servizi sanitari*

Elaboration of the weight (expressed in kg) and height (expressed in m) is obtained mass index (BMI) according to the known formula:

$$BMI = \frac{weight}{height^2} \quad (1)$$

The development of body mass index has been created for all investigations and generated individually for every person's weight and height.

Figures 7, 8 and 9 show how this variable also has a form strongly approximated to the Gaussian curve.

Fig. 7: Distribution of body mass index and curve fitting. 1994

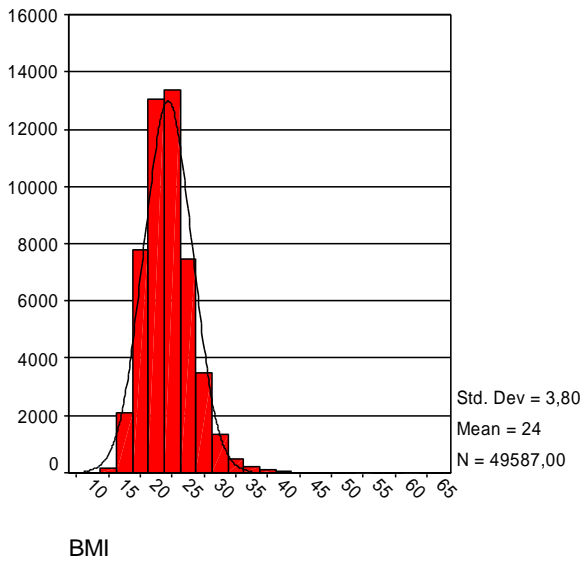


Fig. 8: Distribution of body mass index and curve fitting. 2000

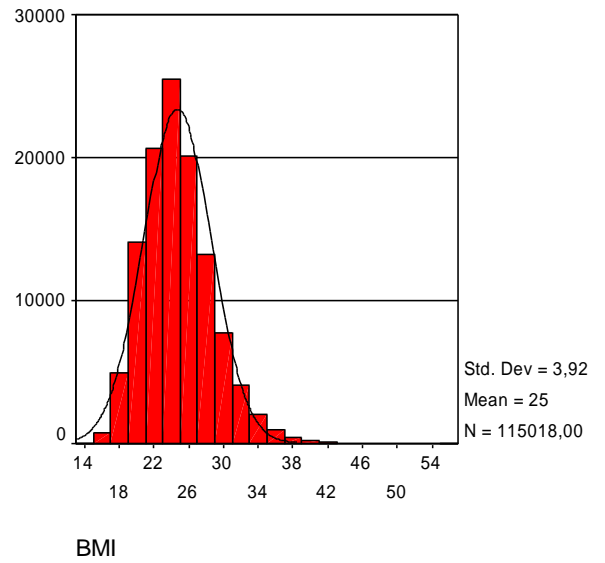
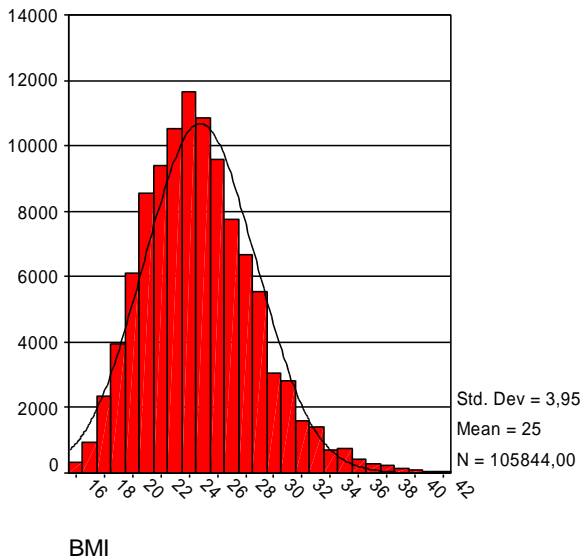


Fig. 9: Distribution of body mass index and curve fitting. 2005



Source: Based on data from ISTAT – Multipurpose Survey families – *Condizione di salute e ricorso ai servizi sanitari*

According to the statement of the Central Limit Theorem, the sum (or average) of a large number of independent random variables (or samples of size increasing) and have the same distribution is approximately normal, regardless of the shape of the underlying distribution.

However, and for the avoidance of doubt, we proceeded with the application of the indices of skewness (2) and kurtosis (3), whose results are summarized in Table 2. For near-zero values of these indices, we accept the hypothesis of normality.

The processing relating to the values of skewness and kurtosis were conducted using the function *ASIMMETRIA* and *CURTOSI* of Open Office 4.0

$$\gamma_1 = \frac{1}{n} \sum_{i=1}^n \left(\frac{x_i - \mu}{\sigma} \right)^3 \quad (2)$$

$$\gamma_2 = \frac{1}{n} \sum_{i=1}^n \left(\frac{x_i - \mu}{\sigma} \right)^4 - 3 \tag{3}$$

Given that the BMI is expressed as the ratio (linear combination) of two quantities (vectors) that are distributed in Gaussian shape, the same shape is also acceptable for the BMI.

Tab 2: Values of skewness and kurtosis

	Weight (1994)	Height (1994)	Weight (2000)	Height (2000)	Weight (2005)	Height (2005)
Skewness	0,515	0,132	0,482	0,151	0,465	0,175
Kurtosis	0,693	0,283	0,419	0,022	0,266	-0,079

Elaboration of the BMI can define levels of thinness, obesity, and the ideal weight of an individual or group of individuals.

According to the World Health Organization (WHO), obesity is achieved when the body mass index is not less than 30 points.

Table 3 summarizes the various thresholds of BMI:

Tab. 3: Threshold values of body mass index

Situation weight	Min	Max
Obesity class III (serious)	≥ 40.00	
Obesity II class (severe)	35.00	39.99
Obesity I class (moderate)	30.00	34.99
Overweight	25.00	29.99
<i>Regular (ideal weight)</i>)	18.50	24.99
Slightly underweight	16.00	18.49
Visibly underweight (moderate anorexia)	15.50	17.49
Severe thinness (severe anorexia)	<15.50	

Source: WHO

3 ANALYSIS OF RESULTS

During the period examined, the percentage of overweight people aged 18 and over increased from 38.7% in 1994 to 43.6% in 2005, analyzing the sample data.

According to the “normal” BMI distributions, it is possible to determine the percentage of Italians who, for many years, were found to be overweight.

The processing relating to the values of the area of the Gaussian curve were conducted using the function *DISTRIB.NORM.ST* of Open Office 4.0.

Given a significance level α of 5%, the percentage of Italians who report a BMI of at least 25 and relative population are summarized in the table 4 (the overall sampling error is equal to 1.98 for all investigations; the stochastic error is always equal to 0.5):

Tab. 4: Percentage and number of population overweight

Investigations	BMI (%)
1994	43.28
1999 – 2000	46.83
2004 - 2005	47.89
Population	
1994	19,975,520
1999 – 2000	22,003,335
2004 - 2005	22,989,807

Source: Based on data demo.ISTAT

You notice a dramatic increase in the population overweight, which increases the projection horizon by nearly 5% (about 3,000,000 individuals).

Similarly we proceed to analyze the different categories of overweight, until severe obesity:

Tab. 5: Distributions based on the levels of overweight

Investigation	BMI (%)	Investigations	Population
$25 \leq IMC \leq 29,99$		$25 \leq IMC \leq 29,99$	
1994	36.39	1994	16,795,499
1999 – 2000	38.03	1999 – 2000	17,868,607
2004 - 2005	38.48	2004 - 2005	18,472,495
$30 \leq IMC \leq 34,99$		$30 \leq IMC \leq 34,99$	
1994	6.63	1994	3,060,021
1999 – 2000	8.34	1999 – 2000	3,918,595
2004 - 2005	8.87	2004 - 2005	4,258,083
$35 \leq IMC \leq 39,99$		$35 \leq IMC \leq 39,99$	
1994	0.25	1994	115,385
1999 – 2000	0.42	1999 – 2000	197,339
2004 - 2005	0.48	2004 - 2005	230,426
$IMC \geq 40,00$		$IMC \geq 40,00$	
1994	0.01	1994	4,615
1999 – 2000	0.04	1999 – 2000	18,794
2004 - 2005	0.06	2004 - 2005	28,803

Source: Based on data demo.ISTAT

Table 5 shows how, over a decade, the number of Italian overweight is steadily increasing, in line with the sample data.

It shows a significant increase in class from 35.00 to 39.99 (obese), which doubles the number between 1994 and 2005.

Worrying situation of extreme class (40 and over, severe obesity) which, although involving fewer than 30,000 people, multiplies its effects over the horizon and is a major sign for the future, considering that in this class the index body mass means the worsening in irreversible manner also of various cardiovascular diseases, as well as persistent motor difficulties and osteoarticular.

To conclude this section, it is worth pointing out that the estimates obtained differ slightly from the one survey that produces similar data, ie *Aspetti della vita quotidiana*, which leads to the ISTAT annual basis since 1993 (with the exception of 2004).

This study, although conducted in a methodologically appropriate, analyze a smaller sample (equivalent to less than 50,000 units) from which some differences in the production of estimates related to body mass index.

The differences are concentrated in the category of “overweight” ($25.00 \leq \text{BMI} \leq 29.99$) as the sample size larger than the surveys used tends to concentrate in the middle class, given the normality of the distribution.

In fact, in the right tail (obesity) where the body mass index takes a value of not less than 30 differences thin, so much so that in 2005 both the investigation *Condizione di salute e ricorso ai servizi sanitari*, and the survey *Aspetti della vita quotidiana* produce similar results for the category “obese”.

4 FORECAST

The survey *Condizione di salute e ricorso ai servizi sanitari* stops at 2005, the year of the last implementation. As stated in the previous paragraph, from that point forward the only survey that provides precise data is *Aspetti della vita quotidiana*, also made by ISTAT.

The reports show that from 2006 to 2012 the percentage of Italians overweight are continues to increase, growing by 1.4% (ISTAT 2012).

This increase affects about 1,200,000 Italians and tends to increase in the future.

By 2020, if the trend of the phenomenon will not change decremental, at least 50% of Italians will be overweight, with a prevalence of obese that will exceed 12%.

This has a significant impact in respect of the National Health System, for which the incidence of obesity-related diseases represents 6.7% of public health expenditure, amounting to 8.3 billion euros, according to a study carried out in 2009 by the Scuola Superiore Sant’Anna in Pisa (2009).

Assuming an average expected life of the obese person 75 years old, the same study estimated at around 100,000 euros total additional social cost of an eighteen year old obese compared to a peer of normal weight throughout their lives.

Therefore, in 2020 the national health system could support a further increase in costs amounting to more than a billion Euro, considering the forecasts provided by ISTAT for the resident population until 2065 (central scenario).

5 CONCLUSIONS

Research has revealed a precise and comprehensive characteristics of the phenomena related to body mass index in relation to the components defined as “overweight”, with the various thresholds of obesity.

It is necessary to point out that the biggest problem in the definition of diseases related to “excess weight” in relation to the stature almost exclusively concerns the classes of obesity, ie. the percentage of Italians who, between 1994 and 2005, increased from 6.89% to 9.41%.

In addition, phenomena related to “overweight” are changing, as an individual who presents with a BMI between 25 and 29.99 can easily control your weight and avoid “obesity”.

Those who have a BMI of at least 30 are already obese and they need a careful control of your health and your lifestyle.

One of the negative aspects of obesity is that this problem is taken into account mainly with respect to the individual, often seen as linked more to aesthetics than health, rather than relative to the entire community, unlike, for example, smoke and pollution (Barilla 2012).

There is, therefore, the lack of full awareness of the problem and its socio - economic consequences in public opinion. At the institutional level, in particular, do not feel that sense of urgency needed to address systematically the problem of obesity.

The OECD emphasizes how a preventive approach can be an effective solution to combat obesity. Covering different age groups and in particular at-risk groups, you could in fact provide important health gains at low cost (OECD 2010).

A similar strategy in Italy would cost the country about 17 euros per person, an amount unnoticeable in health care spending, which in Italy could save about 75,000 lives.

In this way, claiming a cost of about one billion euros per year, you would avoid burdening the National Health System of the total expenditure of 8.3 billion euros (according to the previously mentioned study of the Scuola Superiore Sant'Anna) realizing an annual savings equal to about 7 billion euros, a sum that could be used in a much more fruitful for further research aimed not only to seek cures for currently untreatable diseases, but also to improve the management of medical activity Italian health.

REFERENCES

- American Psychiatric Association 2006: Practice Guideline for the Treatment of Patients with Eating Disorders (Third Edition). *American Journal of Psychiatry* 2006;163 (July Supplement):1-54
- Barilla Center For Food & Nutrition 2012: *Obesità, gli impatti sulla salute pubblica e sulla società*, www.barillacfn.com
- CENSIS 2010: *Primo rapporto sulle abitudini alimentari degli italiani*, Coldiretti, Rome
- Hudson JI, Hiripi E, Pope HG Jr, Kessler RC. 2007: The prevalence and correlates of eating disorders in the *National Comorbidity Survey Replication*. *Biol Psychiatry* 2007;61(3):348-58
- ISTAT 1994: *Condizione di salute e ricorso ai servizi sanitari 1994*, Indagine Multiscopo sulle famiglie, Rome
- ISTAT 2000: *Condizione di salute e ricorso ai servizi sanitari 1999 - 2000*, Indagine Multiscopo sulle famiglie, Rome
- ISTAT 2005: *Condizione di salute e ricorso ai servizi sanitari 2004 - 2005*, Indagine Multiscopo sulle famiglie, Rome
- ISTAT 2009: *La vita quotidiana nel 2009*, Indagine multiscopo annuale sulle famiglie "Aspetti della vita quotidiana", Rome
- ISTAT 2011: *Il futuro demografico del paese, previsioni regionali della popolazione residente al 2065*, Report Statistiche, Rome
- ISTAT 2012: *Aspetti della vita quotidiana. Anno 2012*, Rome
- ISTAT 2012: *Rapporto annuale 2012 – La situazione del Paese*, Rome
- OECD 2010: *Obesity and the economics of prevention: fit not fat*
- Scuola Superiore Sant'Anna 2009: *L'obesità? Un "peso" sociale*, Pisa, 25.09.2009
- Sharpe B, Parry V, Dubhthaigh R, Barter T. 2007: *Future Trends in Technology and Their Impacts on Obesity*, Available at <http://217.33.105.254/Obesity/08.pdf>
- Turchetti G. 2009: *Indagine sul fenomeno dell'obesità*, Scuola Superiore Sant'Anna, Pisa

WHO 2002: GEMS/Food Total Diet Studies, Report of the 2nd International Workshop on Total Diet Studies, Brisbane, Australia 4 – 15 February 2002

WHO 2010: Global Status Report on Noncommunicable Diseases, Geneva