République Algérienne Démocratique et Populaire
Ministère de l'Enseignement Supérieur et de la Recherche Scientifique
Université A.MIRA-BEJAIA

جامعة بجاية
Tasdawit n Bgayet
Université de Béjaïa

Faculté : Sciences de la Nature et la Vie **Département : Sciences alimentaires**
Laboratoire de Biomathématiques, Biophysique, Biochimie et Scientométrie

THÈSE

EN VUE DE L'OBTENTION DU DIPLOME DE DOCTORAT

Domaine : Sciences de la Nature et la Vie
Filière : Sciences Biologiques
Spécialité : Bio-ressources, Environnement et Technologie Agroalimentaire

Présentée par
YOUS Fouzia

Thème

Nutrition, Activités physiques et épidémiologie en milieu scolaire

Soutenue le : 09/10/2021 **Devant le Jury composé de :**

Nom et Prénom	**Grade**		
Mme Boulekbache Lila.	Professeur	Univ. de Bejaia	Présidente
Mr Zaabar Salim.	Professeur	Univ. de Bejaia	Rapporteur
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Mr Ikiouane Mourad	MCA	Univ. de Bejaia	Examinateur

Année Universitaire : **2020/2021**

People's Democratic Republic of Algeria
Ministry of Higher Education and Scientific Research
University A.MIRA-BEJAIA

جامعة بجاية
Tasdawit n Bgayet
Université de Béjaïa

Faculty: Natural and Life Sciences **Department: Food Sciences**
Biomathematics, Biophysics, Biochemistry and Scientometry Laboratory

THESIS

IN VIEW OF OBTAINING THE DIPLOMA
OF DOCTORATE

Field: Natural and Life Sciences
Field: Biological Sciences
Specialty: Bio-resources, Environment and Food Technology

Presented by
Fouzia YOUS

Theme

Nutrition, Physical Activity and Epidemiology in Schools

Defended on: 09/10/2021 **Before the Jury composed of:**

Name and First Name	Rank		
Mrs Boulekbache Lila.	Professeur	Univ. of Bejaia	Presidente
Mr Zaabar Salim.	Professeur	Univ. of Bejaia	Rapporteur
Mr Madani Khodir.	Professeur	Univ. of Bejaia	Co- Rapporteur
Mr Aoun Omar.	Lecturer	Univ. of M'sila	Examiner
Mr Ikiouane Mourad	Lecturer	Univ. of Bejaia	Examiner

University Year: 2020/2021

Dedications

I dedicate this work, above all, to "you" my dearest parents,

To express all the respect and love I have for them
And to show them my gratitude for all
The effort and sacrifices that have undertaken
To see me what I am.

To my lovely sisters: Rbiha, Nouara, Souria, Naima and Lina

To my lovely brothers: Lahsen (Malek) and Fateh

To my brothers and sisters

Tomorrow will not be like yesterday, it will be new and it will depend on us.
Our future as well as our past must be united. This is the most
beautiful thing that is given to us naturally. Our strength
Will always be in our sincere understanding
And our spirit of brotherhood.

To all my friends

For our friendship and all the good times we had and will have,
For your presence, your good advice and our shared laughter
A very big thank you to all of you.

Acknowledgements

At the end of this project, I want to thank **God**, who gave me the power to have courage, will and patience to complete this work.

To Mr. Professeur Salim Zaabar

First of all, I would like to express my deep gratitude, my profound respect and our sincere thanks for their precious advice and especially for having always supported me by granting me widely their confidence, the supervision, for his great availability, his understanding and the presence and the contribution that he has shown during the different stages of this work.

To Mr. Professeur Madani Khodir

I express to him all my deep respect and gratitude for accepting to co-direct, his contribution, his enrichments and his judicious advice, his scientific help which allowed me to carry out this work, and for having welcomed me in his laboratory; I had the great privilege to be your humble student. You have been for us an example on which our professional path has been traced.

To Mrs. Professeur Lila Boulekbache-Makhlouf

You have done us the honor of accepting to chair this jury. Your scientific rigor, your constructive criticism and your suggestions have contributed to further improve our work. Please accept the expression of our deepest respect.

To Mr. Lecturer Omar Aoun

We are particularly touched by the spontaneity and kindness with which you have agreed to judge this work. It was an honor to work with you. Please accept our sincere thanks.

To Mr. Lecturer Ikiouane Mourad

You do us the honor of accepting to judge this work. We thank you for your availability and their advice and criticism. Please receive the expression of our deep respect.

I also thank:

- **To Mrs Lecturer Adjeroud-Abdellatif Nawel** be assured of my deep gratitude for their judicious contribution, for their invaluable councils, your assistance and your kindness and especially to have always supported me by granting me largely their confiances.

- To all the directors of the schools and all the school screening units (SSU) for their availability, their patience and their scientific contributions to the realization of this work.

- **To Dr Bir Hassiba** for her welcome and help. Please find in this work the expression of my deep respect.

- The students, for having trusted us, and thanks to whom the work was born.

Finally, I would like to pay tribute to and express my gratitude to all those who have contributed, directly or indirectly, to the realization of this work

Table of contents

Table of contents

Table of contents

List of tables

List of tables

List of figures

List of figures

List of annex

Abbreviations

AFSSA : **F**rench **F**ood **S**afety **A**gency

ATP : **A**denosine **T**ri-**P**hosphate

AA : **A**mino **A**cids

BMI : **B**ody **M**ass **I**ndex

BM : **B**asal **M**etabolic

BMR : **B**asal **M**etabolic **R**ate

BEE : **B**asal **E**nergy **E**xpenditure

CDC : **C**enters for **D**isease **C**ontrol and Prevention

CVD : **C**ardio- **V**ascular **D**isease

DHP : **D**irector of **H**ealth and **P**opulation

DEE : **D**aily **E**nergy **E**xpenditure

DE : **D**aily **E**nergy

DLW : **d**oubly **l**abeled **w**ater

EE : **E**nergy **E**xpenditure

EMC : **E**ncylopédie **M**édicochirurgicale

FAO : **F**ood and **A**gricultural **O**rganization

IOTF : **I**nternational **O**besity **T**ask **F**orce

IGF1 : **I**nsulinlike **G**rowth **F**actor **1**.

GFR : **G**lomerular **F**iltration **R**ate

Abbreviations

GH : **G**rowth **H**ormone

MET : **M**etabolic **E**quivalent of **T**ask

MRI : **M**agnetic **R**esonance **I**maging

NCD : **N**on-**C**ommunicable **D**iseases

PA : **P**hysical **A**ctivity

PAL : **P**hysical **A**ctivity **L**evel

PCA : **P**rincipal **C**omponent **A**nalysis

PSA : **P**ublic **S**chools **A**ssociation

PNNS : **P**rogramme **N**ational **N**utrition **S**anté

RNI : **R**ecommended **N**utrient **I**ntake

RDA : **R**ecommended **D**ietary **A**llowance

REE : **R**esting **E**nergy **E**xpenditure

TEI : **T**otal **E**nergy **I**ntake

TEE : **T**otal **E**nergy **E**xpenditure

UNU : **U**nited **N**ations **U**niversity

USU : **S**chool **S**creening **U**nits

WHO : **W**orld **H**ealth **O**rganization

Introduction

1. Introduction

In the last decades, the improvement of the standard of living, the consequences of urbanization and industrialization can be factors that have changed our way of life. This change caused by hollow modifications of our food habit and behavior (quantitative and qualitative); a growing sedentarization and an increase of non-infectious diseases such as diabetes type 2, cardiovascular diseases in adults, overweight and obesity affect in priority children and adolescents (mondiale de la Santé, 2004).

The prevalence of overweight and obesity is a phenomenon that affects all countries in the world, particularly the United States (Hedley, *et al.*, 2004). Obesity is a growing health problem in rich countries, the result of a series of changes related to diet, physical activity, health and nutrition; prevalence of obesity is related to an imbalance in energy balance (Bardia, *et al.*, 2007; Dourmashkin, *et al.*, 2005; Misra, *et al.*, 2009), often, the nutritional intake is higher than the expenditure (C Maffeis, *et al.*, 2000).

In adolescence in particular, food brings body image into play. This period represents a crossroads where the image of the subject and its most essential relationships with the environment will articulate and rapid body growth with nutritional needs increase significantly to support growth and development (Rodríguez, *et al.*, 2004; Story, *et al.*, 2000). During this stage described as "transitional", the recommended diet contributions for macronutrients would need to recover both growth movements and protective goals in the puberty period. After the age of 5 years, obesity leads to a high risk of persistent obesity in adulthood (James, 2004).

Body mass index (BMI) is the most frequently used and diagnostic tool in the current obesity classification system. It has the advantage that a subject's height and weight are easy and inexpensive to measure (Gómez-Ambrosi, *et al.*, 2012). A body mass index (BMI, weight in kilograms divided by the square of height in meters) that is in the upper range of normal in adolescence is associated with an increased risk of death from cardiovascular causes (Twig, *et al.*, 2016).

Children and adolescents having BMI characteristic of obesity and overweight are more at risk of becoming obese adults (Harris, 2004; Pande, *et al.*, 2019; Pinhas-Hamiel, *et al.*, 2003). BMI has been used to estimate the probability of overweight in children and adolescents, with attribution limit values, such as the 85th or 95th percentile of baseline data (Shumei S Guo, *et*

al., 1994; J. H. Himes, *et al.*, 1994; Kuczmarski, 2000). This can help children and adolescents who are at risk and need close monitoring or intervention (Shumei Sun Guo, *et al.*, 2002; Ogden, *et al.*, 2012).

Algeria has all the characteristics of a country in nutritional transition, like Tunisia, Morocco and China; in Algeria, the nutritional situation of children and adolescents are a tendency to develop bad eating habits associated with a decrease in the practice of regular physical activity (SAHNOUNE).

Adolescents are spending more time in the school environment, the latter is known to have a strong influence on their eating behavior and physical activity. These eating habits and physical inactivity have developmental, family and environmental influences and the major preventable risk factors for the development of non-communicable diseases (Black, *et al.*, 2007; Moreno, *et al.*, 2008).

Regular physical activity during childhood and adolescence is widely recognized as essential for healthy growth and development (Misra, *et al.*, 2012). These activities include mainly sports activities and transportation and limited sedentary behavior such as watching TV and working on computers.

Excessive food consumption and lack of physical activity are key indicators contributing to the obesity epidemic (Markwald, *et al.*, 2013). Consequently, obesity occurs when the energy balance between energy intake and expenditure is positive (Hill, *et al.*, 1999; Hills, *et al.*, 2011; Lau, *et al.*, 2013; Markwald, *et al.*, 2013). In Algeria, school health could be the basis for preventive actions against nutritional deficiencies and overweight among young people (Mekhancha-Dahel, *et al.*, 2005). To the best of our knowledge this is the first epidemiological study on the prevalence of obesity in Bejaia city (Algeria).

1. Problematic of the Thesis

During the last three decades, the lifestyle of the Algerian child has become more sedentary, notably because of certain leisure activities of children (television, video games) and the development of automobile transportation. At the same time, dietary habits have changed, leading to a reduction in the consumption of complex carbohydrate foods (cereals, legumes and starchy foods), a stagnation or even a reduction in the consumption of fruits and vegetables, an increase in the consumption of simple carbohydrates and fats (fatty and sugary foods and beverages), while the salt intake is too high. Overall, in relation to needs, the energy density of the diet (the quantity of energy it provides in relation to the quantity of food

ingested) is too high, while its nutritional density (the quantity of vitamins and minerals per 100 kcal) is too low.

What are the main causes of excess weight for school children?

From this main question arise a number of subsidiary questions:

- Is there a relationship between daily energy expenditure and nutritional profile in obese children and adolescents?
- Is there a correlation between DEE, PAL, energy intake and BMI in the same subjects?

2. Objective

For this study, the objectives are:

3.1. Main objective

- To evaluate the energy expenditure, to release a nutritional profile and to evaluate also the level of the sporting activity in school of the Wilaya of Bejaia by seeking to check the link with metabolic diseases and to seek the valid evidence to speak about a school epidemiology.

3.1.Secondary objectives

- To determine the body mass index among adolescents in middle and high schools in the wilaya of Bejaia;
- To evaluate the daily energy expenditure of adolescents in middle and high schools in the wilaya of Bejaia ;
- To draw up a nutritional profile (total energy intake) in schools in the wilaya of Bejaia;
- Evaluation of the level of physical activity among adolescents in schools in the wilaya of Bejaia.

Theoretical part

The prevalence and severity of obesity have increased in recent years, probably as a result of complex interactions between genes, dietary intake, physical activity and the environment. Weight gain is considered to result from an energy imbalance, defined as when an individual's energy intake exceeds his or her total energy expenditure. Gene expression favoring the storage of excess calories in the form of fat, which have been selected for millennia and are relatively static, has become maladaptive in a rapidly changing environment that minimizes opportunities for energy expenditure and maximizes opportunities for energy consumption. Diet and nutrition are important factors in the promotion and maintenance of good health throughout life. Adolescence is a defining period of life and engages multiple psychological and physiological changes that affect dietary habits and needs, Insufficient of these dietary habits and physical inactivity are the main risk factors for the onset of chronic diseases is well established and therefore occupy a prominent place in prevention activities.

1. Nutrition

1.1. Eating habits

Feeding is typically studied through observational studies or caregiver reports of mealtime behavior (Black & Hurley, 2007). The food habits have influences on the development, the family and the environment; these habits capture a set of actions related to the food, starting with the decision, availability, preparation, utensils, timing and division of meals and finishing with the consumption (Malik, *et al.*, 2010). Eating meals with family members, able to make the transition to an internal regulation of hunger and satiety are often overtaken by family and cultural patterns, tell that eating breakfast and drinking the recommended amount of water are considered healthy habits (Barufaldi, *et al.*, 2016).

Adolescent eating behaviors are characterized by the absence of meals (especially breakfast), snacking, consumption of fast food, unconventional meals, consumption of soft drinks, likes and dislikes, high energy intakes, and diet (O'Dea, 2005). These broad dietary habits are still relevant in explaining much of today's adolescent malnutrition, with the addition of more recent eating behaviors such as disordered eating in both sexes and increasing rates of vegetarianism among adolescents (Croll, *et al.*, 2002). Adolescents preferring unhealthy eating patterns that include excessive amounts of fat and sugar. At the environmental level, frequent exposure to fast food and other restaurants has led to increased consumption of high-fat foods, such as French fries, sugary drinks that may satisfy hunger or thirst, but offer minimal nutritional benefits (Smith, *et al.*, 1994); rather than more nutritious

options, such as a diet rich in fruits and vegetables, establish food preferences that include fruits and vegetables (Skinner, *et al.*, 2002). Adolescents need high energy intake and large amounts of nutrients, especially iron, calcium and zinc (O'Dea, 2005).

Energy intake is the main determinant of gestational weight gain, is defined as the caloric or energy content of food as provided by the main sources of dietary energy: carbohydrates, protein, fat (lipids) and alcohol. Energy that is consumed in the form of food may be stored in the body in the form of fat (the main store of energy), glycogen (short-term energy or carbohydrate reserves) or protein (rarely used by the body for energy except in severe cases of starvation and other wasting conditions) or used by the body to fuel events requiring energy (Goran, *et al.*, 2001).

1.2. Nutritional needs

1.2.1. Definition

Nutritional requirements are the quantities of nutrients (J. L. Schlienger, 2011b), of micronutrients and energy to cover the net needs, taking into account the quantity actually absorbed (J. L. Schlienger, 2014), necessary to maintain a stable nutritional state or to carry out a biological function. Theoretically, this corresponds to a balance between energy and protein intake on the one hand and expenditure on the other (Annex 10).

1.2.2. Nutritional needs in children

A good knowledge of the nutritional consumption of infants and young children is also essential to allow companies manufacturing food specifically dedicated to these children to adapt the products to their needs (Fantino, *et al.*, 2008).

As a general rule, these estimates most often lead to an overestimation of the child's needs. The specific needs in proteins, vitamins, minerals and trace elements are also most often increased in pathology (stress situation) (Alphonse, *et al.*, 2005).

1.2.3. Recommended Nutrient Intake (RNI)

The RNI represent the quantity of macro- and micronutrients necessary to cover all physiological needs. These are the average nutritional requirements. They are supposed to cover the needs of 97.5% of individuals in a population and are used to assess the risks of

insufficiency or excess. (Wémeau, 2014). hey are estimated from scientific data and meet the rules set by the French Food Safety Agency (AFSSA) (J. L. Schlienger, 2011b) .

The RNI are set for a population group of defined sex and age, take into account variations between individuals and are established on the basis of the coverage of the average requirement; they generally correspond to 130% of the average requirement ("Les apports nutritionnels conseillés en macro- et micronutriments pour la population," 2007).

Table 1. Recommended Daily Intakes compared for adolescents and adults

	Adolescents	Adults	Women	Men
Energy (kcal)	2140	2680	2000	2700
Protein (g)	64	79	60	81
Calcium (mg)	1200	1200	900	900
Iron (mg)	18	15	18	10
Vitamins :				
B1 (mg)	**1,3**	**1,5**	1,3	1,5
B2 (mg)	**1,5**	**1,8**	1,5	1,8
PP (mg)	**15**	**18**	15	18
B6 (mg)	**2**	**2,2**	2	2,2
B9 (mg)	**300**	**300**	300	300
B12 (mg)	**3**	**3**	3	3

1.3.Energy need

1.3.1. Definition

The energy need has been determined a basal expenditure to which we add successively the postprandial extra-heat, the cost of thermoregulation, the cost of physical activities and the energy cost of emotions (Apfelbaum, *et al.*, 2009).

Food intake must represent a sufficient amount of energy from the different macronutrients (proteins, carbohydrates, lipids) to cover the body's needs and maintain a constant weight (Millward, *et al.*, 2004). The energy needs thus represent the food intake necessary to balance

energy expenditure, maintain energy reserves and body mass, and ensure optimal physiological functioning, in order to prevent pathological situations (Bonnefoy, 2013).

1.3.2. The energy needs of children and adolescents

Childhood and adolescence are periods of physiological development during which the diet must be monitored and adapted to the specific needs of each individual. The evolution of quantities and variety of foods allows the child to facilitate the development of organs, skeleton, muscles and brain and to establish essential energy reserves during the growth period. Each child has specific energy needs (Table 2), but a peak is noted in all at the time of Puberty ("Les besoins energetiques des enfants," 2007).

The recommended energy intake for children takes into account the needs related to growth and energy expenditure, two parameters that can vary inter-individually and also intra-individually ("Recommandations nutritionnelles pour la Belgique," 2009).

According to Tounian (2006) For a child of 10 to 18 years the basal metabolic rate can be predicted, with an uncertainty of 5 to 10%, by the following relationships (FAO/WHO/UN 1986):

$$Boys: BM = (69.4 \text{ x } W) + (322 \text{ x } H) + 2392$$

$$Girls: BM = (30.9 \text{ x } W) + (2016.6 \text{ x } H) + 907$$

W: is weight in kg and H: represents height in meters.

Table 2. Average energy intake (kcal/j), based on (Tounian, 2006)

Age (years)	Boys	Girls
2-3	1075-1290	980-1220
6-9	1650-2220	1500-2055
10	1745-2675	1670-2500
12	1890-3100	1815-2870
15	2320-3630	2030-3180

1.3.2.1. Recommended energy needs for children and adolescents

In children, energy requirements correspond to the quantity of calories necessary for the proper functioning of the body, to which is added the energy necessary for tissue accretion, which represents 40% of total energy needs in infants aged 1 month, 23% at the age of 3 months and only 1 to 2% in children over 2 years. ("Recommandations nutritionnelles pour la Belgique," 2009).

Energy needs vary with physical activity Level (PAL). The coefficient of variability can be high. It has been estimated at 34%. (Torun, 2005). The PAL factor selected was derived from work done on children over 5 years of age and on adolescents. The moderate or average activity level concerns those who practice sports several times a week, spend little time on sedentary activities: television or computer for example (Ainsworth, 2002).

The composition of tissue deposited during normal growth varies little between the end of the first year of life and the beginning of puberty. It is estimated to be 10% fat with an energy content of 9.25 kcal/g, 20% protein (5.65kcal/g), 70% water and a small amount of carbohydrates and minerals, without energy content. The average amount of energy deposited during growth is thus estimated at 2 kcal/g of weight gain.

1.3.2.2. Macronutrients

Food provides the necessary substrates for energy production (energy-rich macronutrients and micronutrients for functioning), which results in the synthesis of ATP (adenosine triphosphate). The calorie is a unit of heat translating. The energy obtained by the hydrolysis of ATP and the release of phosphorus.

1.3.2.2.1. Proteins

Dietary proteins provide the amino acids (AA) necessary to cover the protein needs of the body (J. L. Schlienger, 2011a). They are the ones that transmit communication messages between the cells of the body. The decrease in muscle mass is therefore a risk factor for the frailty of the elderly subject (Ferry, *et al.*, 2012).

According to Mongeau (2004) The Recommended Dietary Allowances (RDA) for protein were calculated using the following formulas:

Children (boys and girls 6-13 years): 0.95g x kg median body weight

Adolescents (boys and girls) 14-16 years old: 0.85g x kg median body weight.

Protein needs vary with age, gender, physical activity, physiological state and health status. Protein requirements are the subject of RNI that take into account these particularities. The minimum protein requirements are those that ensure good health in adults and normal growth in children. The recommended daily intake is based on the minimum average need identified in human studies. These are 0.66 g/kg/d, plus a safety factor of about 0.8 g/kg/d of quality protein, so that most individuals will meet these requirements. (C Agostoni, *et al.*, 2012).

Foods containing complete proteins are eggs, milk, meat, fish and poultry. Among all these foods, eggs provide an optimal mix of essential amino acids (McArdle, *et al.*, 2004).

1.3.2.2.2. Lipids

Dietary lipids are multiple (l'alimentation, *et al.*, 2000). They are important sources of energy (9 kcal for 1 gram) that improve the palatability of food and dishes (smoothness). They have a structural role (constituents of cell membranes and myelin) and metabolic role (precursors of steroid hormones) (J. L. Schlienger, 2011a). In the quantities of lipids essential to the proper functioning of the body, it is necessary to define the total energy requirements that must be covered in humans.

1.3.2.2.3. Carbohydrates

The main source of energy for most Africans, Asians and South Americans is carbohydrates, which can make up 80% of their diet. In industrialized countries, on the other hand, carbohydrates constitute only 45 to 50% of the daily diet. (Latham, *et al.*, 2001). According to CV Agostoni, *et al.* (2010) AFSSA recommends that digestible carbohydrates represent between 45 and 60% of total energy intake (EFSA, 2010).

Recommends that carbohydrates should make up at least 50% of total energy intake. According to the nutritional recommendations of most European countries and those of the United States, the overall carbohydrate intake should cover at least 55% of the total energy intake (TEI). These recommendations also indicate that carbohydrate intake should be mainly in the form of complex carbohydrates, i.e. in the form of the starch contained in cereals, legumes, tubers and roots. However, no recommendation specifies the percentage of the TEI

that could or should be covered by simple carbohydrates (mono- and disaccharides) ("Recommandations nutritionnelles pour la Belgique," 2009).

Their energetic interest is considerable since they cover globally 50 to 70 % of the energy needs: 1 g of carbohydrates brings 4 kcal (J. L. Schlienger, 2011a). The current dietary intake of added sugars in Belgium is not precisely known, but in the United States this intake varies in children between 10% and 30% of the TEI (Kranz, *et al.*, 2005), and according to current American recommendations it should not exceed 25% of the TEI in adults (S. P. Murphy, *et al.*, 2003). In addition, increased consumption of these foods decreases the fat fraction of the overall food intake.

1.3.2.3.Micronutrients

These are vitamins, minerals, trace elements and other micro-constituents grouped under the term micro-constituents. Their energy contribution is nil or negligible, and their role is mainly qualitative. Their total or partial deficiency has repercussions of unequal severity, in principle reversible (J. L. Schlienger, 2011a).

All of these substances, classified as micronutrients, are present in small quantities in the body but are essential for many physiological functions such as muscle contraction, traffic and transmission of neuronal information, and repair of damaged tissue. A balanced diet must provide a certain amount of these substances which are necessary for proper cellular functioning (Bigard, 2007). Micronutrients are essential to the enzymes that are at the origin of cellular biochemical activity. Without micronutrients, there is no cellular biochemical activity, and therefore no life (Erbs, 2015).

A defect of intake can lead to a multitude of signs ranging from those that are not very specific, such as fatigue, concentration problems, and reduced resistance to bacterial and viral agents, to those that are much more specific, such as osteomalacia secondary to a lack of vitamin D intake in adults or rickets in children. The first cause of blindness in the world is due to a vitamin A deficiency, fortunately exceptional in France. The diet must therefore be sufficiently well directed and diversified to provide all the nutrients, but also micro-nutrients to cover the needs of the body. These needs are closely related to life situations: age, level of physical activity, maternity, pathology, etc.(Chevallier, 2009).

1.4. Energy Expenditure

1.4.1. Definition

Energy expenditure (EE) can be considered as a process of energy production from energy substrates (carbohydrates, fats, proteins and alcohol), combustion, in which there is a consumption (O2) and production of carbon dioxide (CO2). Some of this chemical energy is lost in heat and in urine, and the remaining energy is stored in molecules known as adenosine triphosphates (ATP). Total energy expenditure (TEE) is the energy required by the body daily and is determined by the sum of 3 components: basal energy expenditure or basal metabolic rate, diet-induced thermos genesis and physical activity (PA) (Clarke, *et al.*, 2010), energy expenditure can be measured by assessing total heat production in the body (direct calorimetry) or by assessing oxygen consumption and carbon dioxide production (indirect calorimetry) and double-labeled water (Goran & Treuth, 2001), Bioelectric impedance, doubly labeled water , predictive equations generally extrapolate the result basal metabolic rate (BMR) a period of 24 hours, expressed in kJ / 24 hours, to be more meaningful, called the basal energy expenditure (BEE) or resting energy expenditure , respectively, and others (Fett, *et al.*, 2006; Table, 2005).

Resting energy expenditure (REE) defined as whole body energy expenditure under standard conditions, is the largest fraction of total energy expenditure (FAO/WHO/UNU, 2004) (Wang, 2012), are the major component of daily energy expenditure, accounting for 60-70% of total energy expenditure for most individuals. Measurements of REE by indirect calorimetry are becoming increasingly popular as indirect calorimeters become more widely available. REE is influenced by various variables, such as height, weight, gender, health status and age. The ratio of resting energy expenditure to body mass (REE/BM) is not stable throughout life, but depends on factors such as age, gender and adiposity (FAO/WHO/UNU 2004) (Monda, *et al.*, 2008).

According to Turton (2006) Metabolic expenditure, like any energy output, is expressed in watts, or joules per second (1W = 1 J/s). This mode of expression is consistent with the whole system of measurement of physical quantities. This is not the case for kilocalories per minute (kcal/min), a unit often used in the past. 1 cal = 4.18 J; 1 kcal/min = 4.18 × 1000/60 = 70 W. Measuring energy expenditure therefore amounts to quantifying one of the three terms that define human energy status, terms that are linked together by the following equation:
Energy input = energy expenditure ± change in energy reserves (Ritz, *et al.*, 2005).

1.4.2. The energy expenditure evaluation method

The Basal Energy Expenditure is the amount of calories expended per minute or per hour that can be extrapolated to 24 hours; it also represents the minimum energy required for vital body functions maintenance. The Basal Energy Expenditure is one of the most important physiological information in clinical and epidemiological nutritional studies, since they are used to determine the energy of an individual or a population (Wahrlich, *et al.*, 2001). BEE contributes 60-70% of daily energy for most sedentary people and nearly 50% for physically active people. Its determination is useful for comparing energy metabolism between individuals (Esteves de Oliveira, *et al.*, 2008).

Assessment of resting energy expenditure (REE) provides useful information for body weight management. The REE corresponding to each activity, as well as the average Daily Energy Expenditure (DEE) of each volunteer, were evaluated by the factorial method used to evaluate the energy RNIs of the French population (Dudouet, 2010):

DEE = sum of the DE corresponding to the N activities of the day (including sleep)

DEE = sum (of 1 à N) of (BM x PAR x duration)

BM= basal metabolic rate (kJ/min); PAR "Physical Activity Ratio", or "relative energy cost": the ratio between the energy cost (kJ/min) of a given activity for a given intensity, and the BM (kJ/min).

Duration of each activity (minutes); 1 to N: activity number. Accurate estimation of BM is essential as it is the basis for evaluating the performance of all activities.

The Food and Agricultural Organization (FAO) prediction relationships were used because they take into account the sex, height and weight of the subjects and were found to be the most accurate and reliable for adolescents aged 10 to 18 years when tested for validity with recent experimental data (Dudouet, 2010):

$$Boys: BM = (69.4 \text{ x } W) + (322 \text{ x } H) + 2392$$

$$Girls: BM = (30.9 \text{ x } W) + (2016.6 \text{ x } H) + 907$$

(*Per 0.239 Kcal.J^{-1}); H: represents height in meters. W: is weight in kg (in KJ.J^{-1} according to (Organization, 1986)).

So :

$$Boys: BM = (16.6 \text{ x } W) + (77 \text{ x } H) + 572$$

$$Girls: BM = (7.4 \text{ x } W) + (482 \text{ x } H) + 217$$

BM is expressed in $Kcal.J^{-1}$($KJ.J^{-1} \times 0.239$ Kcal $.J^{-1}$)

The renewal of energy in the muscle fibers cannot be measured directly. However, there are many indirect measurement methods to calculate the amount of energy expended by the body, at rest or during exercise (Abla, *et al.*, 2015).

1.5. Distribution of intakes between meals

The distribution of energy and nutrient intakes over the course of the day also appears to play an important role in the regulation of intakes and the energy balance of nutrients (Thibault, *et al.*, 2003).

A meal implies many factors, especially the number of components, the foods chosen, how they are prepared and combined, the number of courses, and the number of dishes in each course (Larson, 2002). In the Middle Ages, it is likely that most people took two meals a day. In some countries, the food served or helped define the meals. For many years the typical evening meal in France, supper, included soup, while the midday meal did not.

Due to their long and physically demanding working days, people in Scandinavian countries have developed a different meal pattern with up to six meals per day, for example, three hot meals and two or three lighter meals or snacks (McIntosh, 1995). Energy balance eating behaviors eat regular main meals (breakfast, lunch and dinner) (Mota, *et al.*, 2008) and the other meal as snacks (before breakfast, between breakfast and lunch, between lunch and dinner, after dinner, or other) (Kant, *et al.*, 2015).

The relationship between main meals and overweight and obesity, and also whether watching television during meals is associated with overweight and obesity; high rates of overweight and obesity have been associated with watching television during meals in younger children; there may also be a link between high television viewing and a generally unhealthy lifestyle (Lissner, *et al.*, 2012).

1.5.1. Breakfast

Breakfast suggests an important role in the frequency of meals and define as the first meal of the day that breaks the fast after the longest period of sleep and is consumed within 2 to 3 hours of waking and among our meals in that it is consumed after a long period of fasting, in this case a night fast (Gibney, *et al.*, 2018; O'Neil, *et al.*, 2014).

Breakfast is often widely recognized as the most important meal of the day (T DWYER, *et al.*, 2001); Eating breakfast provides energy to the brain and improves learning, have favorable nutrient intakes, including a higher intake of dietary fiber, total carbohydrates and low amounts of fat and was an important source of calcium and B vitamins, but with a wide range of micronutrients for each meal and also controlled appetite and reduce the risk of overeating (Adolphus, *et al.*, 2013). This meal makes an important contribution to the nutritional intake of children (Wilson, *et al.*, 2006), supply an opportunity to consume foods such as grain products and fruits and considered eating behavior as a marker of diet, in addition to an essential element of a healthy lifestyle, important in the prevention of disease and improve cognitive performance in terms of concentration and memory (Rampersaud, *et al.*, 2005), In addition, regular breakfast consumption was correlated with energy balance.

Breakfast eaters tend to have a higher basal metabolic rate and feel less like eating. Children who skip breakfast argued that "long-suffering from hunger fills the stomach with bad moods "but eat later in the day can catch up with their daily nutrient needs, but they are unlikely to attend and focus on the teacher's lecture in the morning because they are hungry, this behavior associated with the risk of overweight during adolescence (Gajre, *et al.*, 2008).

1.5.2. Lunch and dinner

It is generally accepted that lunch should represent 35 to 40% of the TEI and 30% for dinner (Abla & Agli, 2015).

Dining at home or outside, alone or in the company of a spouse or a friend, are all variations of a practice strongly marked by habits and by age.

Lunch breaks generally present the used with an opportunity to rest from work at mid-day and consume food. In particular, lunch breaks represent the longest break in the working day and therefore are likely to play a considerable role in energy recovery (Trougakos, *et al.*, 2014). Lunch consumed decreases snack consumption compared to recall of non-food memories or breakfast taken the day before (Higgs, 2002). In addition, the effect of the recall

on snacking depends on the time between lunch and snack. Intake is not reduced when the recall occurs only 1 hour after lunch, but is reduced when the recall occurs 3 hours after lunch (Higgs, *et al.*, 2011). In Europe, lunch is always the most important meal, while in the U.S., the main meal is usually eaten in the evening; The restaurant industry tracks customer traffic by meal (Larson, 2002). At lunch, 55% of respondents had a starter, 97% had a main course, 63% had a dairy product or cheese, and 63% had a dessert. These choices, as well as the consumption of cold or hot beverages, do not differ according to income (J.-L. Schlienger, 2010).

1.5.3. Snack and Taste

Everything consumed between the main meals is asked the usual definition of frequency of food consumption between the three main meals (breakfast, lunch, dinner) and the "snack" calculated frequency per week (Hartmann, *et al.*, 2013). Snack eat away from home, snacking and consuming sugary drinks and energy rich foods like salty snacks (Wouters, *et al.*, 2018). This nutrition plays a more important role than the frequency of snacking itself. "Snack" can mean either eating food between meals or eating a light meal. Certain energy-dense foods whose consumption tends to increase (e.g., beef and pizza) have been shown to be important components of meals, rather than snacks. Foods that are consumed as snacks and foods that are consumed as a meal could both influence diet quality, energy intake, and weight gain (HartmannSiegrist & van der Horst, 2013).

Snacks were defined in relation to caloric consumption, in relation to social interaction and based on time of day of consumption (Chaplin, *et al.*, 2011). A distinction has been made with respect to motivation to eat with snacks being defined as eating episodes not triggered by hunger; snacks are often referred to in relation to meals as smaller, less structured eating adventures (Marmonier, *et al.*, 2002). Although there is no clear definition of a snack in relation to a meal as "food or drink consumed other than with the main meals".

The consumption of snacks (e.g., salty snacks and sweetened beverages) and the contribution of snacks to total energy intake have steadily increased over the past few decades. One cause of this disturbing trend may be the difficulty of restricting food intake. Therefore, a conscious decision to stop eating or drinking requires self-control and mental resources (Genschow, *et al.*, 2012).

Although environmental cues can influence food consumption, these situational and environmental cues lead people to classify food as a meal or snack, which they may eat more

than if they had considered it a snack (Wansink, *et al.*, 2010). However, they could end up consuming fewer total calories throughout the day, as they will not eat a full lunch compared to those who coded the reception as a snack. Individual foods contributing the most to the increases in energy consumed were sweetened beverages and salty snacks. Sweetened beverages are sold in almost all grocery stores as well as most restaurants, and are available from snack counters and vending machines in many workplaces and schools and have been associated with obesity and weight gain (Farley, *et al.*, 2010).

Different foods were noted in reference to meals or snacks with candy, cereal bars, cookies and soft drinks being more likely to be reported as snacks. Differences were also observed between males and females, with males consuming more fruit, soft drinks and sandwiches and females eating more chocolate, cookies, cakes and chips as snacks. (Chaplin & Smith, 2011).

1.5.4. Snacking

Nowadays, eating habits are moving away from eating three meals a day to eating more small amounts of food frequently (snacking). Snacks represent 15-20% of our daily energy intake, 15-20% of our mineral intake and 13-17% of our daily vitamin intake. It has been found that snacks differ from meals in terms of size, nutritional content and feelings of hunger and thirst before and after the event (Chaplin & Smith, 2011).

Snacking is the meal most often consumed in response to hunger, is eaten to satiety and as any opportunity to eat between meals (Chapelot, 2011). There are several accepted definitions of snacking for the development of healthy snacking recommendations; concluded: "Leaving such a key concept undefined and simply understood by an a priori common idea seems inappropriate in epidemiological and nutritional research and may affect the accuracy of the information proposed as well as the validity of the conclusions proposed. "Furthermore, concluded: "Clearly, a more consistent approach would facilitate interpretation of the literature and allow one of the health education messages on 'snacking' to be delivered. (Johnson, *et al.*, 2010).

But there are two main approaches have been used to define the term "snack" the first approach focuses on the food consumed; foods are identified as snacks by their nutrient content or because they are commonly associated with snacking. The second approach focuses on the timing of food consumption (HartmannSiegrist & van der Horst, 2013).

Snacking habits more frequently consumed potato chips, French fries, whole milk and fruit drinks, while those with higher incomes consumed more salty cereal-based snacks, fruit, skim milk, soft drinks, coffee and tea (Johansson, *et al.*, 2010).

2. Obesity

2.1. Definition

Overweight and obesity are defined as abnormal or excessive accumulation of body fat that represents a risk to general health and can be considered as a biological phenomenon, either reflecting the normal variation of body fat or indicating some biological dysfunction (Suvan, *et al.*, 2011). Obesity occurs when energy intake exceeds energy expenditure, leading to the storage of excessive amounts of triglycerides in the adipose tissue (Dehghan, *et al.*, 2005). The adverse metabolic effects caused by obesity can result in increased risk of type 2 diabetes, many forms of cancer, fatty liver disease, hormonal disorders, hypertension, cardiovascular disease (CVD) and increased mortality (Flegal, *et al.*, 2007; Herrera, *et al.*, 2010).

Childhood obesity is a significant and common problem. Fat children are less likely to be admitted to university, and this cannot be explained by a trivial academic inferiority, Although the presence of obesity in childhood can have negative consequences on childhood self-esteem, in adulthood, they experience more difficulty in obtaining a job (Loader, 1985; Strauss, 2000).

Technological changes have influenced how children and adolescents use their time outside of school (the Internet and video games being two potentially relevant elements) and decreased food prices and increased costs of time induce higher and less healthy food production, lower food prices combined with lower relative prices of unhealthy foods, and physical inactivity may contribute to increased obesity among adolescents (Classen, *et al.*, 2005).

Adolescence is a critical period for the development of self-esteem in obese people and changes in body composition, as well as changes in insulin sensitivity and concentrations of adipocytes (chemicals produced by the fat cell) such as leptin and adipocytes. Adolescents with higher BMI had 30% higher mortality rates than young and middle-aged adults, although the persistence of higher BMI into adulthood accounted for much of the association (Biro, *et al.*, 2010). Obesity is a growing global pandemic and prevalence rates of obesity worldwide have been duplicated since 1980 (Popkin, *et al.*, 2012). An estimated 205 million men and

297 million women are obese - a total of more than half a billion adults worldwide (Marcos, *et al.*, 2017).

According to Gianquinto, *et al.* (2012) In adults, several methods exist to define obesity. Thus, we can identify:

- Body mass index ;
- Waist to hip ratio ;
- Skin folds ;
- Impedance measurement ;
- The hydro-densitometer ;
- MRI or Magnetic Resonance Imaging;
- The scanner can identify small deposits of adipose tissue.

2.2. Forms of Obesity

Apart from the body mass index, specialists also distinguish two forms of obesity, depending on the type of fat distribution.

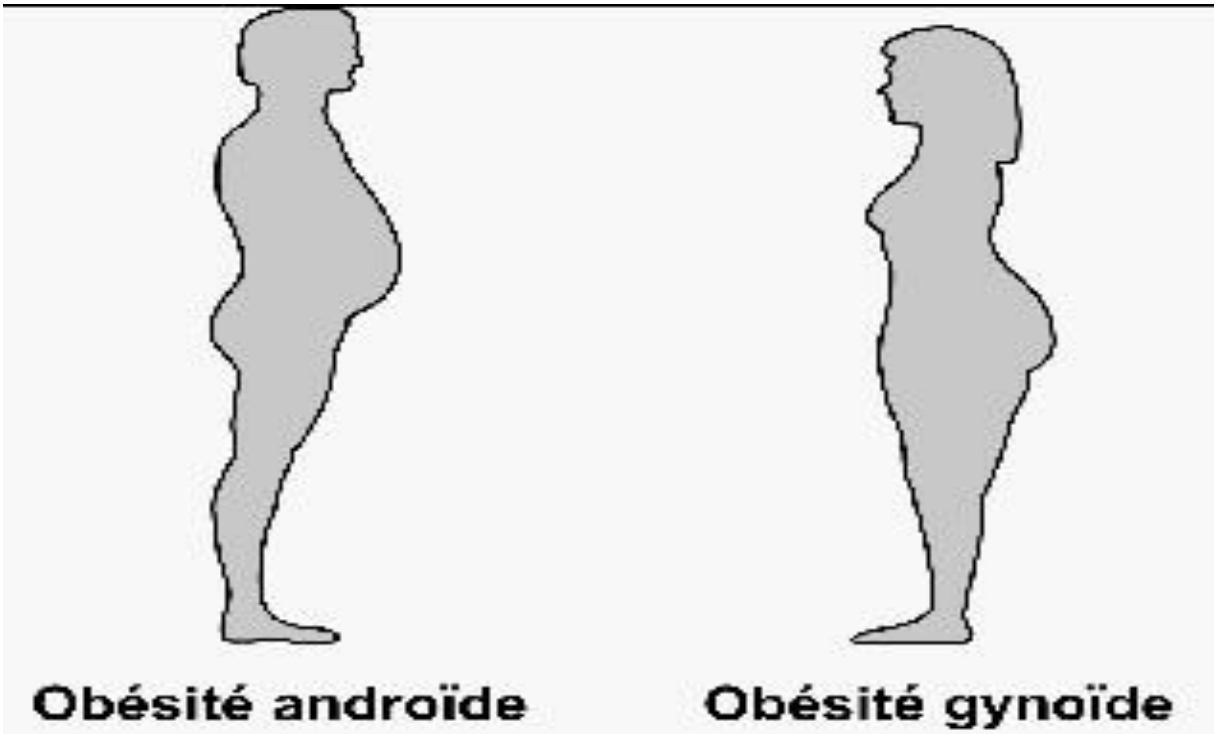


Figure 1. Forms of Obesity

2.2.1. Abdominal Obesity (android)

Abdominal obesity is intimately associated with metabolic syndrome and type 2 diabetes, both of which are independent risk factors for coronary and cerebrovascular disease (Scheen, *et al.*, 2007). The recommendation to measure waist circumference rather than body mass index (BMI) recognized the important part played by abdominal obesity in the metabolic syndrome (Després, *et al.*, 2006). An "android" obesity is defined by the ratio: w/h strictly greater than 0.85 (Bernard, *et al.*, 2003). Android obesity is more diabetogenic than gynoid obesity (Dargent, 2005).

2.2.2. Gynoid Obesity (peripheral)

The fat mass settles rather in the lower part of the body. This type of obesity has less impact on health, mainly causing joint problems or venous insufficiency. It is nevertheless more difficult to overcome than android obesity. A "gynoid" obesity with a ratio strictly less than to 0.64 (Bernard, *et al.*, 2003).

Women with gynoid obesity rarely have disturbed cycles and have normal androgen levels (Poncelet, *et al.*, 2011).

Figure 2. Gynoid obesity in men and women.

2.3. Diagnostic and Classification

2.3.1. Body mass index (BMI)

Overweight and obesity are generally defined by body mass index (BMI) in clinical practice (Elagizi, *et al.*, 2018). BMI has been calculated as body weight in kilograms divided by height in square meters (in kg/m^2) and the most frequently used diagnostic tool in the current system of classification as overweight or obese for decades (Cawley, *et al.*, 2006; Gómez-Ambrosi, *et al.*, 2012; Inge, *et al.*, 2010).

BMI is a robust but indirect measure of body fat that provides more reliable results than "ideal weight" or other weight/height ratios; this method has been used consistently in most behavioral studies, is the key measure for evaluating weight loss programs; the World Health Organization (WHO) has classified BMI as follows (James, 2004; Rahman, *et al.*, 2010; Jaap C Seidell, *et al.*, 2001): Normal weight (BMI less than 25 kg/m^2), overweight is defined as a BMI between 25 and 30 kg/m^2.and Obesity is generally defined as a body mass index (BMI) of 30 kg/m^2 and above (Reyes, *et al.*, 2016; Jacob C Seidell, *et al.*, 1997).

The average human body is generally composed of 82% lean body mass, essential for maintaining daily life and physical activities, and 18% body fat, which in essence is the energy stored for emergency situations (Kanazawa, *et al.*, 2005). Population-based studies have proven the metabolic consequences of a BMI ≥ 25 kg / m^2 and the mortality risk of a BMI ≥ 30 kg / m^2 (Batsis, *et al.*, 2016).

Body mass index (BMI) is a simple measure commonly used to estimate overweight and obesity in the adult population (both sexes and all age groups). BMI is defined as:

$$BMI = \frac{W}{H^2}$$

Table 3. WHO classification in weight category according to BMI

WHO Category	BMI (kg/ m^2)
	Threshold value
Thinness	< 18.50
Severe thinness	< 16.00
Moderate thinness	16.00 – 16.99
average thinness	17.00 – 18.49
Normal	18.50 – 24.99
Overweights	≥ 25.00
Pre-Obesity	25.00 – 29.99
Obesity	≥ 30.00
Obesity classe I	30.00 -34.99
Obesity classe II	35.00 – 39.99
Obesity classe III	≥ 40.00

2.3.2. The waist to hip ratio

It is important to know that the distribution of body fat is different in women and men. It represents 20 to 25% of the weight in women and 10 to 15% in men. Fat mass accumulates on the hips and thighs in women; this is called gynoid distribution. In men, on the other hand, fat accumulates on the abdomen and chest; this is called android distribution. The waist/hip ratio allows us to know where the fatty masses are located. This ratio is calculated as follows: waist circumference in cm divided by hip circumference in cm. This ratio must be less than 1.0 for men and less than 0.85 for women (Gianquinto & Cloes, 2012) .

2.4. The corpulence of children during growth

In children, overweight and obesity were defined using BMI percentile curves specific to each country. At the end of the 1990s, awareness of the global epidemic of childhood obesity led to the development of a common international definition of overweight and obesity. In

France, to define overweight, it was decided to keep the 97th percentile of BMI curves established by Rolland-Cachera et al. (Tounian, 2006) .

When the BMI value is above the 97th percentile curve, it is called obesity (Borys, *et al.*, 2005). The cut-off value used to diagnose obesity (BMI) in children and adolescents by age and gender established by the U.S. Centers for Disease Control and Prevention (CDC) and the International Obesity Task Force (IOTF) as follows (Javed, *et al.*, 2015; Twig, *et al.*, 2016) :

- Underweight was defined as a BMI below the 5th percentile ;
- Body dissatisfaction depressive symptoms in youth who are normal weight (>5th and <85th percentile of BMI) ;
- Overweight was defined as a BMI between the 85th and 94th percentiles ;
- Obesity was defined as a BMI at or above the 95th percentile (Goldfield, *et al.*, 2010; Vivante, *et al.*, 2012).

These curves are essential for monitoring the progress of children. A regular height curve in the same corridor between the limits of -2 and +2 standard deviations indicates that the statuary growth is normal (Thibault & Rolland-Cachera, 2003).

2.5. Causes and risk factors

The severity of the excess weight, the type of body fat distribution plays an important role, in particular, the accumulation of fat at the intra-abdominal level. The risk of cardiovascular disease is increased for a waist circumference greater than 80 cm in women and 94 cm in men, and considerably increased for values greater than 88 cm and 102 cm, respectively. Indeed, such a distribution is associated with multiple pathologies such as type 2 diabetes, arterial hypertension, dyslipidemia and disorders of coagulation and platelet aggregation, obstructive sleep apnea and hypopnea syndrome (Rorive, *et al.*, 2005).

According to Chatard (2005) risk factors for obesity:

- Health living ;
- The duration of sleep ;
- Previous growth ;
- The food ;
- Physical activity and the sedentary.

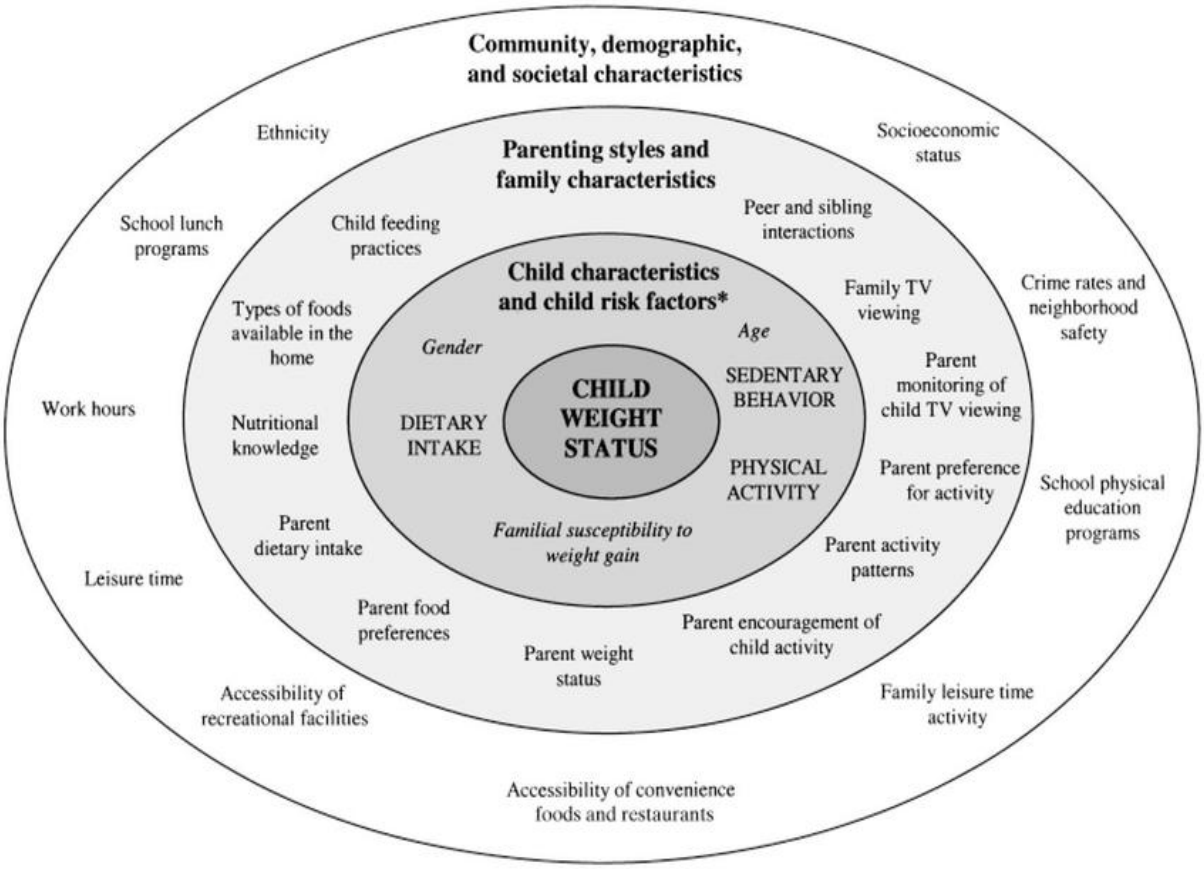


Figure 3. Risk factors for the development of childhood obesity (Davison, et al., 2001)

Childhood is characterized by a series of critical events: the expression of genetic heritage with maximum consequences, the development of fat tissue, the learning of behavior, the establishment of individual physiological and metabolic characteristics. An early imbalance is therefore likely to have long-lasting consequences that are difficult to reverse (Frelut, *et al.*, 2007).

2.6. Epidemiology

Obesity and sedentary lifestyle are the two main factors that predispose to metabolic syndrome (Bonnet, *et al.*, 2005).

The prevalence of obesity, which depends on the definition, increases with age and sedentary lifestyle. More than 30 million overweight children live in developing countries and 10 million in developed countries. Obesity is associated with an increased risk of cardiovascular mortality of 2.5 and overall mortality of 1.5 (J.-L. Schlienger, 2017) .

The first two principles of the treatment of obesity are, firstly, an improvement of the hygiene of life with in particular a loss of weight; secondly, an increase of the physical activity (Bourre, 2010). A change in lifestyle including an increase in moderate physical activity (20 to 30 minutes at least 3 times a week), and a balanced diet with a low-calorie diet in case of overweight and/or obesity (reduction of 10% of daily energy intake with a distribution of 30% lipids, 50% carbohydrates and 20% proteins) constitute the basis of management (Bonnet & Lavile, 2005).

The prevalence of obesity is associated with (M Duclos, 2007) :

- low physical activity level
- low exercise capacity
- low muscle strength

2.6.1. The prevalence of obesity in the world

The prevalence of obesity among children and adolescents remained stable between the mid-1960s and 1980. From 1980 to 2002, the rate of obesity among children aged 6 to 11 years more than doubled, from 7 to 16 percent; among adolescents aged 12 to 19 years, it tripled, from 5 to 16 percent (Classen & Hokayem, 2005). During this period, many medical and public health departments and researchers have sought explanations for this rapid growth (Classen & Hokayem, 2005).

In most countries, the next 30 years witnessed a rapid increase in the prevalence of obesity. In countries with the highest obesity prevalence in the 1970s, such as the United States, the increase continued until the 2000s. At other countries, a clear inflection occurred during the period, as early as the 1980s in Great Britain, during the 1990s in France and in many other Western European countries (Aeberli, *et al.*, 2010; Popkin, *et al.*, 1998). According to WHO global estimates for 2008: more than 1.4 billion people aged 20 and over were overweight and about 40 million children under five were overweight in 2011.

In 2000, the Inseam report entitled "Obesity, screening and prevention in children" confirmed the increasing prevalence of obesity in this population. In France, 10 to 12% of children aged 8 to 10 years are obese. Today, obesity is a chronic disease whose consequences have repercussions at different levels: metabolic, cardiac, respiratory, osteoarticular (Bernard, *et al.*, 2003).

Among the point measures of childhood obesity that have been conducted, a value of 8% was found in a study conducted in a population of children aged 6 to 12 years with a maximum prevalence of 16.7% in 12-year-old girls (Czernichow, *et al.*, 2001).

The prevalence of obesity among children and adolescents is increasing significantly. In France, nearly 12% of children under 18 years of age are obese, i.e. more than 1.5 million children (F. Depiesse, 2009).

In the United States, the prevalence of childhood obesity is 27% for 6 to 11 year-olds, while in France it varies between 12 and 14% but for a younger age group (between 4 and 8 years old). In 2006, the WHO proposed growth curves for children under 5 years of age and is working on harmonizing curves for other age groups (Caroline, 2014).

According to international estimates, the proportion of children and adolescents of average weight who develop obesity as adults is 10%. (Schoentgen, *et al.*, 2017). In addition, about 40% of children who are obese before puberty and about 60% of obese adolescents remain obese as adults (SchoentgenLancelot & Le Gall, 2017).

In Canada, the prevalence of overweight and obesity among children aged 12 to 17 years is 29%. Recent publications showing a stabilization of the prevalence of overweight and obesity in France are of particular importance (Botton, *et al.*, 2008; Diouf, *et al.*, 2010).

2.6.2. The prevalence of obesity in Algeria

Except for a few surveys conducted in Constantine, we do not have precise data on the extent of the problem. In 1999/2000, a study conducted in Constantine among children and adolescents showed that the prevalence of overweight and obesity were respectively 10.2 and 5.2%. (MEKHANCHA D et coll. 2004).

The prevalence of obesity was 17.9% ± 2%. It was more frequent in adults (18.7% vs. 1.8%), women (24% vs. 11.5%) and in rural areas (26.9% vs. 15.4%). 45.8% of non-occupational subjects, 33.3% of shopkeepers, 21.8% of manual workers, 15.7% of civil servants and 5.5% of senior managers were obese. The prevalence of abdominal obesity was 30.4% according to the NCEP-ATP III (13.4% of men and 46% of women), 47.2% according to the IDF (32.2% men vs. 61%), and 29.9% according to the RTH (5.1% of men and 52.7% of women) (Mekideche, *et al.*, 2015). The prevalence of overweight and obesity was estimated in a sample of 1369 infants aged 6 to 24 months. The prevalence of overweight and obesity was 28.34%; overweight alone affected 18.41% and obesity 9.93% of children. (Abla & Agli, 2015).

The prevalence of obesity and overweight in a cross-sectional survey was measured in a sample of 251 children aged 8 to 12 years in the urban population of eastern Algeria. The prevalence of overweight and obesity was 21.5%. Overweight alone affects 15.9% and obesity 5.6% of children. Several characteristics differentiate overweight and obese children from normal weight children: obese children are less likely to eat breakfast and consume milk and snack more often on foods rich in carbohydrates and fats (Oulamara, *et al.*, 2006).

2.7. Consequences

The health consequences of obesity are many and varied, ranging from an increased risk of premature death to several non-fatal but debilitating diseases with adverse effects on quality of life (santé, 2003).

Particular attention is paid to the psychosocial repercussions of obesity in children and adolescents: poor self-esteem, psychological suffering, anxiety and depressive disorders can be found. The body image is generally deeply altered, which is not without influence on the construction of identity, especially during adolescence. Thus, the relational isolation of obese children and adolescents is often very significant, even if the subject defends it (F. Depiesse, 2009).

Overweight-related mortality increases as obesity occurs earlier in adult life. Obesity is significantly associated with hypertension, diabetes, hyperlipidemia, coronary, cardiac and respiratory insufficiency, biliary Lithuania, osteoarticular pathology and certain cancers (Basdevant, 2006).

An acceleration of statuary growth is often observed, but with a normal final height. This is due to an increase in IGF-1 concentration induced by hyperinsulinemia (J.-L. Schlienger, 2010).

Consequences of intra-abdominal obesity (J.-L. Schlienger, 2010) :

- Disorders of glucose metabolism ;
- Insulin resistance with hyperinsulinemia ;
- Glucose intolerance ;
- Type 2 diabetes.

Obese subjects have an increase in Glomerular Filtration Rate (GFR). Its expression in absolute value (ml/min) gives in most of the subjects values of 50% higher than those observed in subjects in norm weight (Laville, 2011).

Table 4. Main complications of obesity and associated pathologies (Basdevant, 2006)

Psychosociales	Alteration of quality of life, discrimination, prejudice; alterations in self-image and self-esteem, consequences of restrictive diets.
Cardiovascular	Coronary insufficiency, arterial hypertension, strokes, deep vein thrombosis, pulmonary embolisms, heart failure, vegetative dysfunction, respiratory insufficiency.
Respiratory	Sleep apnea syndrome; alveolar hypoventilation; pulmonary hypertension.
Osteoarticular	Gonarthrosis, low back pain, static disorders.
Digestive	Biliary Lithuania , hepatic stenosis, gastro esophageal reflux.
Cancers	Men: prostate, colorectal, biliary tract. Women: endometrium, bile ducts, cervix, ovaries, breast, colorectal.
Metabolic	Insulin resistance, type 2 diabetes, dyslipidemia, hyperglycemia, Gout, alterations in hemostasis: fibrinolysis, PAI1.
Endocrine	Infertility, dysovulation.
Renal	Proteinuria, glomerulosclerosis.
Other	Hypersudation, intracranial hypertension, obstetrical complications, operative risk.

3. Physical activity and sedentary

3.1. Definition of physical activity

Physical activity is defined as "any bodily movement produced by skeletal muscles that result in energy expenditure". (Dabrowska-Galas, *et al.*, 2013)

Physical activity level was determined by adding the product of practice times by practice frequency, resulting in a score in minutes per week, as well as exercise is a subset of planned, structured and repetitive activity done for improvement or maintenance of physical fitness. (Cheng, *et al.*, 2014).

Fitness is "a set of attributes that people have or achieve that relates to the ability to perform physical activity." (Eurenius, *et al.*, 2005).

Physical activity includes all modes of movement caused by muscular activity resulting in increased energy expenditure (Rauner, *et al.*, 2013) and "any movement caused by voluntary contraction of skeletal muscles resulting in a substantial increase in energy expenditure above the basal level" (Benjamin, 2012; Committee, 2008).

Children and adolescents 5 to 17 years of age should include accumulation of at least 60 minutes of moderate vigorous intensity physical activity per day recommended physical activity and bone and muscle strengthening activities and would achieve the health benefits associated with physical activity are form of sports, brisk walking (Tremblay, *et al.*, 2011). Strong physical activity strengthens muscles and bones (Faigenbaum, *et al.*, 1999). Decrease in screen time for watching television/computer during leisure time (2 hours a day) (Misra, *et al.*, 2009).

For healthy adults, 150 minutes per week of moderate intensity or 75 minutes per week of vigorous intensity aerobic physical activity, or an equivalent combination of moderate and vigorous intensity aerobic physical activity is recommended (Misra, *et al.*, 2012).

Regular physical activity in children and adolescents is widely recognized as essential for healthy growth and development, and obese youth are less physically active than those with healthy body composition and spend more time in sedentary activities, such as watching television and using other media (Hesketh, *et al.*, 2007). Reduced activity levels are suboptimal motor skill development and lack of motivation to participate fully in physical activity (Misra, *et al.*, 2012). Physical activity with a positive effect and reduced risk for depression may increase monoamines (e.g. serotonin, nor epinephrine, dopamine) (Jerstad, *et al.*, 2010).

Each physical activity can be characterized by intensity, frequency, duration and context. There are usually four main areas of physical activity based on context (Pate, *et al.*, 2008) :

- Professional physical activity ;
- Physical activity related to transportation (motorized, walking or cycling...);
- Leisure (or recreational) physical activity, including most sports activities;
- Domestic physical activity (in or near the home).

An activity can be measured in Kilojoules (KJ) or Kilocalories (Kcal); 4,184 KJ is essentially equivalent to 1Kcal (/). T Technically, the KJ is preferred to because it is a measure of Energy expenditure; however, historically the Kcal a measure of heat, has been used more often (K. SINGH, 2013).

3.1.1. Physical Activity and Health

Physical activities, in particular non-competitive sports or PSA, are structuring for growing youth and contribute to the harmonious development of body and mind. Especially with notions such as the respect of the playful rules of the PSA, with a real educational project of learning the rules of life in community, the values of the sport such as solidarity, equity, learning the rules of the game (Frédéric Depiesse, 2016b). Health promotion through physical activity (PA) is defined by the WHO (First International Conference on Health Promotion - Ottawa 1986) as "a process that empowers people to increase control over and to improve their own health". (Frédéric Depiesse, 2016a).

Regular physical activity has been shown in numerous international trials to be powerful in limiting weight gain and slowing the progression of predisposed subjects to type 2 diabetes (Andreelli, 2008).

Health promotion programs can be based on three fundamental principles (Frédéric Depiesse, 2016a) :

- health is more than the absence of disease ;
- health promotion is more than prevention ;
- Empowering individuals through education is a central strategy for prevention.

3.1.2. Physical Activity and Obesity

In 2000, the WHO declared obesity "the first non-infectious global epidemic." (M. Duclos, *et al.*, 2010).

The WHO Regional Office for Europe organized a ministerial conference on combating obesity in November 2006. This conference was based on expert recommendations which are reproduced in a document entitled: "Promoting physical activity for health: a framework for action in the WHO European Region". It states: "Physical inactivity is an important risk factor responsible for about 3.5% of disease and nearly 10% of death in the European Region. Its economic cost is enormous. The health effects and their costs could be reduced by increasing levels of physical activity.

Regular moderate physical activity is a very cost-effective way to improve and maintain health. Therefore, the promotion of physical activity should be an integral part of public health action." (M. Duclos, *et al.*, 2010).

If food is at the forefront, it is clear that "diets" have no long-term effect on weight loss and that only a global approach combining dietary measures and physical activity can claim to be effective. We have seen previously that after 45 minutes of fasting endurance, the body uses lipids exclusively; moreover, an increase in the basic metabolism of 30% has been noted, which continues in the 24 hours following the exercise. (Paumard, 2014).

3.1.2.1. Physical activity in the life of the obese child and adolescent

Physical activity in its richness and diversity is a stimulating factor in the growth of the child, it is beneficial physically, but also psychologically, intellectually and socially. Motor activity solicits biological, cognitive, social, emotional and relational dimensions. In particular, physical activity is of great benefit to children with disabilities and/or chronic illnesses, and it is important to limit as much as possible the contraindications to the practice of physical activity, whether in school, in a sports environment or in individual practice (F. Depiesse, 2009).

Obese children and adolescents often have a disturbed sleep (too short, of poor quality) because bedtime is delayed by hours spent in front of the television. The consequences on alertness and nocturnal secretion of growth hormone (GH) have been demonstrated. Moreover, the prevalence of apnea and hypopnea is not negligible in the presence of obesity (Frelut & Peres, 2007). Obesity in children and adolescents has multiple causes. Insufficient physical activity is a major contributor, but there are also genetic determinants.

The recent meta-analysis of studies examining the use of physical activity in the treatment of childhood obesity, shows that studies using physical activity doses of 155 to 180 minutes per week result in a decrease in body fat of obese children and adolescents (Atlantis, *et al.*, 2006).

Other objectives are assigned to physical activity as an essential element of the management of the obese child, such as increasing energy expenditure (Claudio Maffeis, *et al.*, 2007), increased lipid oxidation (exercise intensity where lipid utilization is maximal in young obese people: 40-50% of maximal oxygen consumption or 50-60% of maximal heart rate (Brandou, *et al.*, 2006; Stefano Lazzer, *et al.*, 2007), maintenance of lean body mass (S Lazzer, *et al.*, 2005; Claudio Maffeis & Castellani, 2007), appetite regulation (effect still to be clarified) (Moore, *et al.*, 2004)), of sleep (relationship to be elucidated in particular on the mechanisms (Atkinson, *et al.*, 2007)).

3.1.3. Physical Activity Recommendations

The goal of physical activity recommendation is to decrease the risk of chronic diseases such as obesity and cardiovascular disease, therefore it is necessary to increase the level of physical activity (PAL).

WHO developed the Global Recommendations on Physical Activity for Health to provide national and regional policymakers with guidance on the dose-effect relationship between the frequency, duration, intensity, type and total amount of physical activity needed to prevent non-communicable diseases.

Overall, the recommendations do not fundamentally change from the previous ones, regardless of the population considered (youth, adults, elderly), but two major changes should be highlighted (Vuillemin, 2011). The duration can therefore be cumulated over one or more days, and as before, only episodes of at least ten minutes are counted (M. H. Murphy, *et al.*, 2009). The other concerns the amount of vigorous intensity activity, whose duration increases to 75 minutes, instead of the 60 minutes (3× 20 minutes) previously recommended, i.e. half the duration recommended for moderate intensity activities, corresponding to an energy expenditure twice as high (Vuillemin, 2011).

The most recent recommendations, aimed at health maintenance and promotion for the general population, suggest 150 minutes per week of moderate intensity endurance-type physical activity. The equivalent of 75 minutes per week of high-intensity endurance activity

is given as (Ciangura, *et al.*, 2014), the addition of two non-consecutive weekly sessions of resistance activity (such as weight training) is also recommended (Haskell, *et al.*, 2007).

In France, the National Nutrition and Health Plan is the steering structure dedicated to the health determinant nutrition. The physical activity benchmark communicated to the public is "the equivalent of 30 minutes of brisk walking each day", i.e. a recommendation of about 840 Mets per week (calculation based on the average equivalent of the examples given in the PNNS communication tools: 7 days × 30 minutes × 4 Mets) (Antoine-Jonville, *et al.*, 2015).

3.2. Definition of sedentary

Sedentary is "characterized by little physical movement ,lack of physical activity, excessive sitting and low energy expenditure < 1.5 Mets in sitting or lying down or recumbent posture" as well as time spent in sedentary behavior due to a relative lack of movement, as well as a relatively low accelerometer the number of activities/min (e.g., <100) is generally used to define the time of people who engage in sedentary behaviors that increases with motorized travel (Gibbs, *et al.*, 2015; Schoeppe, *et al.*, 2013; Tudor-Locke, *et al.*, 2013; Van der Ploeg, *et al.*, 2017).

Sedentary lifestyle has been defined as prolonged engagement in behaviors characterized by minimal movement, low energy expenditure, and rest (Tudor-LockeCraigThyfault & Spence, 2013). "Sedentary time" this term was used to replace with "sitting" and sitting behaviors (Nurmagambetov, *et al.*, 2011).

Physical inactivity was described as performing insufficient amounts of physical activity, i.e. not meeting specific physical activity guidelines (González, *et al.*, 2017).

Sedentary behavior is defined by an accumulation of activity counts determined by accelerometer/min, as well as the rate of energy expenditure, attitude, or relatively low accumulation rates of activity/min such as sitting or lying down, watching television, screen time, computer, playing video games, using the Internet and other media (Aguilar-Farias, *et al.*, 2018; Colley, *et al.*, 2012; Edwardson, *et al.*, 2012; Gray, *et al.*, 2015).

The effects of time spent being sedentary during leisure time on significant risk associated with several aspects of ill health, including overweight and obesity and associated metabolic diseases have also been studied as (Harvey, *et al.*, 2013; O'Connell, *et al.*, 2014) : a 2-hour per day increase in time spent sitting or watching television was associated with a 7% increase in the development of diabetes (Hu, *et al.*, 2003). Sedentary behaviors; (time spent

sitting during the day between getting up and going to bed without physical stimulation) are defined as low energy expenditure behaviors (Hardy, *et al.*, 2011) (Annex 11).

Although a relationship between a sedentary lifestyle and weight gain has been noted, to date there is no longitudinal study involving repeated calculations of energy expenditure over time that would make it possible to affirm a causal link between sedentary lifestyle and obesity in children (C Maffeis, *et al.*, 1998).

So physical inactivity is now the leading cause of preventable death in developed countries, ahead of smoking (Dutheil, *et al.*, 2017; Wen, *et al.*, 2012). Lack of physical activity and sedentary lifestyle are two independent risk factors for multiple non-communicable diseases (NCD) (Berthouze-Aranda, *et al.*, 2011; Hamilton, *et al.*, 2007; Yung, *et al.*, 2009).

3.2.1. Effects of physical inactivity on the health of children and adolescents

Sedentary behavior is generally quantified in children, by the parents or by the child himself, as the time spent sitting and/or in front of a screen (television, game console, computer, Smartphone...). This measure of sedentary behavior appears acceptable in terms of validity and reproducibility. Physical fitness during childhood or adolescence is a predictive factor of good health in adulthood. Cardio respiratory endurance and muscular strength are the most influential components of physical fitness for prognosticating risk of chronic disease. (Vanhelst, *et al.*, 2016).

Regular physical activity during childhood and adolescence can influence an individual's health status through three mechanisms (Simon, *et al.*, 2005) :

- a direct effect on the child's immediate health (physiological and psychological) and quality of life ;
- a direct effect on the state of health of the future adult, by delaying or slowing down the evolution of risk factors that lead to chronic pathologies ;
- An indirect effect on the health status of the future adult by increasing the probability of maintaining a sufficient level of physical activity in adulthood.

A few longitudinal observational and intervention studies confirm that a high level of sedentary occupation promotes increased body mass index (BMI) or adiposity (SimonKlein & Wagner, 2005).

3.2.2. The consequences of Inactivity

Lack of physical activity, loss of physical-physiological capacities, decrease of the desire to practice and devaluation of oneself, hence the restriction of an already limited physical activity, the accentuation of the loss of capacities and of the desire to move, and so on (Berthouze-Aranda & Reynes, 2011).

The most visible consequence of a sedentary lifestyle is the sharp increase in obesity worldwide in recent years (Berthouze-Aranda & Reynes, 2011).

Obesity is not just a cosmetic issue. It is itself associated with serious health problems, such as increased risk of type II diabetes, cardiovascular disease and various cancers (Coyle, 2009; Patel, *et al.*, 2010; Venables, *et al.*, 2009). Physical inactivity is considered the fourth leading risk factor for mortality worldwide (6% of deaths), just behind hypertension (13%), smoking (9%), and high blood glucose (6%). Globally, 5% of mortality is attributable to overweight and obesity (Organization, 2009).

3.2.3. Prevalence of inactivity according to WHO

To maintain the health of children and adolescents in the 5-17 age group, the World Health Organization (WHO) recommends physical activity levels of at least 60 minutes per day of moderate to vigorous physical activity (Organization, 2010). This is two to three times more than what the WHO recommends for adults aged 18 to 64 (i.e., at least 150 minutes of moderate-intensity endurance activity or at least 75 minutes of sustained-intensity endurance activity per week) (Grélot, 2016).

The underlying reason for the WHO recommendations targeting young people is in fact twofold (Grélot, 2016) :

- PSA is a determining factor in the harmonious development (notably anatomical, physiological, psychological, emotional and social) of children and adolescents;
- Inactivity has become one of the main pillars of premature morbidity and mortality in adults today.

In its global recommendations on physical activity for health, the WHO states that in order to reap the full benefits of physical activity on physical and mental health (McLennan, *et al.*, 2015).

Method and Material

Methodology

1. Study setting

The study was conducted in the wilaya of Bejaia, which is an Algerian wilaya (equivalent to a department or province) located on the Mediterranean Sea at 220 km east of Algiers, at 36°45 north latitude and 5°04 east longitude , it includes 19 Daira (sub-department) and 52 communes. These communes of Bejaia had 160 middle schools and 60 high schools.

2. Study population

The study involves middle and high school students, hence the interest in having a representative sample of the school population (91810 enrolled students). Our sample consists of 3038 students: male (1403 boys) and female (1635 girls) (Annex 5).

This sample includes adolescents, both sexes, aged 11 to 23 years; the mean age is 14.78±2.53. The study is carried out on all 19 Daira composing the territory of the wilaya (Annex 2), it concerns students from the first average year to the third year of secondary school in all colleges and high schools in the wilaya of Bejaia (Eastern Algeria) during the 2017-2018 school year. Within the framework of this study, we reached covered 220 schools, including 160 middle schools (Annex4) and 60 secondary schools (Annex3). Access to these schools was subject to authorization by the Direction of Education National in the Wilaya of Bejaia after agreement of the school heads, in order to facilitate the field survey with the help of school screening units (SSU) affiliated to the Director of Health and Population of the Wilaya of Bejaia.

The schools were grouped into 19 geographic regions (Figure 4).

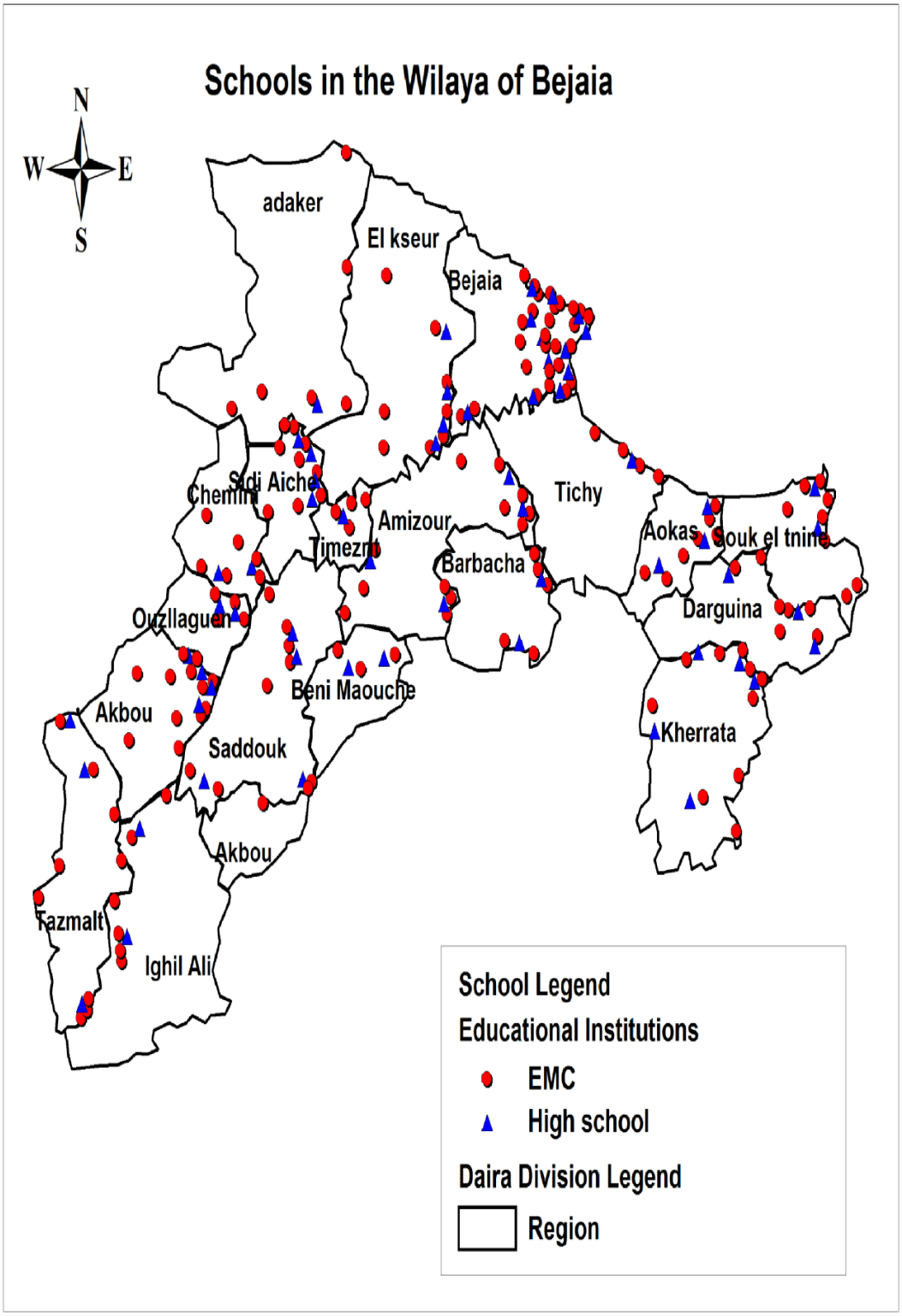


Figure 4. Schools in the wilaya of Bejaia

3. Procedure

This is a cross-sectional descriptive epidemiological survey whose objective is to describe the epidemiological status on a territory to demonstrate the prevalence of overweight and obesity on a sample of students in the wilaya of Bejaia. It is characterized by population sampling, without selection either on exposure or on disease (Bousquet, *et al.*, 2004; Descatha, *et al.*, 2005). The information was gathered from a questionnaire. Data that characterized the student (name, first name, age and gender) were collected, their anthropometric characteristics (weight and height); and schooling (name of school), and information on food consumption, 24-hour recall and physical activity of students were also required.

The questionnaire consisted of a series of questions (54 questions) divided into three sections: food consumption, 24-hour recall and physical activity (Annex1).

3.1. Determination of anthropometric parameters

The anthropometric parameters (weight/height) were measured using a scale (SECA electronic scale) (Annex 7), weight (kg) was taken using a scale (SECA) with a precision of 100 g which had been previously tested, immobile and without supports and a height gauge (conventional height gauges), The height (m) was taken with the help of a height gauge fixed beforehand and the height on the ground of the height gauges was checked with a tape measure. The height was taken on a child standing with his feet together and bare, arms hanging down by his side, knees extended, back and heels against the height gauge (Annex 6).

The length and height measurements were recorded to the nearest 0.1 cm. The weight was taken with a minimum of clothing and recorded to the nearest 0.1 kg. The measurement techniques were carried out using WHO recommendations.

The body mass index (BMI) is calculated by dividing the weight (W)expressed in kilograms by the square of the height(H) expressed in meters (Garriguet, 2008) as follow (Eq.(1)) :

$$BMI = \frac{W}{H^2} \quad (1)$$

BMI is the regularly accepted index for classifying obesity in adults and is recommended for children and adolescents (Garriguet, 2008; Kuczmarski, 2000). For adults there is a single BMI reference value through the WHO classification of adult weight status. BMI value lower than 25 kg/m^2 indicates a normal weight, a BMI value between 25 and 29,99 kg/m^2 indicates overweight, and BMI value over 30 kg/m^2 determines obesity (National Heart, *et al.*, 1998).

In children under 18 years of age, BMI is used in the follow-up of adolescents, with results reported on body shape curves with reference to the Centers of Disease Control and Prevention (CDC) (Annex 8 and 9). We used these values to determine the sensitivity and specificity of BMI values ≥ 85th percentile (overweight risk) and 95th percentile (obese) in the United States (Must, *et al.*, 1991) .

A BMI Z-score was used because it provides a relative measure of age-adjusted adiposity and minimizes the effect of time variation between baseline and follow-up (Thompson, *et al.*, 2006). Overweight can be expressed as a "BMI Z-score" which provides a numerical indication of deviation from the median for gender and age; BMI Z-score is used in clinical practice to accurately quantify overweight and obesity. The WHO recommends the indication of overweight by a Z-score > +1 SD. Obesity is indicated by a Z-score > +2 SD.Z-score expresses the number of standard deviations below or above the reference mean or median value for an anthropometric variable (Martinez-Millana, *et al.*, 2018).

A more detailed description of the distribution of Middle, High School and BMI Z-score calculations for girls and boys (both sexes) is represented on a map of the Wilaya of Bejaia using MapInfo.

3.2.Daily energy expenditure (DEE)

Daily energy expenditure (DEE) decreases gradually with age due to the decline in rest energy expenditure (REE) and physical activity level (PAL) (Bonnefoy, 2013).

DEE was calculated based on physical activity level (PAL) and base metabolism (BM) following this formula (Eq. (2)):

$$DEE = BM \times PAL \quad (2)$$

The DEE is expressed in Kcal

3.3. Basal Metabolic (BM) rate

For a child from 10 to 18 years old, basal metabolism can be predicted, with a measurement uncertainty of 5 to 10% by the following relationships (FAO/WHO/UN 1986) (Boisseau, 2005; Tounian, 2006) :

$$Boys: BM = (69.4 \text{ x } W) + (322 \text{ x } H) + 2392$$
$$Girls: BM = (30.9 \text{ x } W) + (2016.6 \text{ x } H) + 907$$

W: is weight in kg and H: represents height in meters.

So:

$$Boys: BM = (16.6 \text{ x } W) + (77 \text{ x } H) + 572$$
$$Girls: BM = (7.4 \text{ x } W) + (482 \text{ x } H) + 217$$

BM is expressed in Kcal.J^{-1}(KJ.J^{-1} × 0.239 Kcal .J^{-1})

3.4. Physical Activity Level (PAL)

Energy expenditure was assessed using data collected on school activity (number of hours spent in school), daily and leisure activities according to Tableau 5 (Martin, 2001). Physical Activity Level was calculated according to the following formula (Eq. (3)):

$$PAL = \frac{Coefficient\ of\ \ the\ PAL \text{ x } duration\ (hours)}{24} \qquad (3)$$

Table 5. Activities classification of children and adolescents in 7 categories according to physical activity level (PAL).

Category	PAL	Different activities
A	1	Sleep and nap, extended rest
B	1.75	Sitting position. (TV, computer, homework, meals, transportation)
C	2.1	Standing position (shopping, cooking, short trips, toilet)
D	2.6	Light activities of low intensity (games can be active)
E	3.5	Moderate activities (brisk walking, manual work.)
F	5.2	Sports activities (club training, physical education and sports...)
G	10	Sports competition

Energy expenditure is related to physical activity for 24 hours (Bergouignan, *et al.*, 2006; Kleiber, 1961), A PAL of 1.0-1.4 characterizes sedentary individuals, while a PAL of 1.9-2.5 corresponds to very active individuals (Bergouignan & Blanc, 2006; Ekelund, *et al.*, 2002; Hunter, *et al.*, 1997; Salbe, *et al.*, 1997).

Organized sport was at low levels at all ages and unorganized sport was the major component of activity that is declining. The current finding among adolescents is that there is a high risk of decline in physical activity, but it is possible that the risk of decline is equal to or greater at older ages. During adolescence, all categories of physical activity declined due to a decrease in unorganized sport and vigorous physical activity, with maximum declines in the 15-18 year age group (Van Mechelen, *et al.*, 2000).

3.4.1. Evaluation of adolescent lifestyle on physical activities

Refers to the physical (or sports) activities practiced by adolescents (regular physical training, frequency, walking or cycling, physical activity for at least 30 minutes per week, use of collective equipment, regularity and combination of practices).

3.4.2. Environmental determinants

Environmental changes are likely to induce sedentary behaviors and modulate the level of physical activity in the population; therefore a more detailed description of the distributions of physical activity levels for girls, average and high school boys was obtained through mapping (MapInfo) of the wilaya of Bejaia.

3.5. 24-hour dietary recall

The adolescents food consumption is estimated using the "24-hour recall" method (Castell, *et al.*, 2015) , This method consists of describing food intake during the 24 hours preceding the survey (composition of each meal, name of food). These questions aim to find out the frequency of food consumption; meals and daily consumption to detail the food groups intake (such as sugary drinks, vegetables, fruits and dairy products) of adolescents during the three main meals (breakfast, lunch and dinner), and during snacks (morning and evening) and questions on snacking (food eaten, timing of snacking, snacking practice, frequency) and also the frequency of consumption of drinks during and outside meals. The 24-hour recall was calculated based on the energy value of each food, the energy intake supply is available (kcal per 100 grams of food) and the nutrient content (proteins, fat and carbohydrates in grams per 100 grams of food). According to the protein, lipid and carbohydrate content of each food, daily protein, lipid and carbohydrate intakes have been calculated for each consumed food. Then the sum of all the consumed foods was calculated. Thus, we obtained the consumed amount of protein, fat and carbohydrates per day.

3.5.1. Eating Habits and Behaviours

The questionnaire consisted of 25 questions that mainly included questions on eating habits in order to assess the students' lifestyle. This questionnaire aims to know how many meals are eaten, consumption of fruits, vegetables, meat and dairy products and the frequency of consumption of fast food, bakery products, commercial desserts, sweets and sweetened beverages, and salt-coated foods, according to

Institut de recherches cliniques de Montréal -2008 (https://sqha2.hypertension.qc.ca/wpcontent/uploads/2015/04/questionnaire.pdf).

3.6.Mapping of Bejaia

We opted for a mapping approach in our study in order to make the results of our research more visible with a representation of variable differences such as prevalence, Daily energy expenditure (DEE) and Total Energy Intake (TEI) over the whole territory, and also to determine and/or disparities of these variables within the territory (Burstein, 1989).

4. Statistical analysis

Data entry and analysis was done using the following software programs: Excel (2007), XLSTAT (version 2009), SPSS (IBM SPSS Statistics 25), STATISTICA version 7.1 and MapInfo (version 8.0)

The data analysis involved several steps:

- The data are presented as mean for both sexes (girls and boys) ± standard deviation (SD) ($p < 0,05$) ;
- Principal component analysis (Pearson correlation) ($p < 0.05$) was used to determine body mass index (BMI), physical activity level (PAL), daily energy expenditure (DEE) and total energy intake (TEI) using STATISTICA version 7.1 software ;
- The Z-test ($p < 0.05$) was used to compare averages of BMI, PAL, DEE, TEI of girls with those of boys ;

- The Z-test ($p < 0.05$) was used to compare averages of low activity levels with those of high activity levels in overweight and obese girls and boys using XLSTAT 2009 ;
- The Z-test ($p < 0.05$) was used to compare averages intensity of different physical activities in middle school girls and high school girls with those of middle school boys and high school boys ;
- The statistical analysis was based on the use of age regression by PAL of middle and high school girls and boys ;
- The correlation was used between different activities physical in low and high intensity ;
- Descriptive statistics were calculated for the intake of total energy intake (TEI) students at each meal, daily energy expenditure (DEE) and food consumption stratified by gender ;
- Correlations (Pearson Correlation) were examined between meals (breakfast, snack, lunch, taste, dinner party, snacking) and between energy balance (DEE and TEI).
- The mapping software MapInfo Professional 8.0 was used to demonstrate the significant difference between all the Daira in the wilaya of Bejaia ;
- We used a Z-score that more accurately reflects how far the measurement deviates from the mean, in addition it is a useful tool for tracking changes.

Results

Results

1. Body Mass Index (BMI)

Table 6 and 7 show that the average BMI value for the whole sample is equal to 30.51±2.99 Kg/m². However, the averages of BMI for the different sexes are: (32.71±2.48 Kg/m²) and (32.62±2.63 Kg/m²) for obese girls and boys; respectively, with significant difference at (p= 0,486) (Table 6). The mean BMI for overweight girls and boys are :(28.028±0.967 Kg/m²) and (28.252±0.940 Kg/m²), respectively, with significant differences at (p< 0, 0001) (Table 7).

Obese girls had an upper BMI Z-score of +1, whereas obese boys had a lower BMI Z-score of +1 with standard deviation with a significant difference (p < 0.0001) (Table 6). The mean Z-score BMI for overweight girls and boys are lower +1 SD with significant differences at (p < 0, 0001) (Table 7).

Table 6. Basic characteristics of studied obese population.

	Girls (868)	Boys (722)	*P*
Age (year)	15.15 ±2.59 {11-22}	15.09 ±2.61 {11-23}	0,653
BMI (kg/m^2)	32.71 ±2.48	32.62 ±2.63	0,488
BMI Z-score	1,74	0,24	< 0,0001
DEE (kcal)	2551 ±266.28	4089.53 ±640.93	< 0,0001
PAL	1.61 ±0.12	1.85 ±0.21	< 0,0001
TEI (kcal)	3307 ±408.93	4483.75 ±509.86	< 0,0001

BMI: body mass index; DEE: daily energy expenditure; PAL: physical activity level; TEI: total energy intake; {}: extreme
P: values for comparisons between boys and girls (< 0.05), performed with Z tests.

Table 7. Basic characteristics of overweight studied population.

	Girls (767)	Boys (681)	*P*
Age (year)	14.85 ±2.46 {11-22}	14.74 ±2.4{11 – 21}	0.417
BMI (kg/m^2)	28.028 ±0.967	28.252 ±940	< 0,0001
BMI Z-score	0,50	0, 30	< 0,0001
DEE (kcal)	2402.92 ±242.01	3779.62 ±1424.86	< 0,0001
PAL	1.60 ±0.12	1.85 ±0.23	< 0,0001
TEI (kcal)	3185.51 ±372.24	4284.90 ±447.34	< 0,0001

BMI: body mass index; DEE: daily energy expenditure; PAL: physical activity level; TEI: total energy intake; {}: extreme
P: values for comparisons between boys and girls (< 0.05), performed with Z tests.

Table 8 shows the characteristics of the studied population according to student gender. In both sexes, a BMI Z-score from age 11 to 14 years, greater than +2 represents obesity, while a BMI z-score from age 15 to 19 years, between +1 and +2 represents overweight.

Table 8. Characteristics of the studied population.

	Girls				Boys			
Age (years)	height (m)	weight (kg)	BMI (kg/m²)	BMI (Z-score)	height (m)	weight (kg)	BMI (kg/m²)	BMI (Z –score)
11	1.49	67.64	30.28	2.3	1.55	72.25	30.17	2.3
12	1.53	70.07	30.12	2.1	1.6	76.46	29.84	2.1
13	1.54	70.64	30.12	2	1.62	79.39	30.37	2.1
14	1.56	74.53	30.65	2	1.64	82.44	30.65	2
15	1.6	77.82	30.63	1.9	1.68	85.63	30.38	1.9
16	1.62	79.14	30.4	1.8	1.71	89.97	30.74	1.8
17	1.64	81.9	30.63	1 .7	1.74	93.02	30.79	1.8
18	1.65	84.26	31.09	1.7	1.75	93.28	30.63	1 .7
19	1.66	82.84	30.14	1.6	1.77	97.57	30.86	1.7

1.1. BMI for age -percentile: girls and boys, aged from 2 to 19 years

The results of the body shape curve for girls and boys aged from 2 to 19 years (Figure 5 and 6) show that the average BMI in girls between the ages of 11 - 13 years decreased from an average BMI of 30.28 kg/ m² to 30.12 kg/ m² (97th higher in the CDC body shape curve), at the age of 13 - 15 years an increase from 30.12 kg/ m² to 30.63 kg/ m² (95th higher in the CDC body shape curve) was observed, and we noted a decrease in average BMI, at the age of 15 - 19 years, from 30.63 kg/ m² to 30.14 kg/ m² (90th higher in the CDC body shape curve). On the other hand, in boys the average BMI between the ages of 11-14 years shows an increase from 30.17 kg/ m² to 30.65 kg/ m² (97th higher in the CDC body mass curve), a slight increase of 30. 65 kg/ m² to 30.75 kg/ m² at the age of 14-16 years (95th higher in the CDC body mass curve), and at the age of 16 - 19 years an increase was also observed from 30.75 kg/ m² to 30.86 kg/ m² (90th higher in the CDC body mass curve).

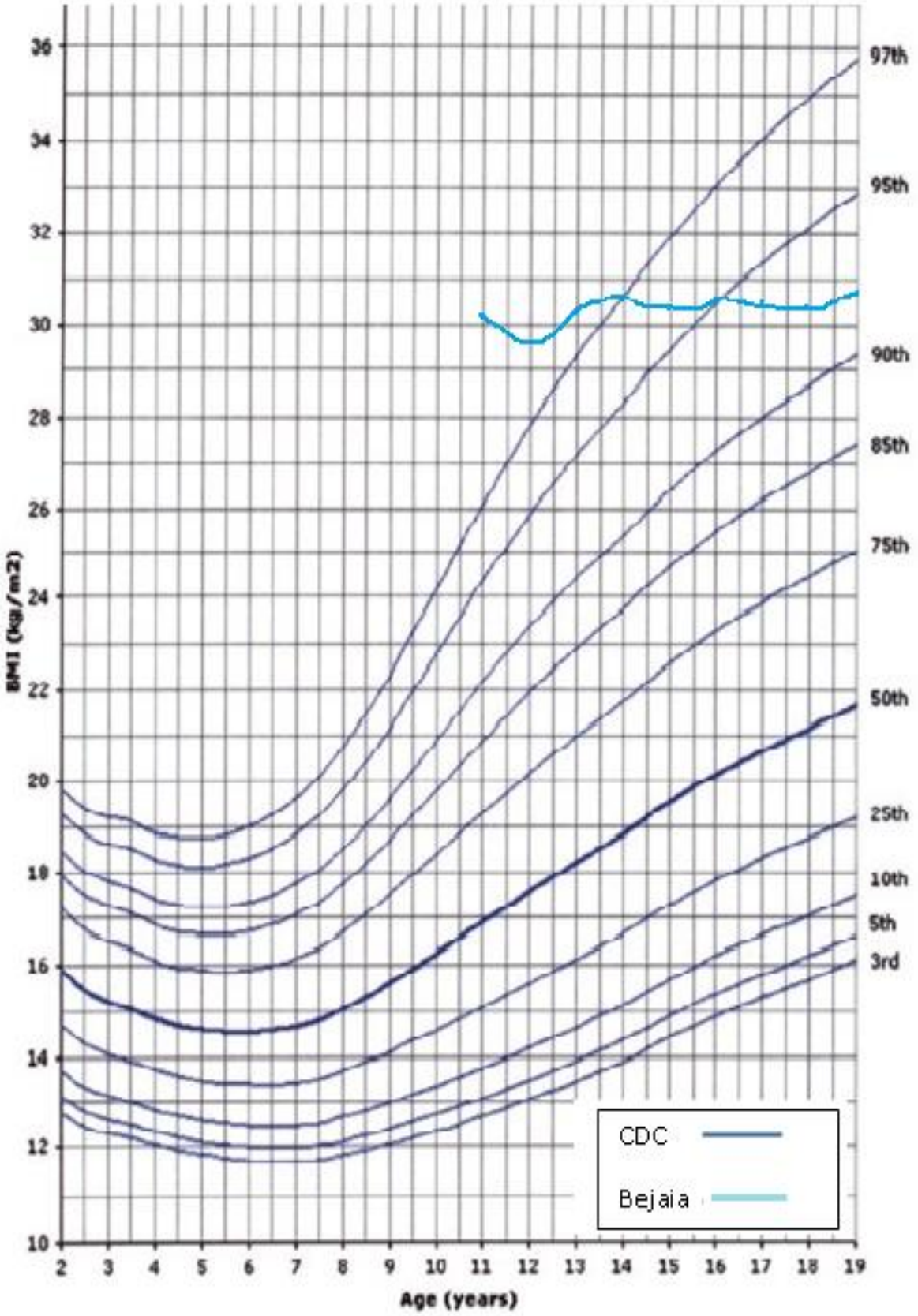


Figure 5. BMI for boys from age 2 to 19 years: comparison with CDC

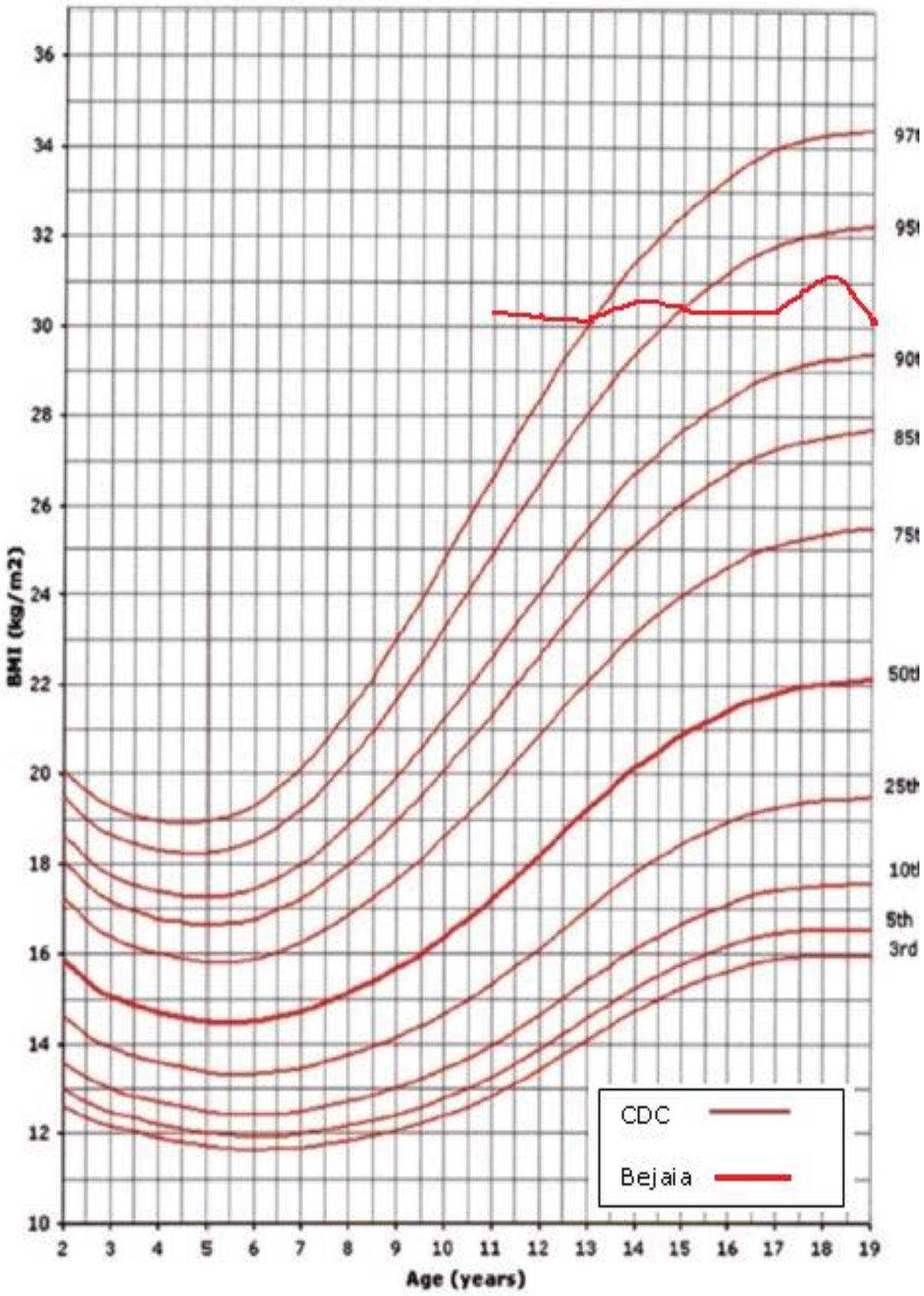


Figure6. BMI for girls from age 2 to 19 years: comparison with CDC

1.2. BMI for 20 to 23 years

The results of Figure 7 for girls and boys aged from 20 to 23 years show, for girls between the ages of 20 - 21 years, a decrease in average BMI from 31.84 kg/m² to 30.98 kg/m², in addition at the age of 21 - 22 years a rapid increase was observed to reach the value of 34.3 kg/m². In boys the average BMI at the age of 20 - 21 years shows an increase from 30.85 kg/ m² to 31.65 kg/ m², then it decreases at the age of 21 - 22 years to 30.82 kg/ m², and at the age of 22 - 23 years a rapid increase to 35.27 kg/ m² is noted.

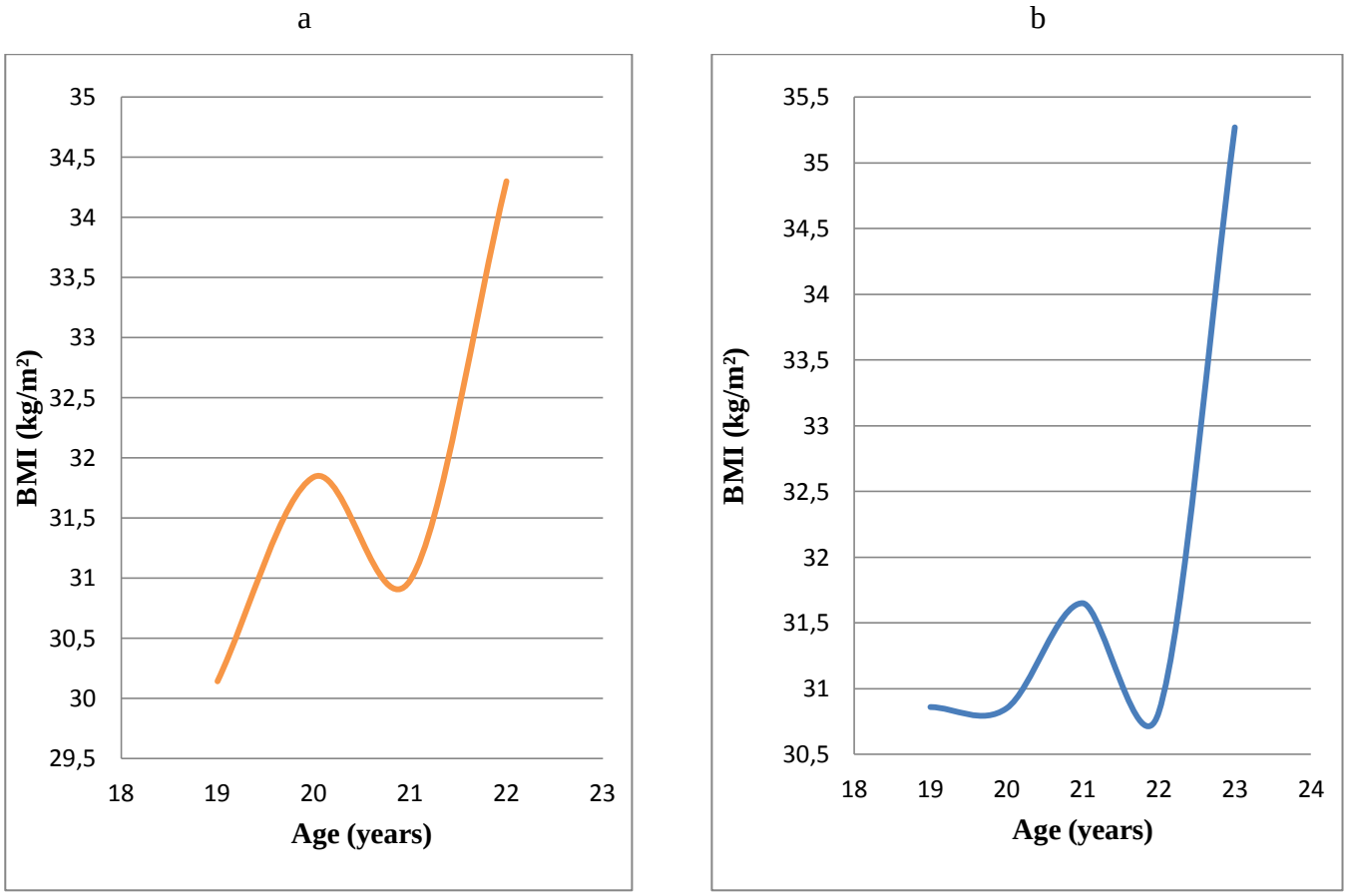


Figure7. BMI for girls (a) and boys (b) aged from 20 to 23 years old.

1.3. Evaluation of BMI, Z BMI distributed throughout the 19 geographical regions

The results show that there is a territorial disparity regarding the distribution of obese subjects defined by BMI, these body mass indices are variable from one Daira to another by mapping. Figure 8 shows the weight classification according to BMI, for girls, obesity (grade 1) is dominant in the territories of Kherrata with BMI = 31.6 kg/m², Darguina with BMI = 31.12 kg/m², Souk El Tenine with BMI = 31. 21 kg/m², Aokas with BMI = 30.79 kg/m², Tichy with BMI = 31.15 kg/m², Bejaia with BMI = 32.42 kg/m², Adekar with BMI = 31.47 kg/m², Elkseur with BMI = 30.53 kg/m², Amizour with BMI = 31.62 kg/m², Barbacha with BMI = 30.07 kg/m², Ighil Ali with BMI = 30.44 kg/m², Ouzlaguen with BMI = 30.91 kg/m², Akbou with BMI = 30.09 kg/m², Saddouk with BMI = 31.97 kg/m², Sidi Aich with BMI = 30.16 kg/m², Tazmalt with BMI = 31.06 kg/m², and Teimezrit with BMI = 30.09 kg/m.

For boys, obesity (grade 1) is dominant in the territories of Kherrata with BMI = 30.6 kg/m², Darguina with BMI = 31.12 kg/m², Souk El Tenine with BMI = 30.4 kg/m², Aokas with BMI = 30.91 kg/m², Tichy with BMI = 30.52 kg/m², Bejaia with BMI = 30.1 kg/m², Adekar with BMI = 30.02 kg/m², Elkseur with BMI = 30.19 kg/m², Amizour with BMI = 30.96 kg/m², Ighil Ali with BMI = 30.27 kg/m², Ouzlaguen with BMI = 30.28 kg/m², Akbou with BMI = 31.46 kg/m², Saddouk with BMI = 33.59 kg/m², Sidi Aich with BMI = 31.07 kg/m², Tazmalt with BMI = 30.68 kg/m², Chmini with BMI = 30.58 kg/m² (Figure 8).

Figure 8 shows that only two Daira (Chmini with BMI = 29.75 kg/m², Beni Maouche with BMI = 29.08 kg/m²) in which girls are overweight, whereas for boys the results show that there are only three Daira where teenagers are overweight (Barbacha with BMI = 29.91 kg/m², Beni Maouche with BMI = 29.62 kg/m², and Teimezrit with BMI = 29.92 kg/m²).

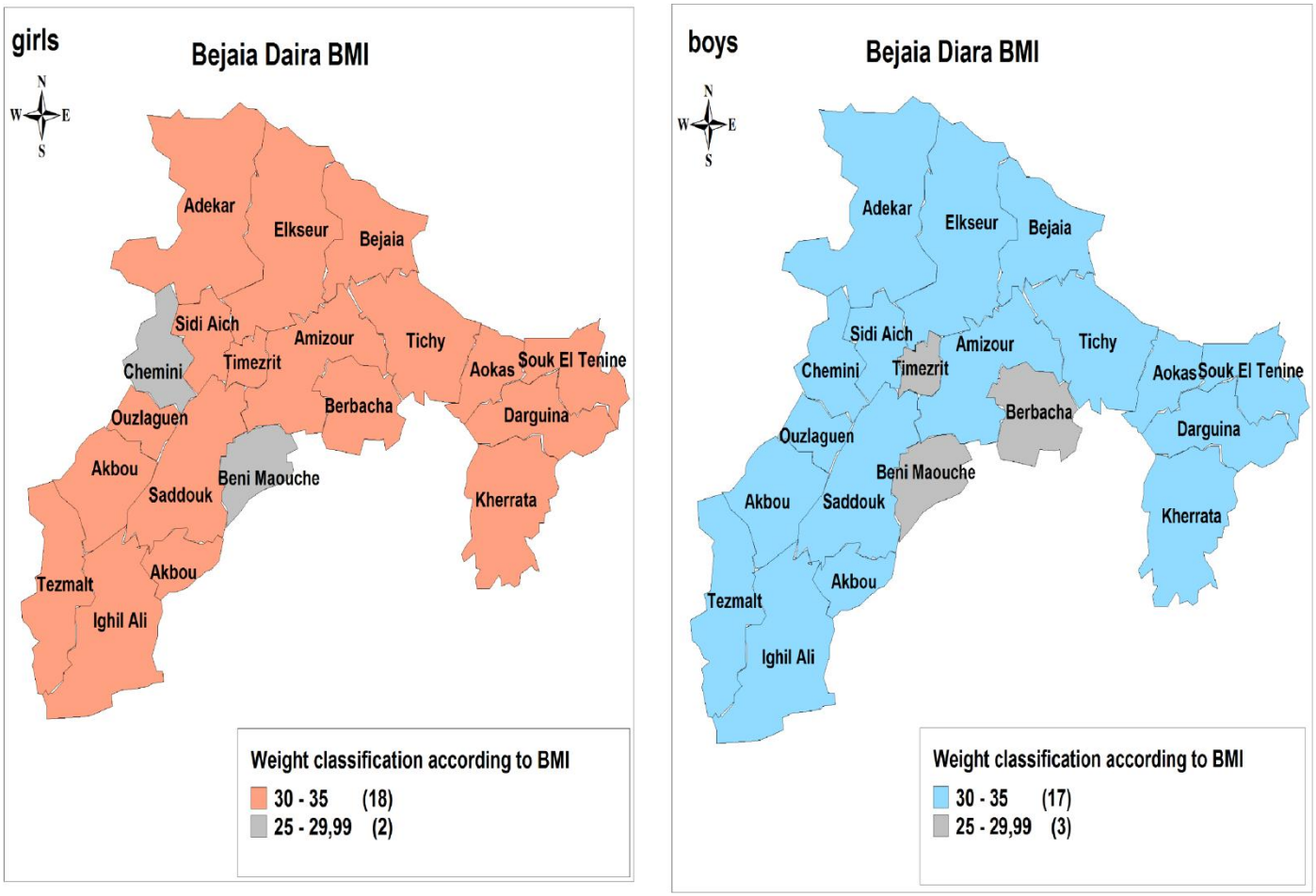


Figure 8. Weight classification according to BMI values for girls and boys.

For BMI in Z-scores among the surveyed students, our results (Figure 9), show that about 4 regions (Kherrata, Darguina, Tichy and Akbou) are attributable to a high BMI in z-scores exceeding (> +1), Souk el Tenine, Barbacha, Adekar, Sidi Aich and Chmini have BMI in z-scores from 0.84 to 0.96. For the other regions (Bejaia, Aokas, Amizour, Beni Maouche, Tazmalt, and Ighil Ali) the BMI in z-scores varied between 0.57-0.84 and the Elkseur, Timezrit, Saddouk, and Ouzellaguen regions had lower BMI in z-scores ranging between 0.15-0.57.

According to the student gender, the load of BMI in z-scores was higher in the regions of Bejaia, Tichy, Adekar, Barbacha, and Ouzellaguen and it varied between 0.85-1.72 for girls. In the regions of Kherrata, Barbacha, Sidi Aich, Chmini, and Ighil Ali, BMI in z-scores varied between 0.84-1.47 for boys than in the regions of Souk el Tenine, Tazmalt, Saddouk, Sidi

Aich, and Chmini for girls.BMI in z-scores for boys, in the regions of Tazmalt, Amizour, Tichy, and Aokas varied between 0.76-0.85.

Estimations by region show that five regions (Kherrata, Darguina, Elkseur, Timezrit, Tazmalt) had the lowest BMI in z-scores, ranging from 0.22-0.65 among girls, and from 0.17-0.48 in the regions of Elkseur, Bejaia, Timezrit, Saddouk, Beni Maouche among boys, as shown in Figure 9.

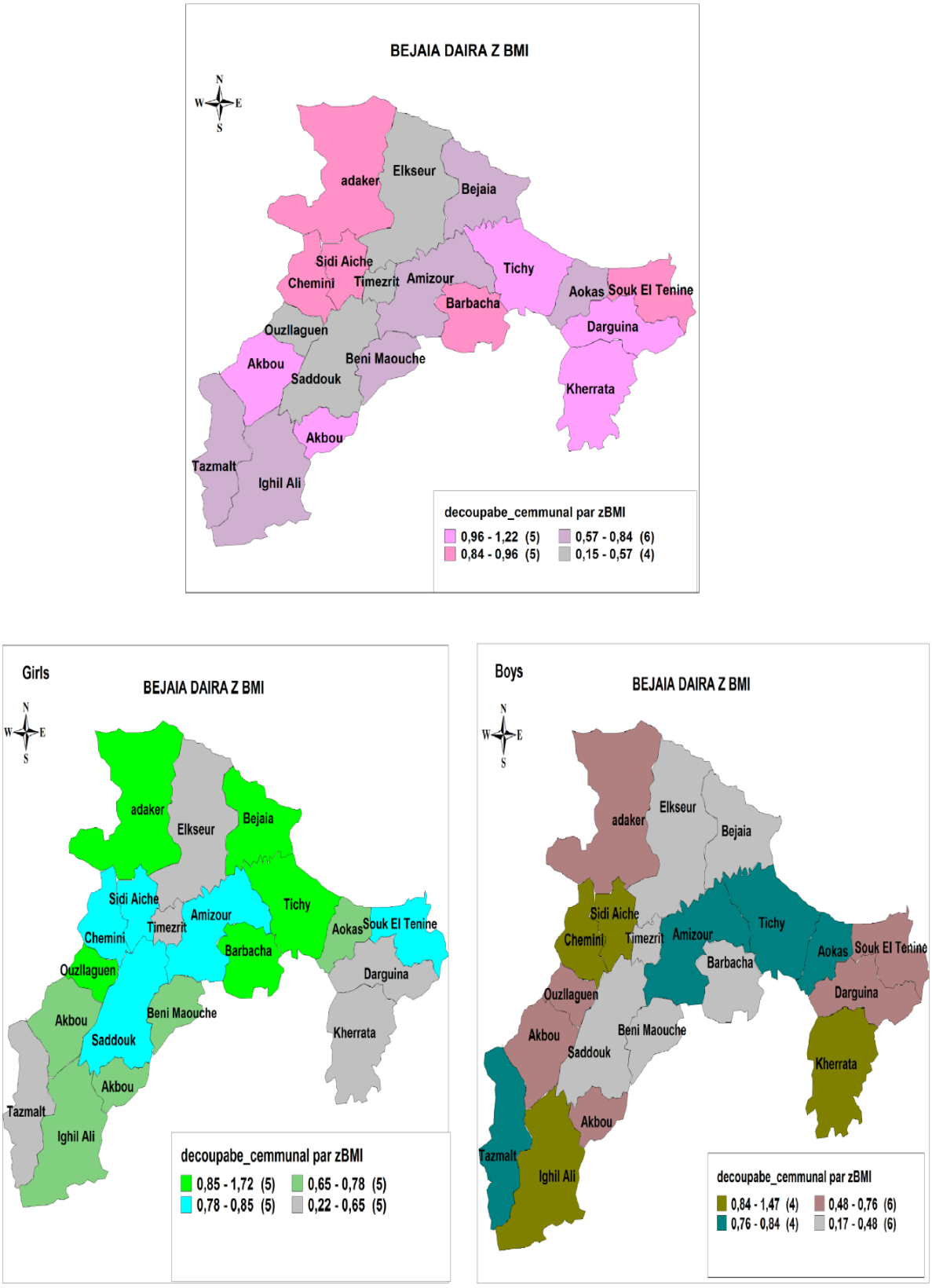


Figure 9. BMI in Z-score for girls, boys and both sexes.

2. Physical Activity Level (PAL)

The results presented in Table 6 and 7show that the mean PAL value is equal to 1.72±0.21 for all samples. However, the PAL for obese girls and boys were: 1.61±0.12, 1.85±0.21, respectively (Table 6). The average PAL for overweight girls and boys were: 1.60 ± 0.12 and 1.85 ± 0.23, respectively (Table 7).

Results of Table 9 showed that different low-intensity activities (sleep and nap, lying down; sitting; standing; low-intensity light activities) represented 94% in obese girls and only 6% for high-intensity activity with a significant difference ($p< 0.007$) and 84% low-intensity activities in obese boys and 16% for high-intensity activity with a significant difference ($p< 0.034$). In overweight adolescents, girls also exhibited 94% of low intensity and 6% of high activity with a significant difference ($p< 0.033$), while boys showed a low level of physical activity (84%) and only 16% of sports activity with a significant difference ($p< 0.009$). In this study, girls were more physically inactive than boys (Table 9). Boys are more likely to participate in sports than girls (16.5% for boys and 6% for girls).

Table 9. PAL hours of boys and girls according to different activities.

			PAL hours of obese girls				PAL hours of obese boys				PAL hours of overweight girls				PAL hours of overweight boys			
	Differentactivities	**PAL**	**N° of hours (h)**	**N° of hours as % of total hours**	**Low and high-intensity activities (%)**	***P* Value (test Z)**	**N° of hours (h)**	**N° of hours as % of total hours**	**Low and high-intensity activities (%)**	***P* Value (test Z)**	**N° of hours (h)**	**N° of hours as % of total hours**	**Low and high-intensity activities (%)**	***P* Value (test Z)**	**N° of hours (h)**	**N° of hours as % of total hours**	**Low and high-intensity activities (%))**	***P* Value (test Z)**
Low-intensity activities	**Sleep and nap, extended rest**	1	10,92	45,5			10,34	43,08			11	45,84			10,27	42,79		
	Sitting position.	1,75	6,23	25,96			4, 5	18,75			6,23	25,95			4,5	18,75		
	Standing position	2,1	2,8	11,66	94,2		2,56	10,67	83,6		2,7	11,25	93,9		2,64	11	83,5	
	Light low-intensityactivities	2,6	2,66	11,08			2,66	11,08			2,61	10,87			2,63	10,95		
High-intensity	**Moderateactivities**	3,5	1,26	5,26		0,007	2,27	9,46		0,034	1,37	5,8		0,033	2,33	9,7		0,009
	Sports activities	5,2	0,13	0,54	5,8		1,36	5,67			0,09	0,37	6,1		1,36	5,66	16,5	
	Sports competition	10	0	0			0,31	1,29	16,4		0,003	0,01			0,3	1,25		
	Total		24h	100	100		24h	100	100		24h	100	100		24h	100	100	

The results in Table 10 and 11 represent the different activities of middle and high school girls and boys, showing that low-intensity activities account for the largest proportion of activities for both sexes (sleeping and napping, lying down; sitting; standing; light low-intensity activities), with the intensity being relatively higher for middle school girls (22. 76 ± 3.8 hours) and high school girls (23.03 ± 3.28 hours) than for high school boys (20.8 ± 2.8 hours) and high school boys (20.92 ± 3 hours). 94 ± 1.27 hours in middle school girls and 10.49 ± 0.88 hours in middle school boys with a significant difference ($P < 0.0001$), as well as 11 ± 0.83 hours in high school girls and 10.39 ± 0. 91 hours for high school boys with a significant difference ($P < 0.0001$); on the other hand, high intensity activities (moderate activities; sports activities; sports competition) represented only 3.17 ± 1.98 hours for middle school boys and 4.04 ± 1.95 for high school boys and 1.2 ± 0.89 hours for high school girls and 0.92 ± 1.5 for high school girls.

Table 10. Different activities hours of college boys and girls in 24 hours

	Boys	**Girls**	***P***
Sleep and nap, extended rest	10.49 ±0.88	10.94 ± 1.27	< 0,0001
Sitting position. (TV, computer, homework, meals, transportation)	4.63 ± 0.86	6.16 ± 0.57	< 0,0001
Standing position (shopping, cooking, short trips,toilet)	2.85 ± 0.54	2.90 ± 0.64	0.059
Light activities of low intensity (games can be active)	2.81 ± 0.52	2.76 ± 1.32	0.080
Moderate activities (brisk walking, manual work.)	2.32 ± 0.69	1.16 ± 0.25	< 0,0001
Sports activities (club training, physical education and sports...)	0.78 ± 0.96	0.04± 0.27	< 0,0001
Sports competition	0.07 ± 0.33	0 ± 0.64	-

Table 11. Different activities hours of high school boys and girls in 24 hours

	Boys	Girls	*P*
Sleep and nap, extended rest	10.39 ± 0.91	11 ± 0.83	< 0,0001
Sitting position. (TV, computer, homework, meals, transportation)	4.81 ± 0.95	6.36 ± 1.21	< 0,0001
Standing position (shopping, cooking, short trips,toilet)	2.84 ± 0.58	2.94 ± 0.54	0.002
Light activities of low intensity (games can be active)	2.88 ± 0.54	2.73 ± 0.7	< 0,0001
Moderate activities (brisk walking, manual work.)	2.27 ± 0.76	0.88± 1.20	< 0,0001
Sports activities (club training, physical education and sports...)	1.72 ± 0.92	0.04 ± 0.27	< 0,0001
Sports competition	0.05 ± 0.27	0.0014±0.038	< 0,0001

The results in Table 12 represent the responses to the questions on physical activity for boys and girls in middle and high school; more than 566 middle school boys, 346 high school boys and 696 middle school girls, 574 high school girls were active at least once (at least 30 minutes) per week, increasing the risk of reduced activity among adolescents; more than 826 college boys, 544 high school boys and 944 college girls, 660 high school girls did not participate in regular physical training, and only 458 college boys, 494 high school boys and 290 college girls, 329 high school girls walked three times a week.

Table 12. Questions about physical activity for adolescents

	College		high school	
Questions	Boys	Girls	Boys	Girls
Do you do regular physical training?				
- yes	23	10	10	21
- no	826	944	544	660
How often do you walk or bike?				
- 3 or more times a week	458	494	290	329
- 1-2 times / week	185	233	163	167
- rarely	206	227	101	185
How often do you choose to take the stairs instead of the elevator?				
- Always	159	136	88	116
- Often	304	332	227	251
- On occasion	292	334	181	215
- Never	94	152	58	99
How many times a week do you get at least 30 minutes of physical activity?				
- ≤ once a week	566	696	346	574
- 2-3/ week	270	238	180	95
- 4 times a week	13	20	23	12
Do you usually feel motivated to be physically active?				
- Always	74	92	46	57
- Often	327	334	207	238
- On occasion	251	351	198	201
- Never	197	177	103	185
Do you recognize in the following statement? "At the moment, I'm not in good shape and I don't know where to start to improve. »				
- Not at all.	48	68	31	48
- A little bit.	302	303	175	252
- Many	369	479	242	262
- Absolutely.	130	204	106	119
Are you too tired to be physically active?				
- Never	49	68	34	45
- On occasion	229	308	177	212
- Often	354	370	218	254
- Always	217	208	125	170
Do you like to be physically active?				
- Very much	71	87	49	57
- Medium	296	323	216	237
- A little bit.	287	380	177	222
- Not at all.	195	164	112	165
Do you organize your schedule to include periods of physical activity?				
- Always	45	71	48	47
- Often	297	344	157	238
- On occasion	324	354	226	245
- Never	183	185	123	151
Do you find alternative ways to stay active when the weather outside is not nice and you don't want to go out and do your physical activity?				
- Always	41	75	42	38
- Often	226	292	182	220
- On occasion	338	370	197	233
- Never	204	217	133	190
Do you recognize in the following statement? "I don't do physical activity for fear of injury. »				
- Not at all.	49	68	45	39
- A little bit	280	339	171	212
- Many	281	353	208	234
- Absolutely.	239	194	130	196
When you have joint problems, do you find alternatives to adapt your exercises and stay active?				
- Always	40	59	40	34
- Often	255	261	154	196
- On occasion	301	379	196	223
- Never	253	255	164	228
Are you practicing the physical activity recommendations to help you lose weight?				
- Absolutely.	35	49	34	38
- Many	215	276	149	170
- A little bit	249	319	195	216
- Not at all.	350	310	176	257
Do you limit your physical activity for fear of becoming hungrier after a workout?				
- Never	107	157	76	100
- On occasion	274	321	154	224
- Often	249	276	168	177
- Always	219	200	156	180

Table 13 shows that there is a correlation between the different activities in both sexes, there is a positive correlation between Sleep and nap, extended rest and sitting position (r = 0.308), between Sleep and nap, extended rest and Light activities of low intensity (r = 0.428) and between Sleep and nap, extended rest and Standing position (r = 0.305) and a negative correlation between Sport Competition and Sleep and nap, extended rest (r = -0.066), between Sport Competition and Standing position (r = -0.060), and between Sport Activities and Sleep and nap, extended rest (r = -0.012).

Table 13. Transformed correlation variables

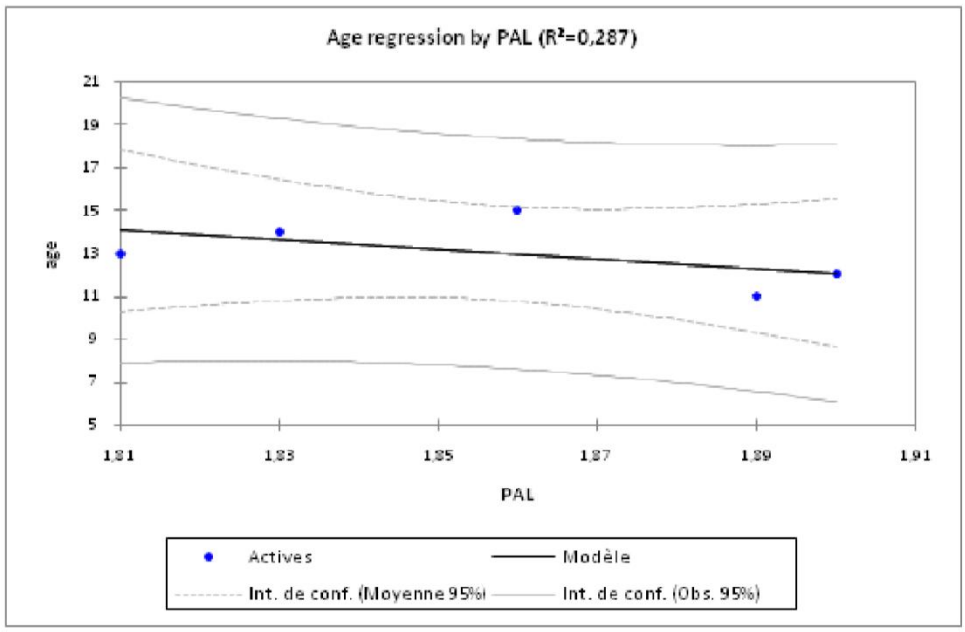
Dimension: 1

	Sleep and nap, extended rest	Sitting position. (TV, computer, homework, meals, transportation)	Standing position (shopping, cooking, short trips,toilet)	Light activities of low intensity (games can be active)	Moderate activities (brisk walking, manual work.)	Sports activities (club training, physical education and sports...)	Sports competition
Sleep and nap, extended rest	1.000	0.308	0.305	0.428	0.203	-.012	-0.066
Sitting position. (TV, computer, homework, meals, transportation)	.308	1.000	0.194	0.312	0.079	-.043	-0.060
Standing position (shopping, cooking, short trips,toilet)[a]	0.305	0.194	1.000	0.230	0.099	0.085	0.072
Light activities of low intensity (games can be active)[a]	0.428	0.312	0.230	1,000	0.053	0.061	0.077
Moderate activities (brisk walking, manual work.)[a]	0.203	0.079	0.099	0.053	1.000	-0.028	0.038
Sports activities (club training, physical education and sports...)[a]	-0.012	-.043	.085	0.061	-0.028	1.000	-0.015
Sports competition[a]	-0.066	-.060	.072	0.077	0.038	-0.015	1.000
Dimension	1	2	3	4	5	6	7
Valeur propre	1.954	1.067	1.045	0.953	0.776	0.703	0.502

a. Missing values were taken into account with the mode of the quantified variable.

Figure 10 represents the regression of PAL by age in college boys and girls showing that the PAL in college boys is decreased from 1.89 at age 11 to 1.86 at age 15 with one degree of regression (R^2 = 0.287); but in college girls the PAL is increased from 1.59 at age 11 to 1.61 at age 15 with one degree of regression (R^2 = 0.450).

boys



Girls

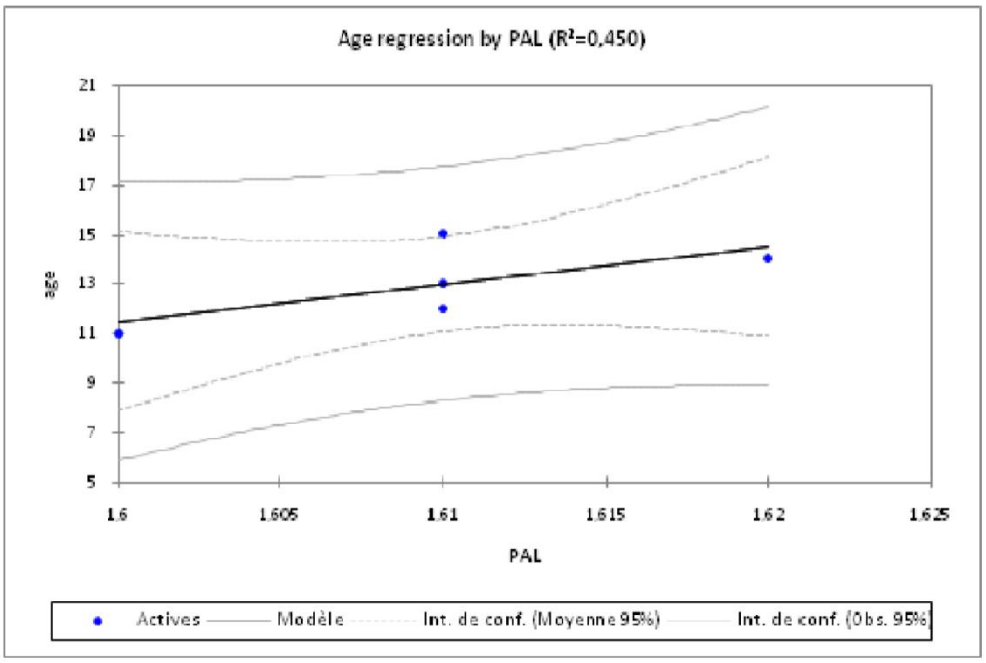
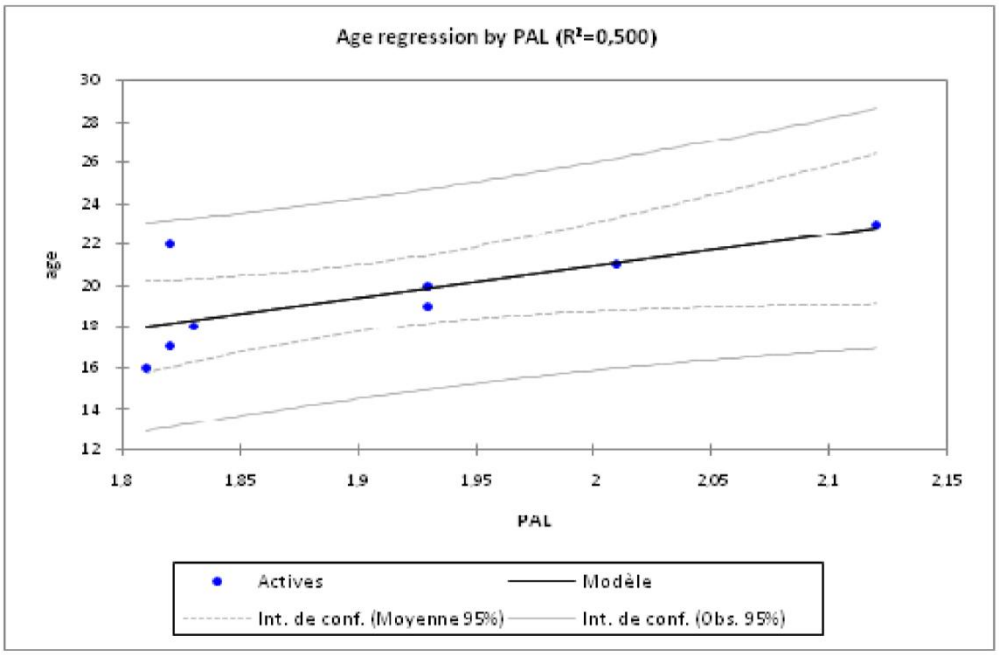


Figure 10. Age regression by PAL in middle school boys and girls

In contrast, Figure 11 shows the regression of PAL by age in high school boys and girls, showing that the PAL in high school boys increases from 1.81 at age 16 to 2.12 at age 23 with one degree of regression (R^2 = 0.500) and decreases in high school girls from 1.59 at age 16 to 1.54 at age 22 with one degree of regression (R^2 = 0.533).

boys



Girls

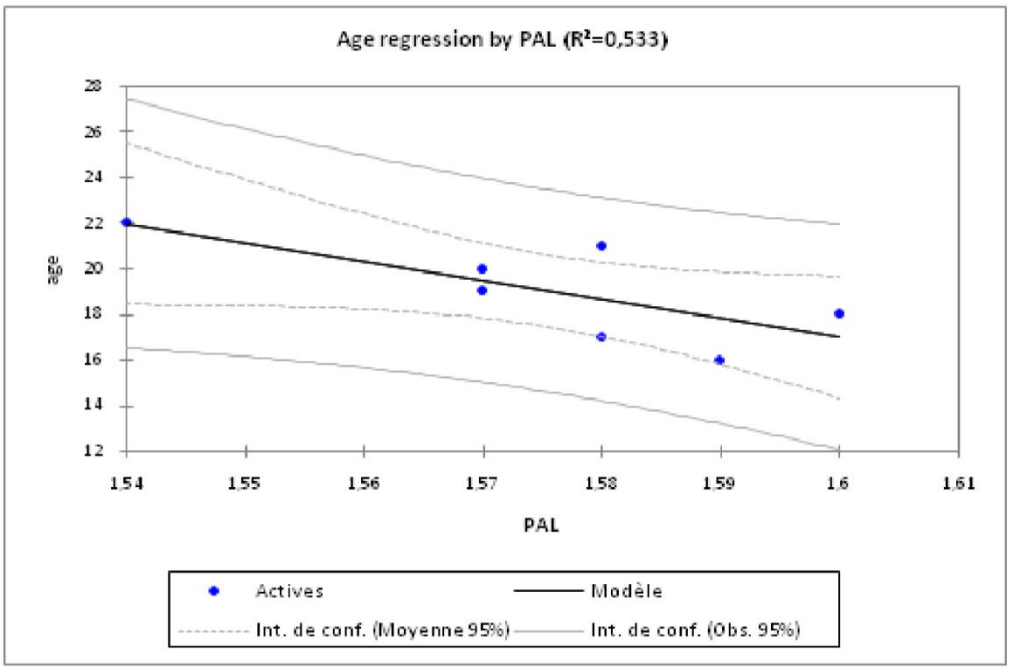
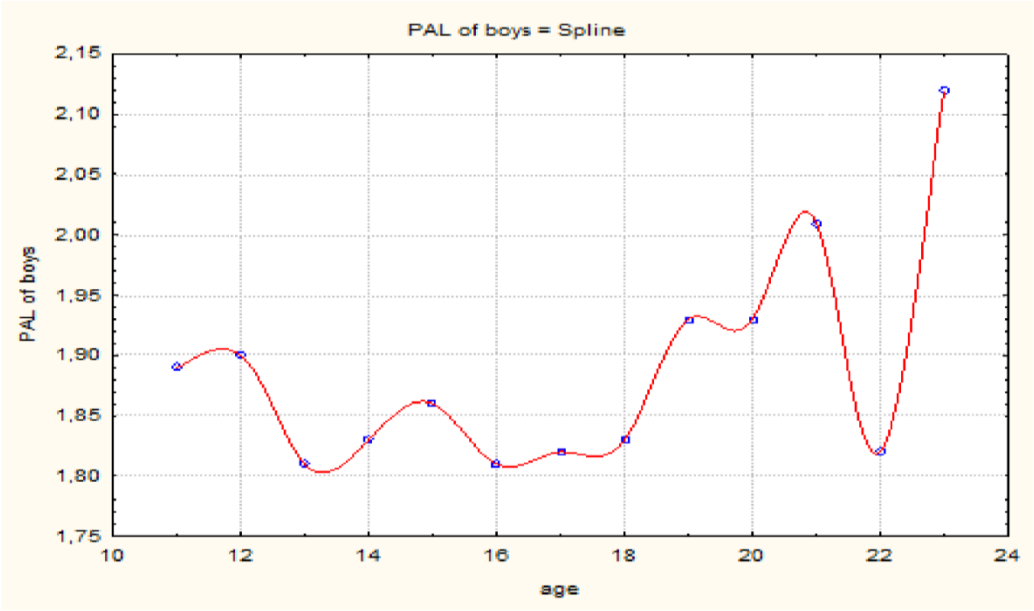


Figure 11. Age regression by PAL in high school boys and girl

Figure 12 compares the PAL for girls and boys and determines that the PAL for boys decreases from 1.89 at age 11 to 1.81 at age 16 and increases from 1.81 at age 16 to 2.12 at age 23; in contrast, the PAL for girls increases by 1. 59 at age 11 to 1.62 at age 14 and decreases from 1.61 at age 15 to 1.54 at age 22; these results show that girls decrease their PAL with age, while boys increase their PAL with age.

boys



Girls

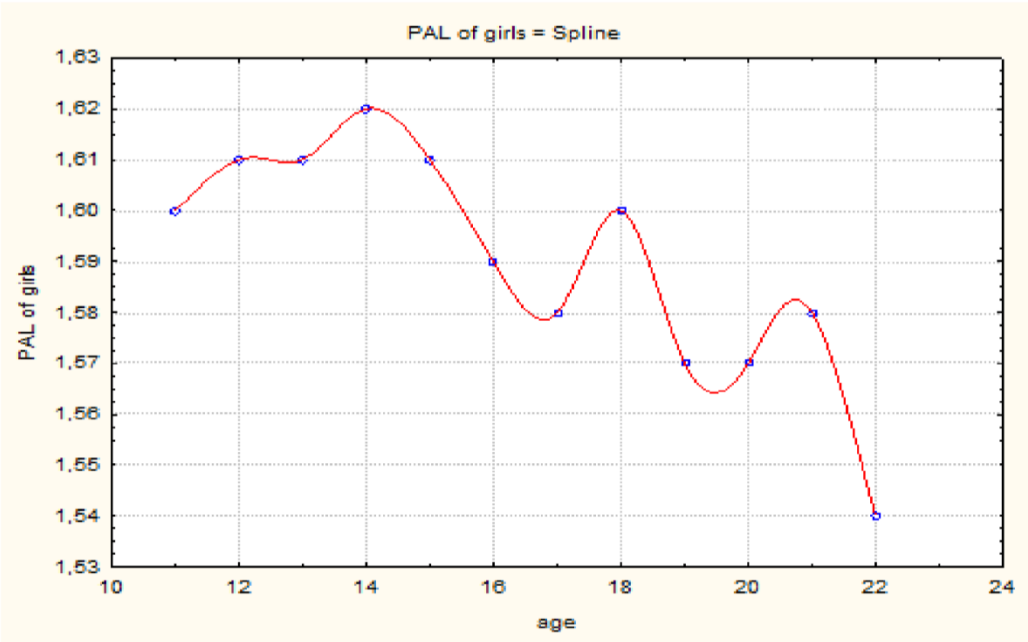


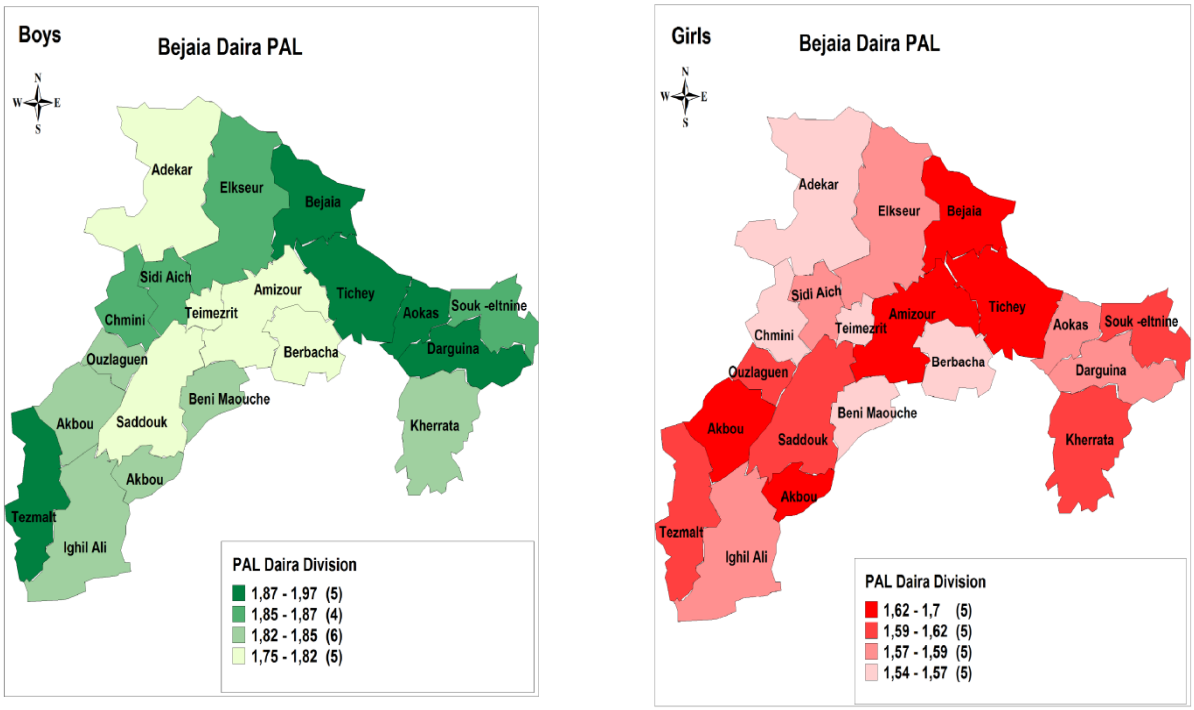
Figure 12. PAL for boys and girls in middle and high school

2.1. PAL distribution for girls and boys

The results show that there is a territorial difference affect the distribution of obese subjects defined by PAL, these levels of physical activity are changing from one daira to another by mapping, Figure 13A shows the classification of physical activity level, among college boys, low physical activity levels is dominant in the territories (Amizour with PAL= 1.75, , Saddouk and Adekar with PAL= 1.80) and low physical activity levels are dominant in the territories (Aokas with PAL= 1.97, Darguina with PAL= 1.89 Tazmalt with PAL= 1.93); Among college girls, the results show that lower physical activity levels affect the following territories (Beni Maouche and Timezrit with PAL= 1. 54, Adekar and Chmini with PAL= 1.56) and low activity levels is dominant in the territories (Bejaia with PAL= 1.70, Amizour and Akbou with PAL= 1.62).

Figure 13B shows the low physical activity levels among high school boys in the following territories (Tazmalt with PAL= 1.76, Timezrit with PAL= 1.97, Aokas with PAL= 1.65) and the low physical activity levels is dominant in the territories (Adekar with PAL= 1.97, Saddouk with PAL= 1. 93); Among high school girls, the results show lower physical activity levels affecting the following territories (Beni Maouche with PAL= 1.50, Adekar with PAL= 1.53) and low activity levels is dominant in the territories (Bejaia with PAL= 1.64, Chmini with PAL= 1.60).

A



B

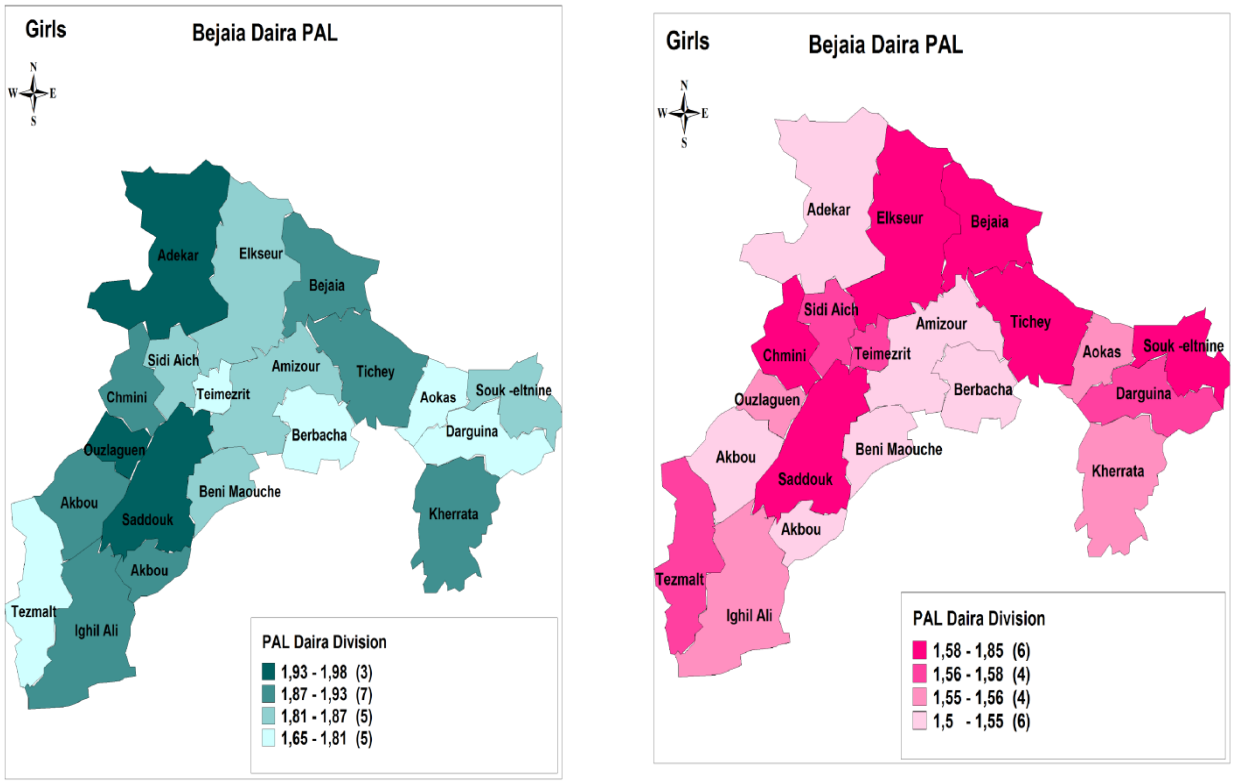


Figure 13. Distribution of PALs for middle and high school boys and girls

3. Daily Energy Expenditure (DEE)

The results for the entire sample show that the mean DEE was3144.13±850.54kcal. From Table 6 we can see that the mean DEE of obese girls was equal to 2551±266.28 kcal, which was lower than that of obese boys (4089.53 ± 640.93 kcal) with a significant difference (p < 0.0001). The results presented in Table 7 show that the mean DEEs of overweight girls and boys were2402.92 ± 242.01 kcal and 3779.62 ± 1424.86 kcal, respectively.

Table 14. MB and DEE of the studied population

	Girls		Boys	
Age (years)	BM (Kcal.J^{-1})	DEE (kcal)	BM (Kcal.J^{-1})	DEE (kcal)
11	1435.01±97.62	2294.92±223.86	1868.86±175.14	3566.62±542.29
12	1473.77±94.45	2382.90±256.50	1958.47±166.06	3633.66±627.15
13	1440.10±774.74	2395.96±271.12	1909.19±164.83	3695.80±457.21
14	1518.66±102.95	2469.07±264.07	2013.96±201.43	3789.82±481
15	1560.88±98	2525.04±246.71	2061.85±164.52	3859.13±604.25
16	1583.61±94.56	2530.11±242.09	2194.49±191.84	3986.04±527.36
17	1613.05±89.71	2551.227±223.51	2247.20±174.66	4024.84±677.29
18	1619.93±164.98	2574.48±335.57	2249.52±165.88	4128.50±518.97
19	1699.68±160.32	2642.59±257.96	2327.13±179.56	4414.22±644.92
20	1642.27±90.47	2591.63±229.71	2304.50±190.37	4463.88±401.81
21	1658.28±84.99	2632.51±225.94	2376.87±338.54	4457.98±342.06
22	1669.27±119.91	2577.8±291.42	2382.18±158.45	4329.57±343.15
23	-	-	2413.47	4832.53

Table 14 shows that the basal metabolic rate of girls and boys is high due to overweight and similar, while the DEE was very high in both sexes and increases with age.

4. Total Energy Intake (TEI)

The analysis of daily food intake among adolescents showed that girls usually consume 3255.6 kcal/day (recommendation for girls 2900 kcal/day) with fat amount of 89.6 g and a very high frequency of carbohydrate (493.7g). Boys consume 4386.61 kcal/day (recommendation for boys 3500 kcal/day) with fat value of 108.29 g and also a very high frequency of carbohydrate (735.4g) (Table 14). For obese students, the results show that the TEI for girls was 3307 kcal/day, while that for boys was 4483.75 kcal/day (Table 6). For the TEI of overweight students, Table 7 shows that the mean value for boys was 4284.90±447.34 kcal/day, which is higher than that of girls (3185.51 ± 372.24 kcal/day), with a significant difference ($p < 0.0001$).

Concerning the 24-hour dietary recall, the results presented in Table 15 show the frequency of consumption of the different food groups distributed according to the 4 daily intakes (breakfast, lunch, dinner and snacking between meals), which is very high in carbohydrates and lipids. This result represents the average composition and amount of macro and micronutrients in foods in each meal for both sexes; the foods most consumed at breakfast were: cakes, biscuits, jam, and coffee with milk. The food groups most consumed at snack time were: sweets, deli meats, candy choco, orange juice. Lunch was generally composed for sexes of bread, chicken, eggs, dry vegetables (lentil, dry beans), vegetables (potato, carrot), fruit (apple, orange, date), sweet drinks (lemonade, coca cola). The foods most consumed at snack time were: cakes, biscuits, chocolate, jam, milk coffee, orange juice. The foods that made up dinner were the same as those for lunch except that dried vegetables were replaced by cereal products (pasta, rice, couscous). The most snacked foods were: pizza, cheese, yoghurt, honey, fruit juice, Candy choco. A very high frequency of carbohydrates (614.55g), fat (98.95g) and a low quantity of water (0.65 l), group of vitamins (vit A= 2836.46 µg) and minerals (ca = 1028.46 mg) in meals.

Table 15. Composition and quantity of macro- and micronutrients in food in each meal

Vit B3 mg	Vit B5 mg	Vit B6 mg	Vit B9 µg	Vit B12 µg	Vit C mg	Vite E mg	Vit pp mg	Vit D µg	Vit K1 µg	Ca Mg	Fe Mg	Cu Mg	Mg Mg	Mn Mg	I Mg	P Mg	K Mg	Na Mg	Zn Mg	Si Mg
0	0	0	0	0	10	0	0,78	0	0	100	0,3	0	0	0	0	0	0	100	0	0
0,4	0,2	0,1	33,2	0	38,3	0,2	0	0	0,1	31,1	0,8	0,1	29,4	0,1	0	23,1	239,3	62	0,165	10
0	0	0,1	0	0	0	0	9,8	0	0	358	14,6	0	26	0	0	6,3	115	491	1,5	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0,68	0,3	0,48	0	0	2,07	0,33	10,5	0	0	298,62	9,36	0,082	59,9	0,37	0	24,7	478,5	497, 3	1,25	10
0,1	0,5	0	14,5	0,2	0,3	0,1	0,2	400	0	128	0,7	0	8	0,1	8	92,4	105	53,3	0,3	1,3
0,3	0,3	0	8	0	10	0,0013	0,78	0,3	17,5	158,4	1,5	0,1	14,4	0,1	24	73	122	147	0,5	12
5,8	0,6	0,3	0	0	5,1	0,3	0	0,6	0	37	0,3	0	11	0	0	24	0	0	0	0
0	0	0,2	0	1,1	0	0	0	8754	0	327	5,9	0	66	0	0	6,3	691	615	0	0
0,4	0,2	0,1	33,2	0	48,3	0,2	0,78	0	0,1	104,5	0,4	0	9,8	0	0	15,8	171	0,6	0,065	0
0	0	0	0	0	97,6	0	3,85	0	0	326,5	26,5	0	35	0	0	0	560,5	7,3	0	10
2,3	0,8	0,3	44	0	26,5	1,8	0	0,1	8,9	187,8	1,4	0,1	29,1	0,5	24	300 ,4	364	566,4	1,4	22,5

Gender	Meals	Food	Protein g	fat g	carbohydrate g	Water G	fibre g	Vit A	béta caroténe µg	Vit B1 Mg	vit B2 mg
Boys	**Breakfast**	Cakes; biscuit; chocolate; bread; croissant; rusks; cheese; yoghurt; jam; honey; milk only; coffee with milk; chocolate milk; fruit juice; orange juice; chocolate drink (Candy choco)	8	8,2	159,4	19,5	1	0	0	0,01	0,13
	snack	Bread; pizza; cakes; biscuit, chocolate, cheese; yoghurt; conferring; honey; deli meats; sweets; fruit juice; orange juice; chocolate drink (Candy choco); apple; banana; pear; date; orange; rusks	2,4	6,29	88,6	95	0	0	30	0,1	0,
	lunch	Bread; fish; chicken; eggs; lentil; dry bean; chickpea; dry pea; potato; carrot; courgette; pepper; tomato;green bean; green pea; spinach; salad; apple; banana; pear; orange; yoghurt; cheese; pasta; rice; semolinaas an Algerian traditional meal; couscous ; fruit juice; lemonade; coca; orange juice	48,2	29,4	189,4	89	17	371	0	0,14	0,31
	taste	Cakes; biscuit; chocolate; pizza; bread; croissant; rusks; cheese; yogurt; jam; honey; milk only; coffee with milk; chocolate milk; fruit juice; orange juice; chocolate drink (Candy choco)	6,4	34,3	49	0	0	0	0	0	0
	dinner party	Bread; meat; fish; chicken; eggs; potato; carrot; courgette; pepper; tomato; cauliflower; green bean; peas; spinach; salad; apple; banana; pear; date; orange; strawberry; pasta; rice; semolinaas an Algerian traditional meal; couscous ; fruit juice; lemonade; coca	35,2	28,6	168	165,8	1,9	360,33	26	0,285	0,249
	snacking	Cakes; biscuit; chocolate; pizza; bread; croissant; rusks; cheese; yoghurt; jam; honey; milk only; coffee with milk; chocolate milk; fruit juice; orange juice; chocolate drink (Candy choco)	17,4	1,5	81	80	0	16	0	0	0,25
Girls	**Breakfast**	Cakes; biscuit; chocolate; bread; croissant; rusks; cheese; yoghurt; jam; honey; butter ; milk only; coffee with milk; chocolate milk; fruit juice; orange juice; chocolate drink (Candy choco)	9	14,6	99,7	40	0	1262	0	0,11	0,23
	snack	Bread; pizza; cakes; biscuit, chocolate; cheese; yogurt; yoghurt; conference; margarine, honey; deli meats; sweets; fruit juice; orange juice; chocolate drink (Candy choco); apple; banana, pear; date, orange; rusks	17,4	19	14	154,5	1,5	602	0	0,5	0,3
	lunch	Bread; meat; fish; chicken; eggs; lentil; dry bean; chickpea; dry bean; small dry pea; potato; carrot; courgette; pepper; tomato; cauliflower; green bean; peas; spinach; salad; apple; banana; pear; date; orange; cheese; yoghurt; paste; rice; semolinaas an Algerian traditional meal; couscous ; fruit juice; lemonade; coca ; orange juice	47	15,6	152	166,5	17	271,57	0	0	0
	taste	Cakes; biscuit; chocolate; pizza; bread; croissant; rusks; cheese; yoghurt; jam; honey; milk only; coffee with milk; chocolate milk; fruit juice; orange juice; chocolate drink (Candy choco)	3	1,8	88	88	O	0	30	0,11	0,13
	dinner party	Bread; meat; fish; chicken; eggs; potato; carrot; courgette; pepper; tomato; cauliflower; green bean; peas; spinach; salad; apple; banana; pear; date; orange; strawberry; rice; semolinaas an Algerian traditional meal; couscous ; fruit juice; lemonade; coca; orange juice	33	28,6	105	257,1	2,6	2726,03	0	0,54	1,23
	snacking	Cakes; biscuit; pizza; bread; rusks; croissant; cheese; yoghurt; jam; honey; milk only; coffee with milk; chocolate milk; fruit juice; orange juice; chocolate drink (Candy choco)	9,2	10	35	137	2	65	316	0,2	0,1

Table 16 shows the classification of food groups for meals.

Table 16.Preference classification by percentages of food groups for consumed meals.

Most consumed foods at breakfast	Most consumed foods as a snack (at 10 am)	Most consumed foods at Lunch	Most consumed foods at snack time (at 4:00 pm)	Most consumed foods at dinner	Most popular snack foods(in the evening)
Cakes (6.5 %), biscuits (26.5 %), chocolate (24.7 %), croissants (23.7 %), rusks (22.1 %), jam (30.8 %), honey (46.8 %), coffee with milk (55.1 %), and chocolate milk (24.7 %).	Pizza (14.8 %), yoghurt (15.8 %), jam (32.2 %), sweets (45.3 %), cold cuts (18.5 %), chocolate drink (Candy choco) (42.7 %), fruit juice (19.5 %).	Bread (98.6 %), chicken (91.9 %), meat (5.5 %), fish (2.1 %), eggs (32.2 %), dried vegetables (lentils (46 %), dried beans (15 %), chickpeas (20.9 %), peas (21.1 %)), vegetables (potatoes (48.8 %), carrots (60.5 %)), fruit (apples (37.3 %), pears (22.5 %), oranges (41.7 %), dates (49.6 %)), sweet drinks (lemonade (56.5 %), coca cola (36.4 %)).	Cakes (16.4 %), biscuits (26.8 %), chocolate (47.8 %), rusks (26.8 %), pizza (5.1 %), croissants (10 %), yoghurt (6.3%), jam (11.3%), dairy coffee (38.6 %), and chocolate milk (20.9 %).	Foods that make up dinner are the same as those for lunch except that dried vegetables are replaced by cereal products: Pasta (33.5 %), rice (47 %), and semolina as the Algerian traditional meal; couscous (13.6 %).	Biscuit (23.7%), pizza (30.6%), cheese (14.4 %), rusk (21.3 %), yoghurt (14.8 %), jam (32.7 %), coffee with milk (218.4 %), chocolate milk(15.2 %), fruit juice(11.6 %), chocolate drink (Candy choco) (18.86 %).

Table 17 represents the daily food intake of each meal for students according to the 24-hour recall. In breakfast the boys at age 11-13 years were usually consumed 715.82 kcal but at age 20-23 years were consumed 809.64 kcal; in lunch at age 11-13 years were usually consumed 1154.7 kcal but at age 20-23 years were consumed 1388.81 kcal; in dinner at age 11-13 years were usually consumed 1011.65 kcal but at age 20-23 years were consumed 1225.07 kcal. Girls consumed 524.98 kcal in breakfast at the age of 11-13 years and 646.17 kcal at the age of 20-23 years; in lunch at the age of 11-13 years they usually consumed

888.58 kcal but at the age of 20-23 years they consumed 1038.83 kcal; in dinner they consumed 771.87 kcal at the age of 11-13 years and 913.62 kcal at the age of 20-23 years.

Table 17. Total energy intake from meals according to the 24-hour recall

Sex	Age meal (years)	breakfast (kcal)	snack (kcal)	lunch (kcal)	Taste (kcal)	dinner party (kcal)	snacking (kcal)
Boys	11- 13	715,82±82,53	406,96±84,53	1154,7±172,03	513,40±122,22	1011,65±145,02	396,44±118,53
	14-16	743,22±65,02	409,82±68,47	1216,79±144,16	522,66±65,41	1071,04±131,39	400±71,33
	17-19	771,89±61,92	444,57±64,93	1264,29±144,86	554,08±66,91	1122,52±135,18	427,56±70,45
	20-23	809,64±54,92	485,22±47,10	1388,81±47,1	595,58±106,89	1225,07±117,82	463,48±57
Girls	11- 13	524,98±71,62	272,88±47,42	888,58±75,15	340,9±75,32	771,87±71,12	240,67±54,68
	14-16	556,96±88	295,30±58,24	931,61±112,9	381,86±93,95	797,38±92,58	266,26±64,77
	17-19	607,28±83,54	316,92±64,14	987,62±127,96	418,21±83,94	856,14±105,96	291,35±62,40
	20-22	646,17±60,50	349,93±52,92	1038,83±97,84	462,82±55,61	913,62±76,5	321,62±56,58

The results of the Energy Balance were positive between Total Energy Intake (TEI) and Daily Energy Expenditure (DEE). This balance was an average of 458.67 kcal in obese boys and an average of 857.17 kcal for obese girls (Table 18).

Table 18. Positive energy balance

Sex	Age (Years)	TEI (kcal)	DEE (kcal)	Energy balance (kcal)
boys	11- 13	4200±459,21	3661,62 ± 544,82	538,38 ±85,61
	14-16	4363,18±451,96	3896,43 ± 543,87	466,75 ± 91,91
	17-19	4585,06±458,99	4197,28 ± 596,32	387,78 ±137,33
	20-23	4968,19±357,53	4526,41 ± 722,41	441,78 ±364,88
girls	11-13	3040,36±259,05	2368,12 ± 240,63	672,24 ± 18,42
	14-16	3228,81±385,52	2506,42 ± 252,73	722,39 ± 132,79
	17-19	3477,17±397,74	2572,36 ± 268,18	904,81 ± 129,56
	20-22	3733,1±227,06	2603,87 ± 239,72	1129,23 ± 12,66

Breakfast was almost always eaten (94%); lunch and dinner was usually eaten (98%) in both sexes, but half of the students were always eaten between meals (snack at 10:00 am (48% to 62%), snack at 4:00 pm (50% to 60%), snack in the evening (50%)) (Table 19).

Table 19. Percentages of taking meals

Sex	Answer	breakfast %	snack %	lunch %	taste %	dinner party %	snacking %
boys	Always	94,4	62,8	97,2	57,7	97,5	52,1
	Sometime	5,4	37,2	2,8	41,9	2,4	47,7
	Never	0,2	0,1	0	0,4	0,1	0,2
girls	Always	94,4	48,3	98,2	53,5	98,5	48,2
	Sometimes	5,5	51,7	1,8	46,4	1,5	51,7
	Never	0,1	0	0	0,1	0	0,1

The results show that the majority of boys and girls preferred to eat lunch with friends (Figure 14) and preferred to snack in the evening Watching TV (Figure 15).

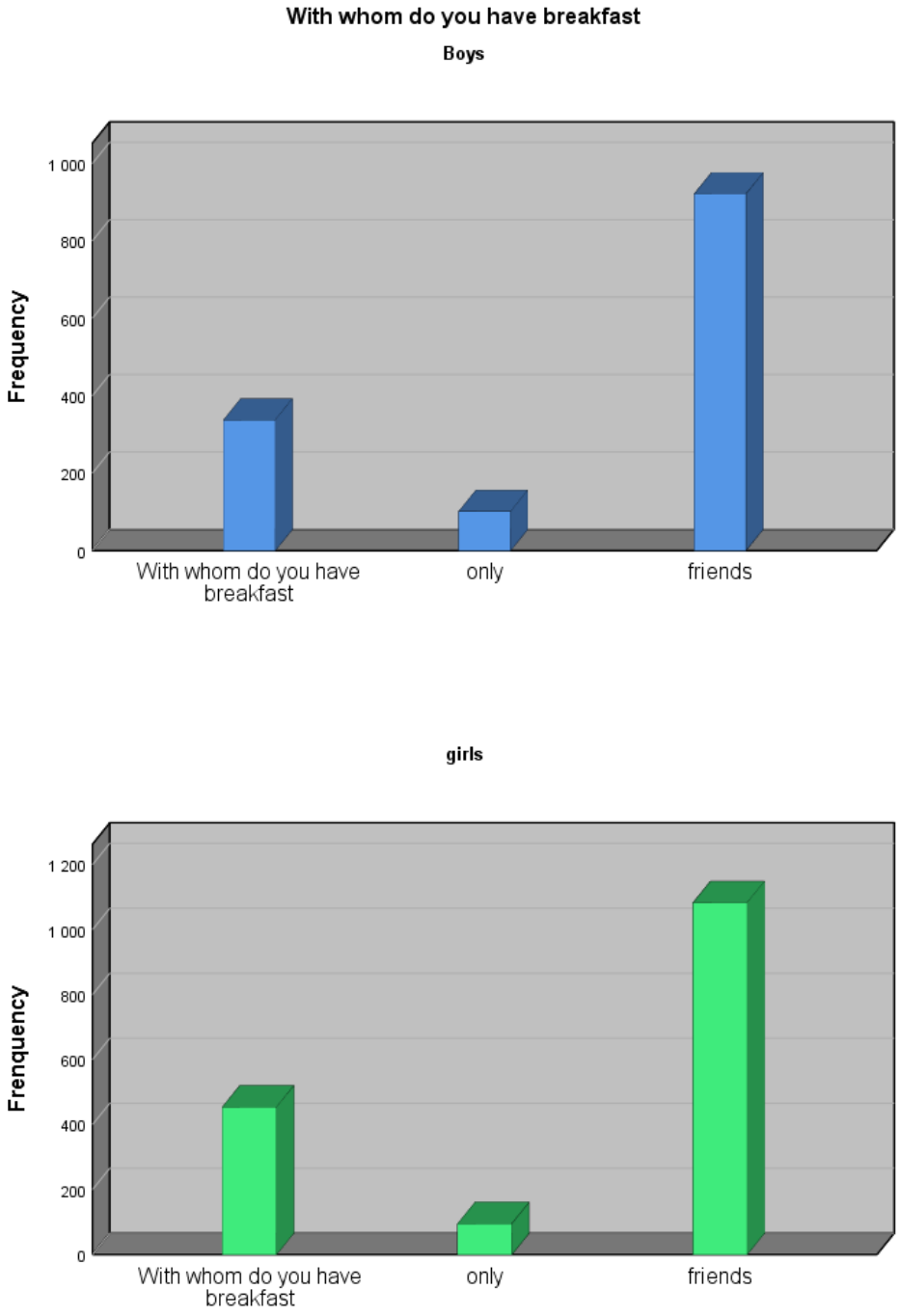


Figure 14. With whom do you have breakfast

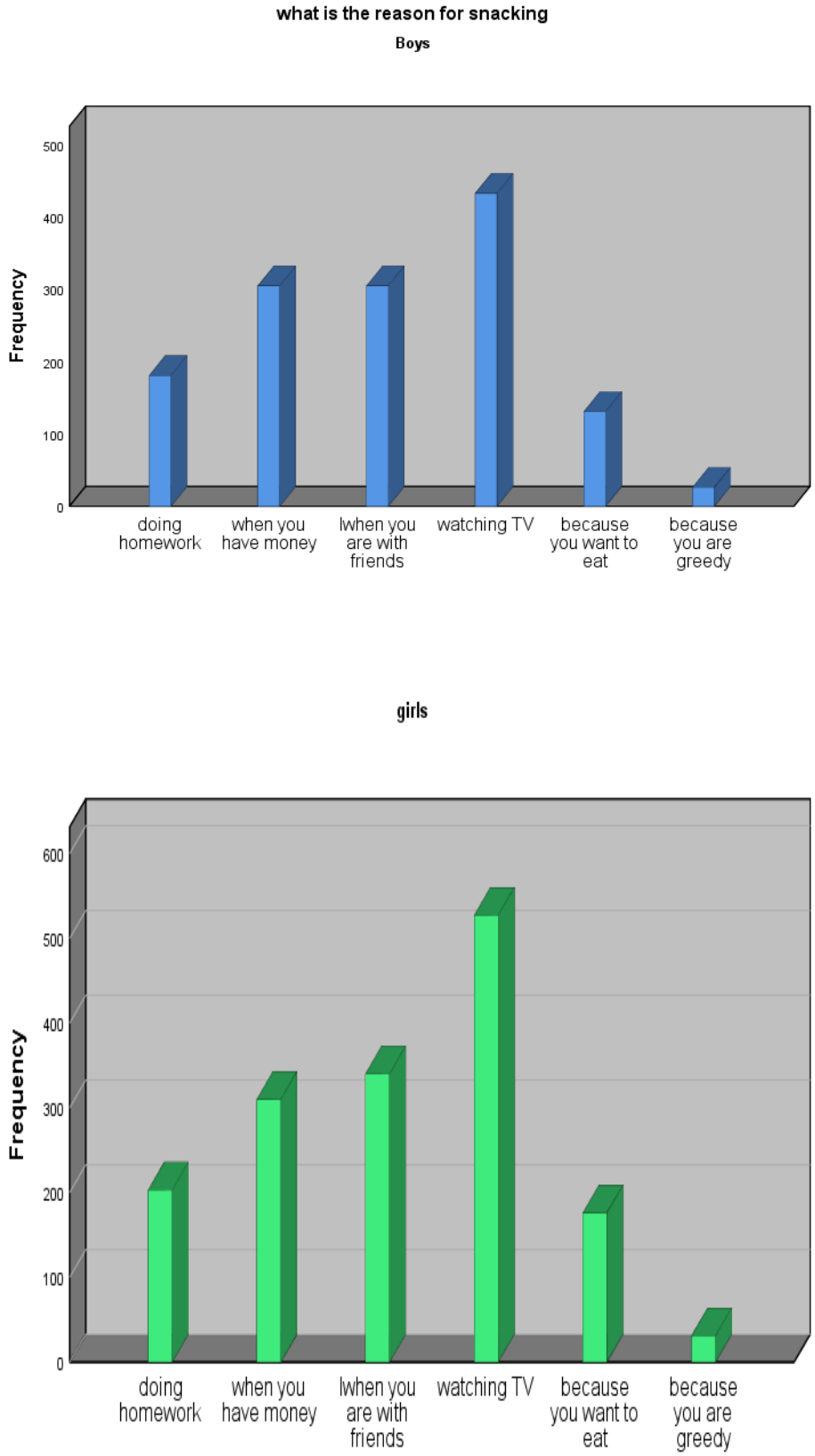


Figure 15. Reason for snacking

4.1. Eating Habits

Table 20 presents the questions on eating habits; most of the girls and boys were eating 3 meals/day, nibbled very often between meals, ate 2-3 times a week in restaurants (fast food, pizza), consumed 2-3 vegetables and 2 fruits a day, ate 1-2 times a week meat, ate more than twice a week cheese and 2-3 times a day milk.

For grain products, most of the schoolchildren were consumed more than the ½ plate of pasta, rice, couscous and potato and also were consumed 4-5 times a week of sweets, chocolate, honey, jam. Most of the schoolchildren were drunk 1-2 times a day of soft drink and lemonade. The majority of the schoolchildren were desired to lose weight (Table 20).

Table 20. Questions about eating habits

Questions about eating habits		Boys	girls
Have you ever met a dietition in the past			
	Yes	8	8
	No	1395	1627
Are you arrently on special diet			
	Yes	156	149
	No	1247	1486
How many meals do you take per doy			
	1-2meals/day	252	261
	3meals/day	703	794
	I often eat a 4th meal	448	580
Eat between meals			
	No/I eat a snack if I need it	139	185
	I usually eat in the avening	584	625
	I nibble very often between meals	680	825
How often do you eat in restaurants (sandwiches, fast food, pizza, rotisserie)			
	Less than once a week	130	145
	1-2/week	1015	1234
	3meals and + / week	258	256
Do you eat meals to serve			
	Less than once a week	123	177
	1-2/week	999	1112
	More than 3/week	281	346
How many vegetables do you eat			
	1per day	273	269
	2-3/day	883	1098
	More 4/day	247	268
How many fruits do you eat			
	1per day	283	352
	2 days	768	825
	More than 3/day	352	455
How often do you eat meat			
	1-2 per day	332	323
	1-2 often week	814	995
	1-2 per menthe	257	327
Do you eat the chicken or the visible fat of the meats			
	never	490	625
	On accasion	687	744
	Always	226	266
Do you eat cold meats or fatty meats			
	Less than once a week	48	65
	1-2/week	1103	1316

	3times and +/week	252	249
Do you eat uncoated fish			
	rarely	1040	1190
	Once a week	331	410
	More than twice a week	32	35
Do you eat cheese			
	Twice a week	1102	1250
	3-4/ week	299	382
	more than 5/week	2	35
Do you eat dairy products (milk and yogurt)			
	1day	272	307
	2-3/day	817	906
	More than 4/day	314	422
What types of fat do you use more often			
	Vegetable oil or margarine or batter	400	450
	Oil; margarine, batter	683	785
	batter, cream	320	400
What proportion of cereal products or starch do they occupy on your plat			
a- Pasta	¼ of the plate	61	115
	1/2 of the plate	181	259
	More than ½ of the plate	276	269
b- Rice	¼ of the plate	44	65
	½ of the plate	218	276
	More than ½ of the plate	387	452
c- Couscous	¼ of the plate	58	77
	½ of the plate	207	306
	More than ½ of the plate	318	296
d- Potato	¼ of the plate	65	106
	½ of the plate	180	244
	More than ½ of the plate	306	280
Do you choose whale grain products			
a- Wheat bread	rarely	81	118
	Occasionally	173	238
	Yes always	713	916
b- Breakfast cereals rich in fiber	rarely	102	113
	Occasionally	166	180
	Yes always	137	108
c- Brown rice	rarely	8	34
	Occasionally	36	48
	Yes always	27	26
How often do you eat baked goods			
a- donuts	1times or less/ week	21	32
	2-3 or less/week	16	14
	4 or more/ week	8	2
b- Brioches	1times or less/ week	113	124
	2-3 or less/week	37	37
	4 or more/ week	16	8
c- Croissant	1times or less/ week	309	410
	2-3 or less/week	376	447
	4 or more/ week	168	170
How often do you eat commercial desserts			
a- Tension bar	2times or less/week	110	104
	3-4/week	18	10
	5 or more/ week	7	2
b- Biscuits	2times or less/week	448	578
	3-4/week	192	260
	5 or more/ week	180	168
c- Regular ice cream	2times or less/week	40	41
	3-4/week	14	6
	5 or more/ week	5	4
d- Gateaux	2times or less/week	388	507
	3-4/week	221	260
	5 or more/ week	184	202

e- Patisseries	2times or less/week	31	31
	3-4/week	17	5
	5 or more/ week	7	4
f- Tart	2times or less/week	8	10
	3-4/week	5	6
	5 or more/ week	13	2
How often do you eat sweets			
a- bonbons	3times or less/week	228	269
	4-5/week	266	265
	Everyday	111	139
		201	253
b- chocolate	3times or less/week	284	305
	4-5/week	205	193
	Everyday	200	216
c- honey	3times or less/week	239	280
	4-5/week	47	61
	Everyday	205	229
		227	239
d- confute	3times or less/week	91	105
	4-5/week		
	Everyday		
Do you drink sugary drinks			
a- juice or fruit drink	1-2 per day	150	176
	2-4 per week	74	118
	4 or more per week	29	33
b- fizzy drink	1-2 per day	445	528
	2-4 per week	391	484
	4 or more per week	130	178
c- lemonade	1-2 per day	399	426
	2-4 per week	392	408
	4 or more per week	173	177
Do you eat soup , broths and sauces, in sachets or canned?			
	1times or less/week	272	361
	1-2/week	138	104
	3or more/week	17	18
	Never	928	1100
Do you salt -coated foods			
a- pop com	once or less/week	95	138
	2-3/week	300	335
	4 or more times/week	267	301
b- nuts or salted grains	once or less/week	130	170
	2-3/week	324	414
	4 or more times/week	417	503
Add salt to your food			
	Rarely	405	491
	often/with some food	496	575
	Most of the times	500	557
Do you want to lose weight			
	Yes	1151	1292
	No	155	190

5. Principal Component Analysis (PCA)

PCA was used in this research (Pearson's correlation, $p<0.05$) to determine the degree of correlation between the different variables (BMI, PAL, DEE and TEI). The aim is to verify which factor influences the BMI variable, i.e. the one that causes overweight or obesity (3.3%), our results disprove that the prevalence is due to the influence of the studied following factors.

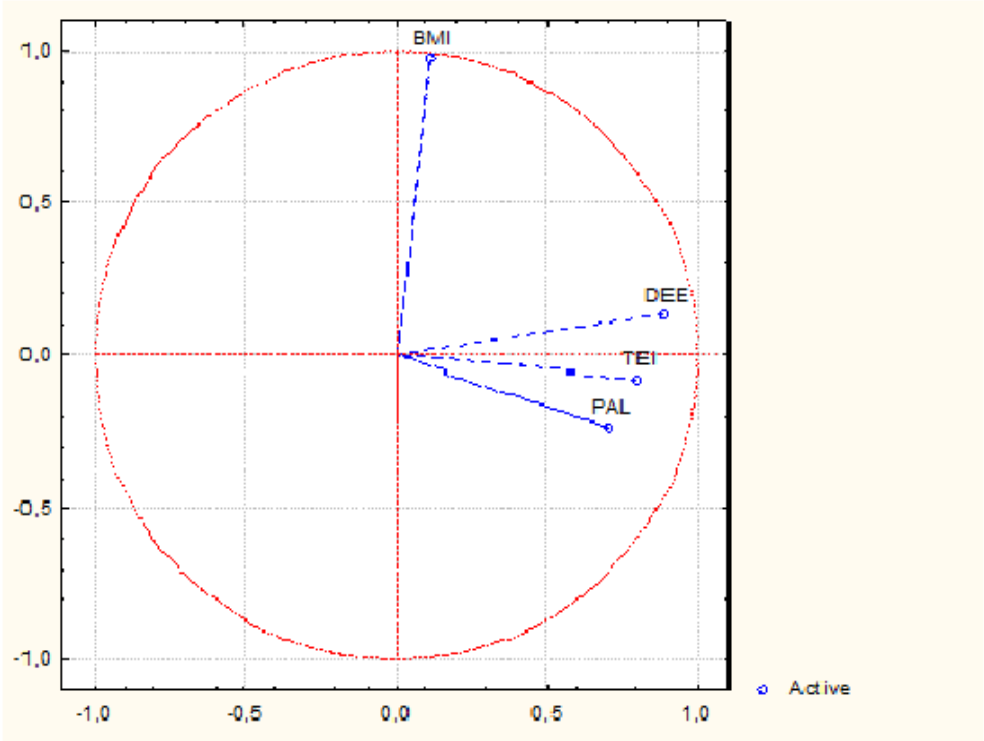
The results are shown as follows: Figures 16 and 17show the existence of a correlation between the studied parameters (BMI, PAL, DEE and TEI) in obese and overweight girls and boys.

For obese girls the results showed a strong positive correlation between TEI and DEE (r = 0.61) and between PAL and DEE (r = 0.48), however a positive proportional mean correlation between PAL and TEI (r = 0.32), and a weak positive correlation between BMI and DEE (r = 0.16) were illustrated. We noted that there is a weak negative correlation between BMI and PAL (r = -0.05) and between BMI and TEI (r= -0.007) (Figure 16a).

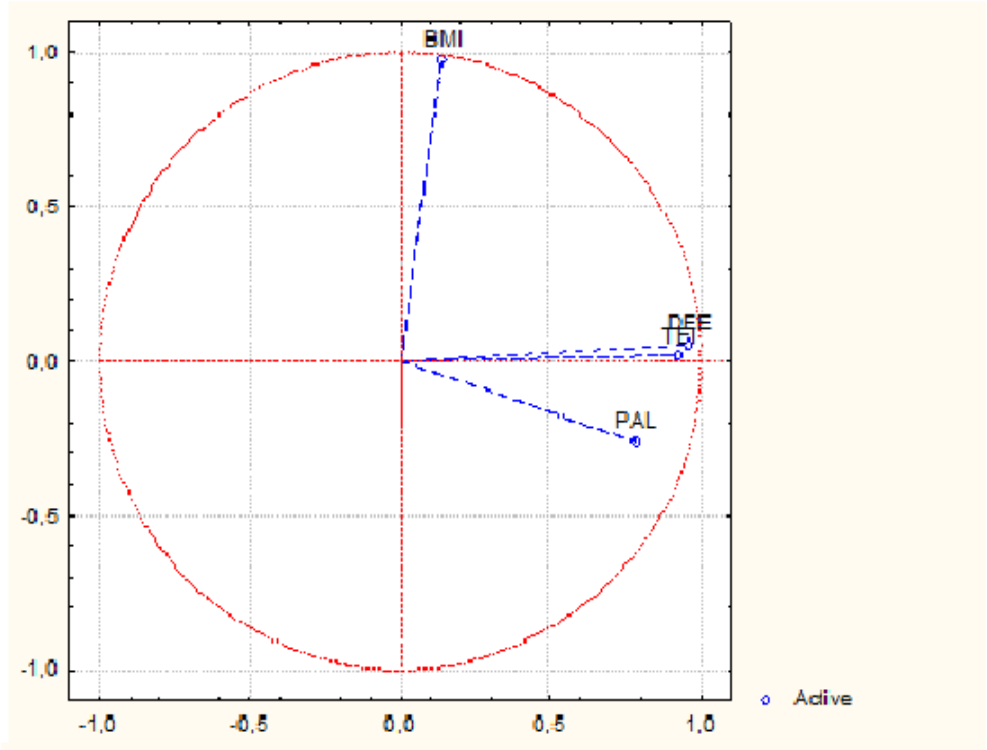
Concerning obese boys, the results showed a strong positive correlation between DEE and TEI (r = 0.87), between DEE and PAL (r = 0.63) and between PAL and TEI (r = 0.54). A weak positive correlation between DEE and BMI (r = 0.15) and between TEI and BMI (r = 0.09) were noted. While, there is a weak negative correlation between BMI and PAL (r = -0.06) (Figure 16b).

In the case of overweight girls, the results show a strong positive correlation between DEE and TEI (r = 0.65) and between DEE and PAL (r = 0.56). We noted a positive proportional mean correlation between PAL and TEI (r = 0.35), between DEE and BMI (r = 0.31), and between TEI and BMI (r = 0.30), but a weak positive correlation between PAL and BMI (r = 0.09) (Figure17a).

For overweight boys, the results indicate a strong positive correlation between PAL and TEI (r = 0.58), and a positive mean proportional correlation between DEE and TEI (r = 0.33), between DEE and PAL (r= 0.26), between BMI and TEI (r = 0.23), and a weak positive correlation between BMI and DEE (r= 0.11); while, there is a weak negative correlation between BMI and PAL (r= -0.05) (Figure 17b).

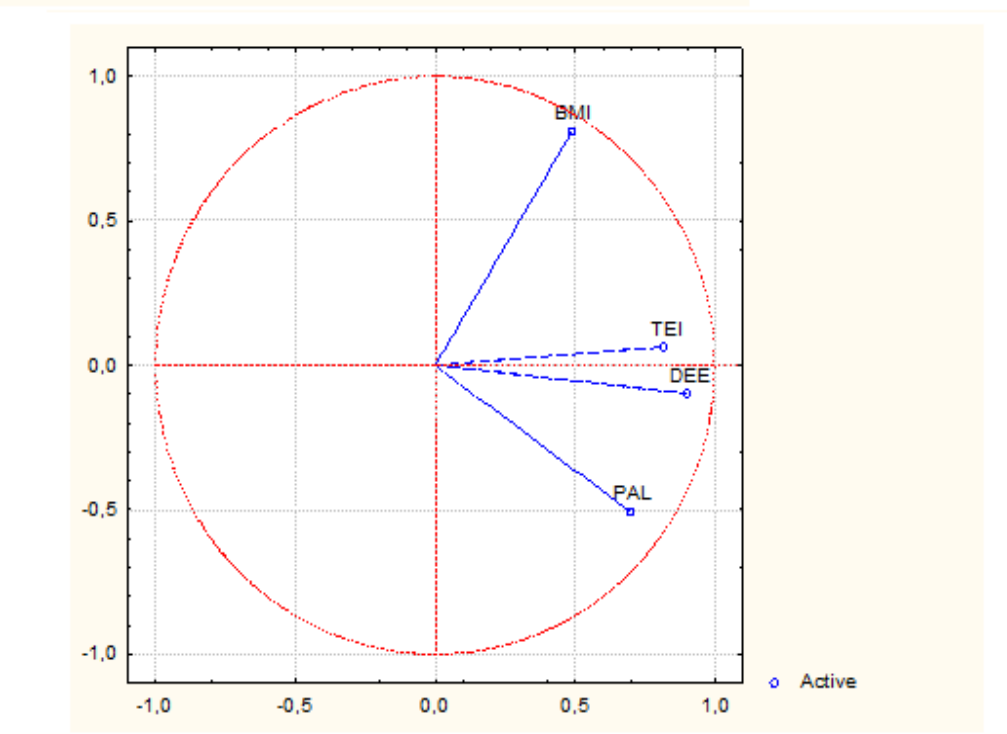


a : Obese girls

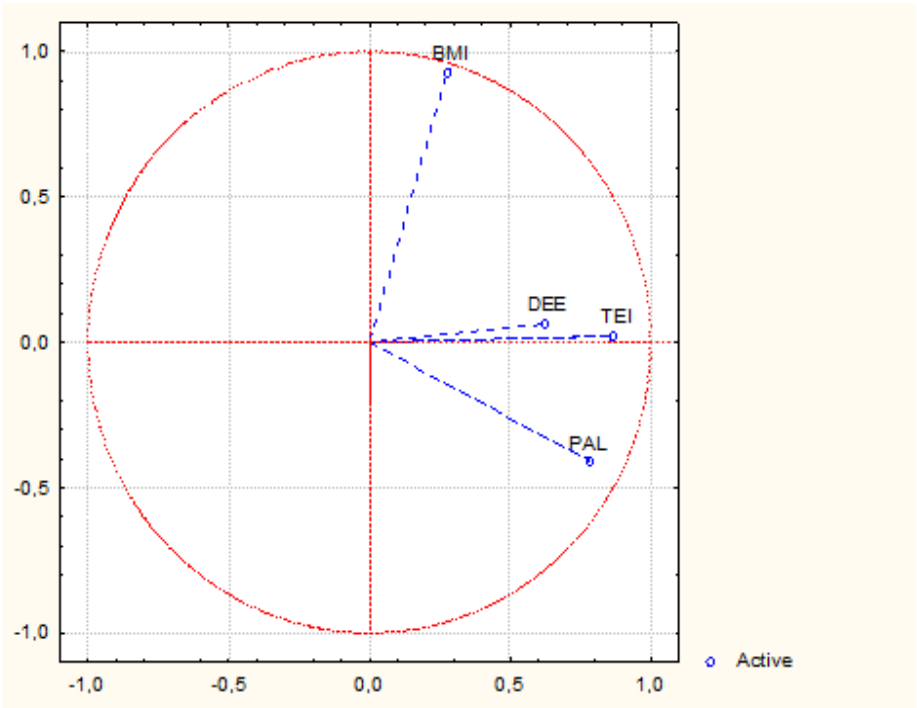


b: Obese boys

Figure 16. Principal component analysis (PCA) of body mass index (BMI), physical activity level (PAL), daily energy expenditure (DEE) and total energy intake (TEI) among obese girls and boys.



a : overweight girls



b : Overweight boys

Figure 17. Principal components analysis (PCA) of body mass index (BMI), physical activity level (PAL), daily energy expenditure (DEE) and total energy intake (TEI) among overweight girls and boys.

Our results show that the most influential factor on the BMI variable is the NAP with a lower degree (1.72) represented with a negative correlation (r = -0.16). DEE has also an influence on the prevalence of high energy intake (r = 0.23) and low energy expenditure (r = 0.15). These results show that DEE and TEI factors play an important role in the prevalence of BMI with excessive consumption of high carbohydrate (614.55 g) and fat (98.9 g) foods, which is due to poor diet and are related to insufficient physical activity.

Cross-referencing the results of the PCA with those of the 24-hour questionnaire, we found that the frequency of consumption of the different food groups divided according to the 4 daily intakes (breakfast, lunch, dinner and snacking between meals), which is very high in carbohydrates (614 .55 g) and lipids (98.9 g); therefore we noted poor eating habits; these behaviors were due to high BMI (30. 5) and an obesogenic environment; and regarding the results of the PAL questionnaire and also the daily energy expenditure that in this study it was shown that our environment is obesogenic due to low level of physical activity (1.72) either in school and/or out of school due to sedentary behaviors in the school environment. On the other hand, there is another influential variable that acts on this environment which is diet and makes it obesogenic. This sample is characterized by a very high consumption of carbohydrates and fats and low energy expenditure; i.e. a higher energy intake and a low energy expenditure which implies low levels of physical activity.

6. BejaiaMapping

The results in Table 21 are shown as follows:

Figures 18 and 19 show the significant difference in the mean BMI, PAL, DEE and TEI of girls with those of boys were examined by the Student test ($p<0.05$); the results (Figure 18, 19) indicate that there is a territorial disparity concerning the distribution of overweight and obese students defined by the BMI, these indices are variable from one zone to another.

Table 21. The significant difference in the means of the parameters (BMI, TEI, DEE, PAL) of girls and boys

	obese population				overweight population			
Daira	**P for BMI**	**P for TEI**	**P for DEE**	**P For PAL**	**P for BMI**	**P for TEI**	**P for DEE**	**P For PAL**
Kherrata	0,04432	0,0001	0,0001	0,0001	0,0001	0,0001	0,0001	0,0001
Darguina	0,201	0,0001	0,0001	0,0001	0,045	0,0001	0,045	0,0001
Souk-eltnine	0,3231	0,0001	0,0001	0,0001	0,0001	0,0001	0,0001	0,0002
Aokas	0,6466	0,0001	0,0001	0,0005	0,0001	0,0001	0,0001	0,0025
Tichy	0,4562	0,0001	0,0001	0,0009	0,0001	0,0001	0,0001	0,0001
Barbacha	0,1542	0,0001	0,0001	0,0001	0,0001	0,0001	0,0001	0,0001
Amizour	0,4967	0,0001	0,0003	0,0001	0,0001	0,0001	0,0001	0,0016
Teimezrit	0,3888	0,0001	0,0001	0,0505	0,0001	0,0001	0,0001	0,0001
Sidi Aich	0,1393	0,0001	0,0001	0,0001	0,0001	0,0001	0,0001	0,0001
Chemini	0,6735	0,0001	0,0001	0,0001	0,0001	0,127	0,0001	0,0042
Ouzlaguen	0,3336	0,0001	0,0023	0,0002	0,0001	0,0001	0,0001	0,0001
Saddouk	0,4208	0,0001	0,0001	0,0001	0,0001	0,0001	0,0001	0,0001
Beni Maouche	0,9937	0,0001	0,0001	0,0001	0,0066	0,0001	0,0066	0,0005
Bejaia	0,023	0,2038	0,3993	0,0001	0,0096	0,0001	0,0096	0,0001
Elkseur	0,2563	0,0001	0,0001	0,0007	0,0001	0,0001	0,0001	0,0062
Adekar	0,8405	0,0008	0,0001	0,0088	0,0001	0,0001	0,0001	0,0001
Akbou	0,0307	0,0001	0,0006	0,0395	0,0001	0,0001	0,0001	0,0001
Tazmalt	0,8193	0,0001	0,0001	0,0001	0,0001	0,0001	0,0001	0,0003
Ighil Ali	0,2608	0,0001	0,0001	0,0021	0,0001	0,0001	0,0001	0,0014

BMI: body mass index; DEE: daily energy expenditure; PAL: physical activity level; TEI: total energy intake;

P: values for comparisons between boys and girls (< 0.05), performed with student's tests.

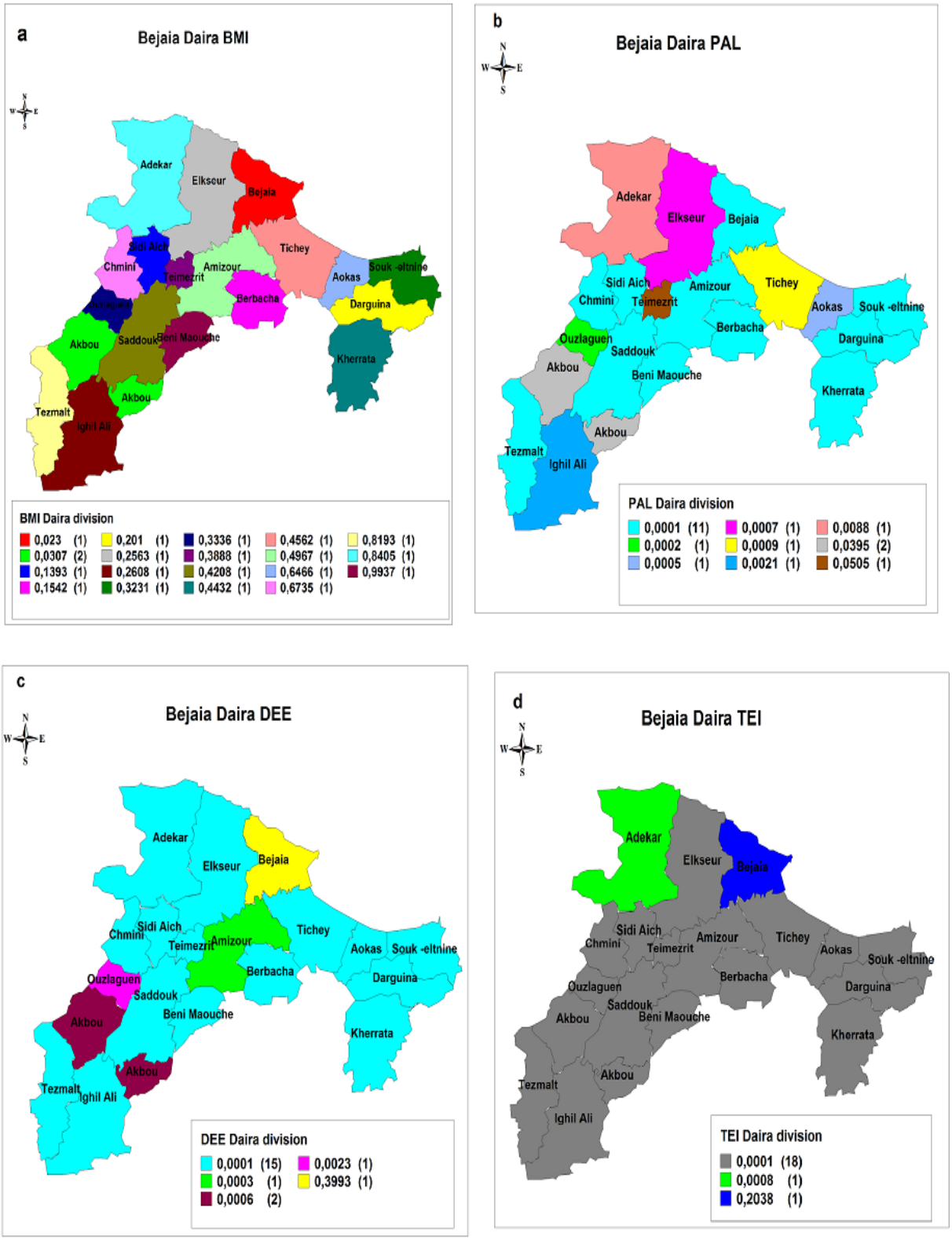


Figure 18. Student's test (p<0.05) to compare the averages of body mass index (BMI), physical activity level (PAL), daily energy expenditure (DEE) and total energy intake (TEI) of obese girls with those of obese boys of all Bejaia Daira.

The mapping shows that certain areas (Bejaia, Akbou, Sidi Aich, Barbacha, Darguina, Elkseur, Ighil Ali, Souk El Tenine, Ouzellaguen) are strongly characterized by obesity (Figure 18a), and by overweight (Darguina, Chmini, Sidi Aich, Elkseur, Akbou, Beni Maouche, Ighil Ali, Tichy, Timezrit) (Figure 19a).

Low physical activity level (PAL) is dominant in both territories: obese (Figure18b) and overweight (Figure19b) students; but high expenditure and energy intake are dominant in both territories: obese (Figures18c and 18d) and overweight (Figures19c and19d).

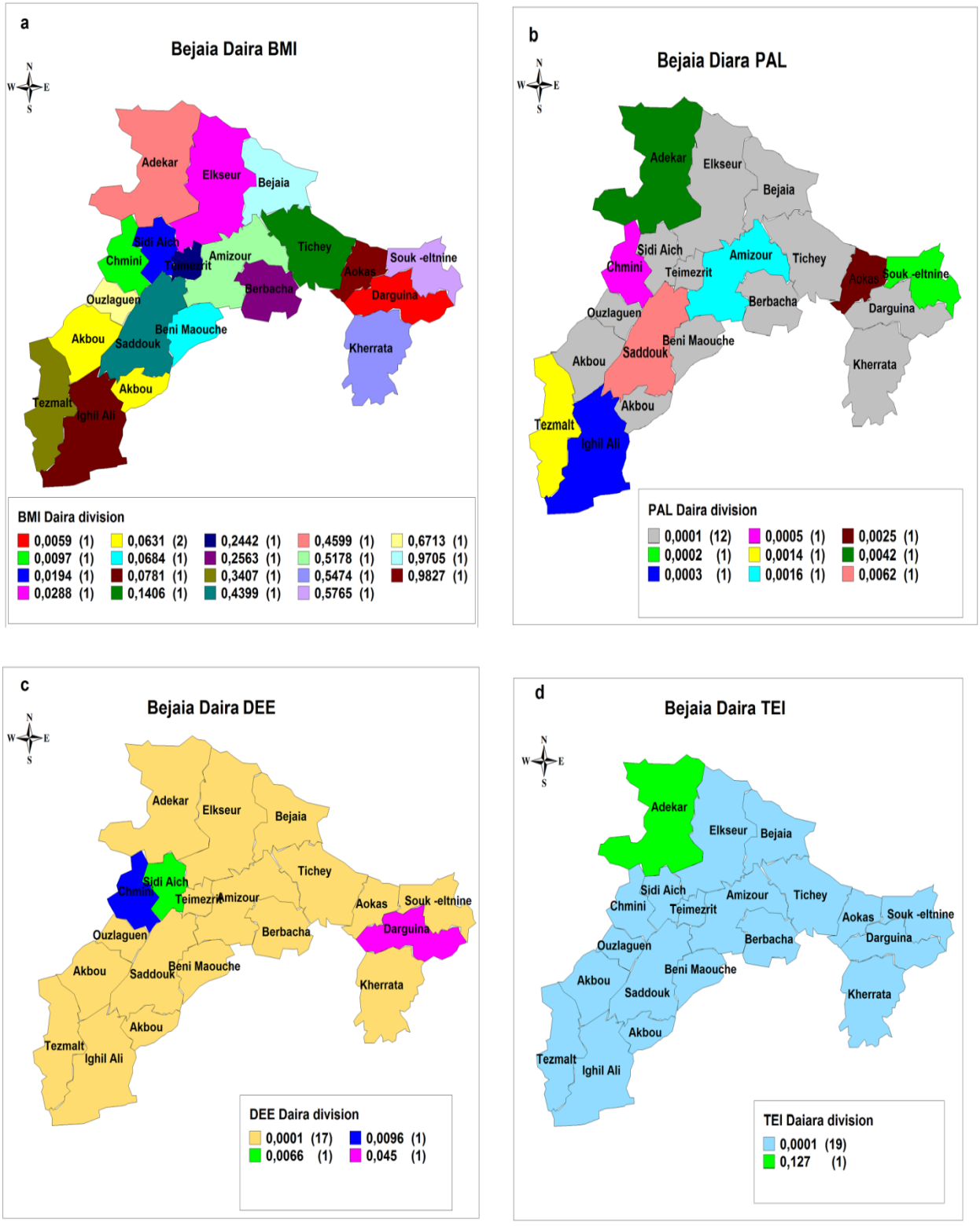


Figure 19. Student's test ($p < 0.05$) to compare the averages of body mass index (BMI), physical activity level (PAL), daily energy expenditure (DEE) and total energy intake (TEI) of overweight girls with overweight boys of all Bejaia Daira.

Discussion

Discussion

1. Prevalence of obesity and overweight

A weight status that is increasing from overweight to obesity is an indicator that gives information on the evolution towards an obese phenotype, the one that leads to students obesity.

The prevalence of obesity and overweight was equal to3.3%. Compared to other studies in our country, our prevalence result is lower than that of Oulamara, *et al.* (2020), in which the prevalence of overweight varied from 22.8 to 28.3 % for a young child population (6-10 years) concerning a small cohort of 509 subjects. However, our research work is based on a different population, that is of 11 to 23 years old, so these are different biometric obesity prevalence characteristics that could cause disparities in prevalence calculation. In the work of éronique Addor, *et al.* (2003) obesity was more frequent in younger children compared to adolescents. Our study concerns a larger cohort sample, which includes a sample of 3038 obese and overweight subjects from a representative sample of the school population (91 810 enrolled students) in the wilaya of Bejaia.

We are facing an obesity phenomenon that sets up a weight status, meaning a prevalence of overweight and obesity in the Maghreb territory. These countries (Algeria, Tunisia, Morocco) have probably the same problem of public health as the most industrialized countries; so our results are concomitant with those of Maghreb countries (Regaieg, *et al.*, 2014). Obesity and overweight in Tunisia were equal to2.4 and 6.3%, respectively. In Morocco, the prevalence of obesity and overweight were3.41 and 7.29%, respectively among 12-18 years aged adolescents (El Kabbaoui, *et al.*, 2018), these values are lower than that found in developed countries (Ng, *et al.*, 2014). According to WHO, the obesity rate in developed countries is twice as high as in developing countries; in the USA (2009-2010) 16.9% of children and 12-19 years aged adolescents were obese (OgdenCarrollKit & Flegal, 2012).

2. body mass index (BMI)

The use of an anthropometric criterion to assess obesity is much more complex and difficult for adolescents than for other age groups. BMI is an important tool for growth, as it has been essential for identifying weight category (obesity, overweight) and assessing body

growth in children, adolescents and adults (Michèle Guillaume, 1999; J. Himes, *et al.*, 1989; Roche, *et al.*, 1981). Growth charts have been used to assess the growth of healthy and sick adolescents (El-Mouzan, *et al.*, 2007).

Correct estimation of anthropometric Z-scores is relevant for clinical patients care as well as for clinical studies since these Z-scores is used for the classification of obesity with implications for treatment and/or nutritional intervention; included as part of more complex scoring systems to assess the presence or recovery of the disease (Martinez-Millana, *et al.*, 2018).

2.1. BMI for age -percentile: girls and boys, 2 to 19 years

In adolescents, BMI is specific to age and sex, and since BMI augmented significantly with age, rapid changes in body composition in girls and boys are assessed differently throughout adolescence; according to Daniels, *et al.* (1997) BMI value by sex and stage of maturation shows visible body composition.

In our study the values we found for body mass index were high for both sexes, a mean decrease in BMI from 30.28 kg/ m² to 30.12 kg/ m² (97th higher in the CDC body mass curve) at the age of 11-13 years in girls and an increase from 30.17 kg/ m² to 30.65 kg/ m² (97th higher in the CDC body mass curve) at the age of 11-14 years in boys truly represents obesity. In this case 97th percentile BMI designates obesity in Netherlands (Brugman, *et al.*, 1995; Spee-van Der Wekke, *et al.*, 1998) and morbid obesity in France (Rolland-Cachera, *et al.*, 1987). However, BMI increased from 30.12 kg/ m² to 30.63 kg/ m² (95th higher in the CDC body mass curve) at age 13 to 15 years in girls and an increase from 30.65 kg/ m² to 30.75 kg/m² (95th higher in the CDC body mass curve) at age 14 to 16 years in boys represents obesity. According to Veiga, *et al.* (2001) the 95th percentile of the U.S. curve was the best prediction of obesity. Nevertheless, from our survey the BMI was a mean decrease in BMI from 30.63 kg/ m² to 30.14 kg/ m² (90th higher in the CDC body mass curve) at age 15 to 19 years in girls and an increase from 30.75 kg/ m² to 30.86 kg/ m² (90th higher in the CDC body mass curve) at age 16 to 19 years in boys represents overweight. The definition of overweight and obesity thresholds ranges from above the 85th to above the 97th percentile (Michèle Guillaume, 1999). The McCarthy, *et al.* (2006) recommendations for body fat were 85th and 95th percentile that representing excess fat and values above the 95th percentile represent-obesity (Laurson, *et al.*, 2011).

The 85th percentile of the U.S. curves represents the risk of overweight, however the same 85th percentile, as well as the 90th percentile to the 95th percentile of the same population, represents obesity in adolescents, these thresholds have been recommended by the World Health Organization (MustDallal & Dietz, 1991; Organization, 1995). The 85th percentile of the U.S. seems to be similar to the 97th percentile of France (Organization, 1995).

The determination of obesity and overweight in adolescents is not well elucidated. However, morbidity is less common in children, and the role of body fat distribution has not been extensively studied (Fox, *et al.*, 1993; Michele Guillaume, *et al.*, 1996). However, the use of BMI may be justified when screening a study population (Michèle Guillaume, 1999). Childhood obesity has been associated with exposure to diabetes in utero (Dabelea, *et al.*, 2000; Huang, *et al.*, 2007; Malcolm, *et al.*, 2006); this exposure is associated with higher BMI in this period of childhood. We have seen some associations between higher BMI in children and their precociousness (Lamb, *et al.*, 2010).

2.2. BMI for 20 to 23 years old

In our study the BMI values of adult were studied. In girls and boys at the age of 20 to 22 years, BMI values over 30 kg/m² represent class I obesity. For boys, BMI values equal to 35.27 kg/m² exceeding the category of 35 kg/m² at the age of 23 years means class II obesity, current WHO BMI cut-off points classify BMI values above 30-34.9 kg/m² (obesity class I), 35-39.9 kg/m² (obesity class II)(Cole, *et al.*, 2000; Who, 2004). The evolution of the BMI of our population shows an increase in obesity with increasing age.

In the case of obesity (with BMI values of 30 kg/m² or more) a prevention and assessment strategy is required and obesity may set in and progress to other degrees, that will affect the health of subjects who will be affected by different diseases such as: metabolic syndrome, diabetes and heart disease. The highest percentage of body fat at BMI indicates an increased risk of disease (hypertension, diabetes and heart disease) (Who, 2004).

2.3. Evaluation of BMI, Z BMI distributed throughout the 19 geographical regions

In our results, there is a variation in the distribution of BMI across the regions underscores the need for research on the cumulative effects of overweight and obesity. Our results show that a high BMI is related to obesity distributed particularly across most regions, more importantly that about 16 to 17 of the total Daira are concerned by obesity class I (BMI ≥

30kg/m²),this could have been attributed to an obesogenic population and may move to other degrees.

In our study, we made numerous hypotheses that the main causalities of obesity can be attributed to genetic and environmental factors as poor dietary behavior and decreased physical activity levels. While obesity related to high BMI has become a global problem, the risks associated with excess body weight vary by ethnic group and geographic location (Arnold, *et al.*, 2015).

In our study, the differences between zones in the prevalence of obesity, reported by the BMI in z-scores for girls and boys and for both sexes, means that there is an epidemic in all territories with a degree between each zone composing the cited territory (Figure 9). The prevalence of BMI in z-scores obesity cases attributed to high BMI in z-scores was relatively higher for girls than for boys in all regions (Figure 9). 50 for boys) and Bejaia (1.11 for girls and 0.37 for boys), the proportion related to high BMI in z-scores was two to three times higher for girls than for boys.

This study shows that changes in BMI include drastic changes in BMI in z-scores as a function of the sample age, sex and initial BMI, so that the change in BMI in z-scores is a logical choice for measuring the evolution and classification of adiposity over time.

3. Physical Activity Level (PAL)

Physical activity is a key factor in determining the biometric profile of adolescents by determining the importance of physical activity levels; the goal is to determine how the PAL affects the weight status of this population and how these manifestations and their impacts.

PAL and caloric intake are among the main risk factors for developing obesity. Boys (PAL = 1.85) are more likely to participate in sport than girls (PAL = 1.61). In addition, boys often practice more physical activity than girls in European countries (Martinez-Gomez, *et al.*, 2010; Sato, *et al.*, 2012).

Our results suggest that physical activity levels are declining precipitously in both girls and boys. When compared with other studies conducted in our country, our result on the decline of physical activity is similar to the several studies conducted in adolescents that show that the level of physical activity is low and also of low intensity (Belounis, 2014; Chibane, *et al.*, 2016; Houti, *et al.*, 2018; Rachid, 2015; Sersar, *et al.*, 2019) (Figure 20).

This decline in physical activity is observed in the literature of the Maghreb countries, according to El Haouari, *et al.* (2018), physical activity is low in Morocco. In industrialized

countries, in Australia; the decline in physical activity among low-income adolescents (Sutherland, *et al.*, 2013). According to Butt, *et al.* (2011); (Kimm, *et al.*, 2002), as age increases in the United States, the amount of physical activity decreases. Adolescence has been identified as the age of the greatest decline in activity, although it is possible that sharp declines may be seen at younger ages (Bélanger, *et al.*, 2011; Corder, *et al.*, 2015; Dumith, *et al.*, 2011; Sallis, 2000; Sutherland, *et al.*, 2016). Declines in adulthood occur at a much slower rate than during adolescence (Nelson, *et al.*, 2005).

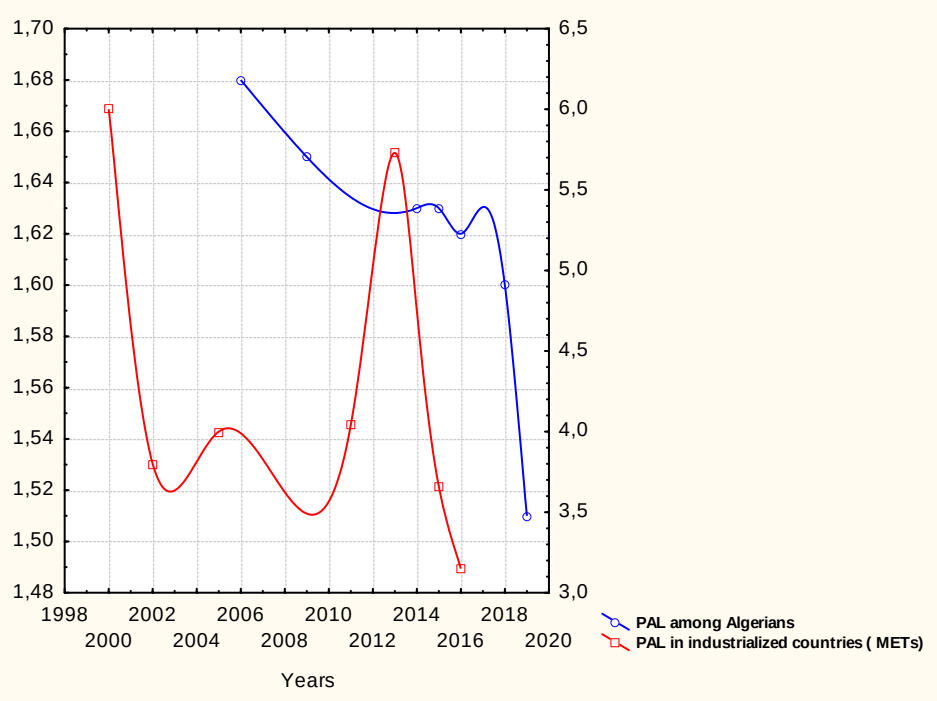


Figure 20. Compared the decline of physical activity in Algeria with industrialized countries

Our results indicate the decrease in physical activity levels, separately for boys and girls in middle school at ages 11-15 and high school at ages 16-23 with a reduction in physical activity sessions and duration, with boys participating in sports for only 3.68 ± 1. 41 hours which is comparable to that of girls who report doing sports for 1.56 ± 1.13 hours in high school girls and 2.47 ± 1.24 in college girls, but it was observed that boys engage in much more physical activity than girls which actually leads to low intensity which decreases activity and increases sedentary lifestyle. (Cureau, da Silva *et al*. 2016 et Health 2000).

In addition, this study evaluated physical inactivity by: time spent sleeping (10 à11hours), sitting (4.73 ± 0.92 hr in college boys and 6.26 ± 1.23 hr in college girls), standing and light activities (2 hours); a reduction in low-intensity activity induces sedentary behavior and increases the risk of sedentary behavior - possible risk factors for obesity (Parsons, *et al.*,

1999). This study indicates that adolescents who were obese at baseline were significantly more likely to reduce their physical activity (Lakerveld, *et al.*, 2011). A number of recent studies focus centrally on the decline in individual physical activity in relation to the development of modern society (Brownstone, *et al.*, 2005; Foster, *et al.*, 2004).

High school students (6.37 ± 1.19 hours per day for girls and 4.81 ± 0.95 hours for boys) watch significantly more television than middle school students (6.15 ± 1.28 hours per day for girls and 4.65 ± 90 hours for boys) are more likely to reduce their physical activity levels and may also be at higher risk for additional weight gain; television watching has been identified as a key behavior between the number of hours spent watching television and obesity (Crespo, *et al.*, 2001; Dietz, *et al.*, 1985). The higher level of time spent watching television and lack of sleep, as well as the lower PAL, due to parents negligence, are the greatest risks of physical inactivity among children and adolescents (Gordon-Larsen, *et al.*, 2000; G. K. Singh, *et al.*, 2008; Strauss, *et al.*, 2001). Reducing the amount of time spent watching television can reduce high weight gain (Robinson, 2001). In addition, time spent watching television in adolescents (sedentary lifestyles) may be associated with an increased risk of obesity. In recent years, children and adolescents have reduced the number of hours spent watching television, having been replaced by other media such as computers and video(Christakis, *et al.*, 2004; Rideout, *et al.*, 2003). Some studies in Europe and the United States have found positive associations between the use of computer games and high physical weight (Attewell, *et al.*, 2003; Gordon-Larsen, *et al.*, 2002; McMurray, *et al.*, 2000; Stettler, *et al.*, 2004). Most of the time, children and adolescents spend more time watching television than other low-intensity activities except for sleep (Huston, *et al.*, 1998; Wright, *et al.*, 2001).

In this study girls were less active than boys of all ages and locations and also showed that girls had a lower PAL with age, whereas boys showed an increase in their PAL with age, girls reported that time spent watching TV increased time spent in other sedentary leisure activities and less time spent in leisure time physical activities (Lakerveld, *et al.*, 2011) . According to Epstein, *et al.* (1996) Both sexes prefer different types of physical activities (exercise material), so they are socialized differently. However, uses such as fatigue, muscle tension, pain caused by physical activity may be associated with collecting incompetence (Deforche, *et al.*, 2004).

Most girls and boys in middle and high school have at least once (at least 30 minutes) a week of physical activity. Evidence shows that adolescents who engage only in school sports activity in school and spend sedentary time outside of school can increase sedentary behavior, sedentary lifestyle and cause excessive weight gain. However, most adolescents who do not

walk or cycle to school decrease physical activity levels (Table 12) ; according to Rennie, *et al.* (2005) walking or cycling to school increased activity levels.

The physical activity levels of adolescents who walk to school are higher than those of adolescents who drive to and from school; although this behavior represents only one of the daily activities as students walk on some days and drive to school on others, it appears that adolescents who actively travel to school have the ability to have higher activity levels throughout the school day (RennieJohnson & Jebb, 2005). Thus, the choice to walk to school is a way to encourage children and adolescents to increase and sustain their regular physical activity levels, and it may be necessary to make programs to include additional education to the movement schedules to increase physical education in schools. The authors begin by mentioning general factors that explain the dramatic decline in physical activity: the reduction in the individual's physically active occupations, car use, the decline in walking (especially among children, women and the elderly), certain public space amenities (escalators, elevators, automatic doors), the reduction in physical education and sport in some schools and the replacement of leisure time physical activity with television, video games and the Internet. A recent receipt of (Brownstone & Small, 2005) taking into consideration about sixty studies is interested in the reduction of physical activities in the USA (walking, use of stairs, household activities, gardening work).

Our findings reinforce the importance of preventing weight gain and promoting the adoption and maintenance of physical activity in all weight categories (Lakerveld, *et al.*, 2011) and their benefits on increasing physical activity levels and their effect on health. Increased physical activity may be an important factor in repairing energy balance (Esparza, *et al.*, 2000). The recommended thresholds for cardiovascular health are at least 60 minutes of moderate-intensity activity per day in children (RennieJohnson & Jebb, 2005). The prevention of excessive weight gain in the recommended childhood period requires determining the amount and type of physical activity to demonstrate effective public health interventions (RennieJohnson & Jebb, 2005).

The results of this study show an inversely negative correlation between sport Competition and Sleep and nap, extended rest (r = -0.066), between Sport Competition and Standing position (r = -0.60), these results show an independent relationship on the lack of physical activity and their effect on adolescent lifestyle due to less active sedentary behaviors, therefore our studies show that obese adolescents prefer to be sedentary rather than active (Figure21). In order to increase physical activity levels in adolescents, it is necessary to reinforce that they should be more active (EpsteinCOLEMAN & Myers, 1996).

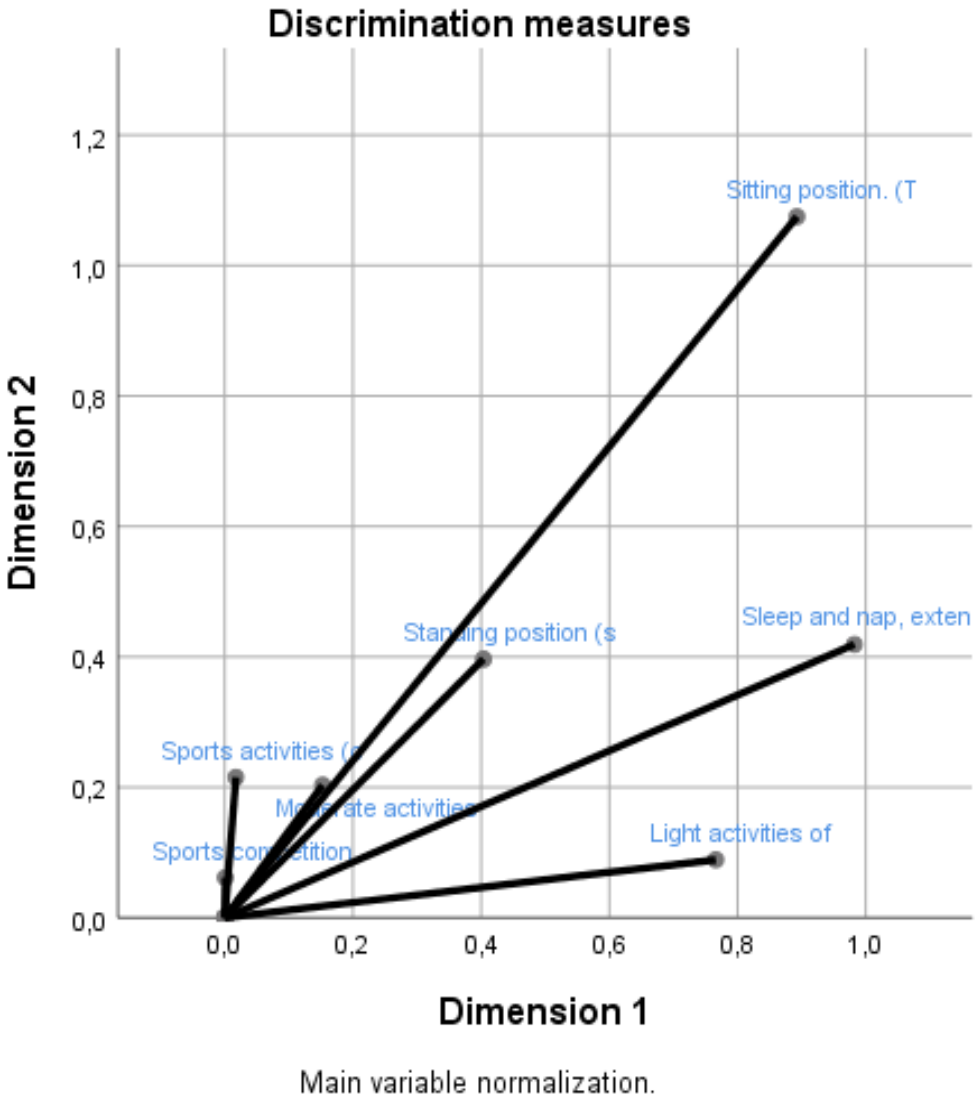


Figure 21. Main variable normalization

During the period of adolescence, there is a significant relationship between changes in the difference in PAL and changes in BMI. The results of many previous studies are comparable to our results (Kimm, *et al.*, 2005). According to Meininger, *et al.* (2010) numerous studies showed that there is a link between the increase in the prevalence of childhood obesity and the current trend towards their greater sedentariness.

3.1.PAL distribution for girls and boys

In our results, variation in the distribution of PAL across regions can be explained by the low levels of activity and their role in the development of increased weight status directly associated with adolescent health outcomes. In this study the comparison between rural and urban areas in the same region did not show differences in physical activity levels. Figures 13 show that the physical activity levels in college and high school girls is lower than that observed in boys. This contributed to a reduction in energy expenditure related to physical activity contribute to the increase in the prevalence of obesity in these areas, in particular, the very low level of activity in the following regions: in Beni Maouche and Timezrit with PAL= 1. 54 among college girls and in Amizour with PAL= 1.75 among college boys and in Beni Maouche with PAL= 1. 50 in high school girls and in Aokas with PAL= 1.65 in high school boys; these environmental changes induce sedentary behaviors and modulate the physical activity level in the population and represent the preponderant factors conditioning the adherence to sport and physical activity and can be considered as intermediate variables, and treated as such logically certain environmental determinants will have the status of so-called facilitating factors allowing the optimization of the conditions for the practice of physical activity (and/or sport), with a positive impact on the health of the person concerned. In contrast, other environmental determinants constitute a deferential register of intermediate variables which, in this case, designate as many real or presumed obstacles to physical activity ("objective" obstacles: under sports equipment, poor security of pedestrian or bicycle networks, or social representations or obstacles subjectively perceived as such: impression of insecurity, poor image of the district); therefore, future research will need to analyze the causality to these problems such as environmental variables (climate). According to Ewing, *et al.* (2003) Small changes in distribution at the population level can have serious implications for public health.

However, low physical activity levels are associated with an increased risk of cardio metabolic and vascular disease (HillsAndersen & Byrne, 2011; Strong, *et al.*, 2005). Thus, inactivity may have a more detrimental effect on children already suffering from obesity (high weight status).

4. Daily Energy Expenditure (DEE)

In this study, we showed that DEE is of the order of3144.13kcal in adolescents, it was greater with increasing weight status and low PAL. These results have been reported in other studies (Bandini, *et al.*, 1990), in which DEE was significantly greater in obese than in the non-obese subjects.

Results also indicate that the energy balance is of the order of 631.31 kcal/day, this positive rate of stored energy shows that the TEI exceeds the DEE causing obesity (the excess calories will be stored in adipose tissue) (BandiniSchoeller & Dietz, 1990). Several previous studies showed that associations between snack food consumption, fast foods and overweight are reducing the diet energy density (Drewnowski, 2004; S. French, *et al.*, 1994; S. A. French, *et al.*, 2000).

Here we determined the physical activity role in adolescent's obesity development. Energy expenditure is related to the PAL, so it is the main factor in determining energy expenditure. Epidemiological studies have shown the importance of activity in preventing weight gain (Schmitz, *et al.*, 2000). Levine's team at the Mayo Clinic in the United States has just demonstrated a very significant relationship between spontaneous physical activity and adiposity in slim and obese subjects (Levine, *et al.*, 2005).

5. Total Energy Intake (TEI)

Our results indicate that the daily diet provides a sufficiently high amount of energy; we found that fat absorption often exceeded recommendations, so the nutrition of most adolescents is not balanced. TEI is of the order of 3775.44 kcal divided into food groups. We noticed a very high consumption of the different sweet food groups that are distributed over the different daily intakes, in breakfast, adolescents consumed 129.55g of carbohydrates, 51.3g as a snack, 170.7g for lunch, 68.5g as a snack, 136.5g for dinner, and snacked between meals 58 g of carbohydrates. The consumption of breakfast meals from 524.98 to 809.64 kcal of cereals and resulted in a greater increase in the daily proportion of sweets; and also decreases in the proportion of hunger, the desire to eat and the food outlook increasing the feeling of satiety (Leidy, *et al.*, 2013); In addition, breakfast was the only meal that resulted in a daily reduction in the ghrelin hormone, an increase in the satiety hormone PYY, and a reduction in evening snacks, especially high-fat foods (LeidyOrtinauDouglas & Hoertel, 2013). Overweight and obese adolescents are very sensitive to the current nutritional environment, which provides easy access to highly palatable products and energy-dense foods (Daniels, *et al.*, 2005; Ebbeling, *et al.*, 2006). These results have been shown to support the

effects of increasing dietary protein in morning meals on improving the appetite and hormonal signals that monitor the regulation of caloric intake (energy intake) in adolescents (LeidyOrtinauDouglas & Hoertel, 2013).

Snacks have been exacerbated the craving for eating usually very appetizing foods, with foods of high caloric density with low nutritional value for example (desserts, sweets, deli meats, pizza, sweet drinks) (Piernas, *et al.*, 2010) ; These eating habits and behaviors leading to a positive energy balance and obesity. Snack food intake has been increased to the contribution of energy-dense, nutrient-poor foods and beverages (Sebastian, *et al.*, 2010). More boys (66.2%) report snacking between main meals by eating a large amount of different sweeter food groups (chocolate, jam, honey, sweetened drinks). The consumption of fast food shows adverse effects on the quality of care that may increase the risk of obesity in children and adolescents (Bowman, *et al.*, 2004).

Adolescents were generally snacking more salty and sweetened high-fat foods and soft drinks for breakfast (Haire-Joshu, *et al.*, 2011; Sjöberg, *et al.*, 2003) ; with higher energy intakes at snacks earlier in the day, especially an evening snack, as one of the adolescents were less likely to be active and expend energy consumed. Snacking is usually maintaining a negative influence on the development of obesity.

The correlations between meals were significantly positive (Table 22) explore that our study determined that energy intake from a particularly high carbohydrate breakfast (129.55g) appears to be aimed at increasing motivation to eat at 10am, higher protein intakes at breakfast (47,6g) and a high carbohydrate content (170.7 g), Although we found unhealthy snacks at 16:00 pm high-fat afternoon snacks (34.3g), the consumption of higher energy and carbohydrate snacks in the afternoon (68.5g) and evening (81g), higher fat (28.6g) and carbohydrate (136.5g) and low micronutrient intake in the evening in overweight or obese adolescent girls suggest daily dietary misconduct . These data advise that eating healthier and more nutrient-rich foods at the main meal (breakfast, lunch, and dinner) could be an interesting maneuver to improve satiety and decrease food cravings, eating and snacking behaviors especially in the evening.

Table 22. Correlation between meals

Sex			beakfast	snack	lunch	taste	dinner party	snacking
Boys	Beakfast	Pearson Correlation	1	,967*	,990*	,982*	,996**	,968*
		Sig. (bilateral)		,033	,010	,018	,004	,032
		N	1403	1403	1403	1403	1403	1403
	Snack	Pearson Correlation	,967*	1	,971*	,998**	,971*	1,000**
		Sig. (bilateral)	,033		,029	,002	,029	,000
		N	1403	1403	1403	1403	1403	1403
	Lunch	Pearson Correlation	,990*	,971*	1	,985*	,998**	,974*
		Sig. (bilateral)	,010	,029		,015	,002	,026
		N	1403	1403	1403	1403	1403	1403
	Taste	Pearson Correlation	,982*	,998**	,985*	1	,986*	,998**
		Sig. (bilateral)	,018	,002	,015		,014	,002
		N	1403	1403	1403	1403	1403	1403
	dinner party	Pearson Correlation	,996**	,971*	,998**	,986*	1	,974*
		Sig. (bilateral)	,004	,029	,002	,014		,026
		N	1403	1403	1403	1403	1403	1403
	Snacking	Pearson Correlation	,968*	1,000**	,974*	,998**	,974*	1
		Sig. (bilateral)	,032	,000	,026	,002	,026	
		N	1403	1403	1403	1403	1403	1403
girls	Beakfast	Corrélation de Pearson	1	,991**	,999**	,994**	,994**	,996**
		Sig. (bilateral)		,009	,001	,006	,006	,004
		N	1635	1635	1635	1635	1635	1635
	Snack	Pearson Correlation	,991**	1	,995**	,997**	,992**	,998**
		Sig. (bilateral)	,009		,005	,003	,008	,002
		N	1635	1635	1635	1635	1635	1635
	Lunch	Pearson Correlation	,999**	,995**	1	,998**	,993**	,998**
		Sig. (bilateral)	,001	,005		,002	,007	,002
		N	1635	1635	1635	1635	1635	1635
	Taste	Pearson Correlation	,994**	,997**	,998**	1	,987*	1,000**
		Sig. (bilateral)	,006	,003	,002		,013	,000
		N	1635	1635	1635	1635	1635	V
	dinner party	Pearson Correlation	,994**	,992**	,993**	,987*	1	,990**
		Sig. (bilateral)	,006	,008	,007	,013		,010
		N	1635	1635	1635	1635	1635	1635
	Snacking	Pearson Correlation	,996**	,998**	,998**	1,000**	,990**	1
		Sig. (bilateral)	,004	,002	,002	,000	,010	
		N	1635	1635	1635	1635	1635	1635

*. The correlation is significant at the 0.05 level (bilatéral).

**. The correlation is significant at the 0.01 level (bilatéral).

Food consumption was increased at breakfast, but much more at lunch and dinner levels generally have greater effects on a higher mean BMI, which is constantly changing and of continuing interest in food, at the same time that the observed intakes of micronutrients were low; nevertheless, the low intakes of calcium (1028.46 mg), fiber (21.5g), iron (26.38mg) and vitamins (vit A(2836.46 µg), groups B(B12= 0.65 µg), vit C(119 mg), vit D(4577.5 µg) and lower intake of water (0.65 l g). Fiber could be an important cofactor to help weight loss, encourage satiety (Jeffreys, *et al.*, 2012), as well as water should be encouraged as an essential source of fluids. As a result that macronutrient intake was consistently higher carbohydrate intake (614.55g) are due to the quality of carbohydrates ingested; these data removed many problems related to the composition of macronutrients in meals. Therefore, it is necessary to feel advice on the partially higher levels of cholesterol, sodium and full fats in the meals and recommendations a healthy diet such as fruits, vegetables, milk and set the amount of salt, fats. Adolescents should decrease their consumption of foods very high in sugar from industrial preparations, such as sweetened drinks, jam, sweets. These high amounts of sugar were an important contributor to energy intake and increased the total caloric intake (Alexy, *et al.*, 2003; Øverby, *et al.*, 2004). These associations appear to be related to the high prevalence of overweight and obesity among adolescents. We found that TEI provides a high amount of energy, and we noted bad dietary habits. These behaviors were caused by high energy density foods rich in carbohydrates and fats. According to Nielsen, *et al.* (2002)adolescents obtain an exposed increase in their TEI away from home, usually in fast-food restaurants.

Results indicated that those with lower fiber intakes and higher fat intakes had a poor diet (Storey, *et al.*, 2009). Obese adolescents derived more of their energy from fat supplied by meat and meat products and grains that lead to body fat accumulation. This finding suggests a positive energy balance between energy intake and expenditure; these results also suggest a positive correlation between TEI and DEE (Table 23) Our cross-sectional studies show that obesity is positively associated with the total energy intake and also with the daily energy expenditure that match between fats and carbohydrates (control of the carbohydrate balance has a higher priority than the lipid balance).

Table 23. Correlations between TEI and DEE

Correlations

Sex			TEI	DEE
boys	TEI	Pearson Correlation	1	,991**
		Sig. (bilateral)		,009
		N	4003	4003
	DEE	Pearson Correlation	,991**	1
		Sig. (bilateral)	,009	
		N	4003	4003
girls	TEI	Pearson Correlation	1	,932
		Sig. (bilateral)		,068
		N	1635	1635
	DEE	Pearson Correlation	,932	1
		Sig. (bilateral)	,068	
		N	1635	1635

**. The correlation is significant at the 0.01 level (bilatéral).

Our adolescents who were consuming higher daily energy intakes were spending more time watching television. According to Berkey, *et al.* (2003) Higher energy intakes were related to higher time of inactivity such as television. These results have been shown that TV can indirectly influence the weight of adolescents through the consequences of food intake (Francis, et al., 2003). Boys and girls who watched more time on TV reported habitual snacking while watching TV especially in the evening had higher energy intakes promoting sedentary behaviors that due to obesity; the investigators were consumed products higher in energy (sugary drinks) and poor diet while watching TV. Our results are similar with previous research that published that snacks were the foods primarily consumed while watching television (Matheson, *et al.*, 2004). We found that TEI provides a high amount of energy, and we noted bad dietary habits. These behaviors were caused by high energy density foods rich in carbohydrates and fats. According to NielsenSiega-Riz and Popkin (2002), adolescents obtain an exposed increase in their TEI away from home, usually in fast-food restaurants.

5.1. Eating Habits

The association between mealtime habits and behaviours associated with obesity in adolescents with high frequencies of food intake and an increased desire to snack very often between meals. Although fast food consumption has been associated with higher intakes of

energy, fats, drinking high amounts of sugar and soft drinks at least daily, these are risk factors for aggravated energy intake, weight gain, overweight and obesity, metabolic syndrome and type 2 diabetes (Currie, *et al.*, 2009; Mis, *et al.*, 2012) ; with lower intake of fruits, vegetables and milk (S. A. French, *et al.*, 2001). Results showed that adolescents who took the recommended 2-3 servings of dairy products (milk and yogurt) per day reported higher energy intake, but had lower body fat weight, even though milk intake does not protect overweight and obese adolescents but are good sources of calcium and other micronutrients essential to support bone health and reduce risk of chronic disease (Fiorito, *et al.*, 2006; Ilich, *et al.*, 2000). Snacking behaviour may be a more productive intrusive goal than TV viewing per se, although this behaviour has been influenced in determining higher caloric intake (Gore, *et al.*, 2003).

In our study, adolescents with a poor diet with a high frequency of consumption at breakfast, lunch, dinner and snacks that were simultaneously high intakes of energy and poor dietary quality. However, parents who catch some ability to control their children's consumption to limit snack (junk food) consumption. Both boys and girls were preferred sweet and high-fat foods. Insufficient amounts of fruits and vegetables and increased consumption of sugar, fast food, fast food, drinks such as cola, lemonade and skipping breakfast, as well as long hours of TV viewing may be some of the habits that lead to obesity. Results have been shown that both sexes eating in front of the TV can calm the physiological cues that herald satiety to a person's body which could lead to discretionary access and increase the risk of obesity (Bellissimo, *et al.*, 2007; Hetherington, *et al.*, 2006).

6. Principal Component Analysis (PCA)

The main conclusion of our study included that Body Mass Index correlated positively with energy intake (r = 0.31) and negatively with energy expenditure and level of physical activity (r = - 0.06). These results show that high Body Mass Index and fat mass stored in adipose tissue are caused by poor nutrition and excessive consumption of foods rich in carbohydrates and fat, and are related to insufficient level of physical activity and sedentary life.

Our results indicate that energy intake should be assessed either in relation to two important components, physical activity level or in relation to body mass index, which is the best simple predictor of energy requirements. The ratio of high body mass index and low level of physical activity are the main cause of obesity because energy requirement appears to be a direct

function of high body mass index. These changes in energy expenditure and intake were evident during periods of stable body weight change and tended to be in a direction tending to return subject to one's initial weight.

Physical activity has a significant impact on energy expenditure and the total 24-hour energy balance. Adolescents often spend most of their time sleeping and napping, resting for a longer period (11 hours) over the 24 hours. For these reasons they find physical inactivity and sedentary living (r = -0.06), in addition the basal metabolic rate of sedentary adolescents is mainly attributed to changes in body composition by increasing weight status; these changes appear to be the main factors increasing energy expenditure (r = 0.29) and energy intake (r = 0.31) rich in carbohydrates and fats. Body weight gain can therefore be seen as an adaptive change to overfeeding (Tappy, *et al.*, 2003).

It is important to emphasize that the regulation of body weight requires not only the maintenance of the energy balance but also the maintenance of the balance of nutrient consumption; i.e. energy.

The energy balance gives a full and rich amount of micronutrients because of eating habits with high consumption of sweet products, this explains a less balanced diet during the period of adolescents compared to adults, where protein and carbohydrate reserves are very little, while the mass of adipose tissue can change markedly (Fonseca, *et al.*, 2018; Jéquier, *et al.*, 1999).

7. The mapping of Bejaia

Figures 18 and 19 shows that there is a disparity in territory that can be found from one zone to another, but this disparity in anthropometric parameters (BMI, PAL, DEE and TEI) means that there is an epidemic in all territories with a degree of significance between each zone corresponding to the cited territory. These data show the extent to which overweight and obesity status has been established.

Regarding the level of physical activity (Figures 18b and 19b), we saw that there is a territorial disparity regarding the sports practice of our adolescents that drops significantly.

These two parameters provide information on the emergence of other parameters justifying the status and level of physical activity and one influences the other; but the BMI index and PAL are not the only factors that generate weight status, the eating behaviors represented by DEE (Figures18c and 19c) and TEI (Figures18d and 19d) are imposed as parameters reinforcing the existence of the epidemic.

The Mapping demonstrates that there is disparity regarding the studied parameters: high BMI, low PAL and unhealthy food consumption (DEE, TEI).

Conclusion

Conclusion

The prevalence of overweight among adolescents has increased and has become a serious public health problem in the world and in Algeria. In recent times it affects the youngest population that is at risk of becoming obese early in their lives due to significant changes in behavior regarding eating habits and physical activity.

In Algeria, there are few statistical data in this field. Our study carried out in the school environment is the first work carried out in the wilaya of Bejaia. Its main objective is to evaluate energy expenditure, to draw up a nutritional profile and also to evaluate the level of sports activity in the school environment.

We chose this age group (11 - 23 years) for several reasons, namely:

- Adolescence is a period of rapid body changes.
- This period of adolescence represents rapid physical growth with changes in eating habits and behaviors (quantitative and qualitative) and nutritional needs increase such as snacking on nutrient poor, high fat foods and high sugar drinks.
- Finally, it could be a good time for prevention strategies.

At the moment we can see that the obesity of teenagers is slowly settling in and very difficult to fight when they are declared.

Our studies show that there is an increase in BMI values, especially in younger groups, should result in an increase in the burden of obesity in the future.

The more comfortable living conditions (transportation, elevator) are a little low compared to the time spent in front of the screen, sitting time that is usually very high. The latter are associated with the lack of participation of adolescents in physical activities and decreased daily energy expenditure.

At the end of this work, we can say that the results of the dietary survey conducted by the method of "recall of 24 hours" indicated that the food intake of obese adolescents is higher than the daily energy expenditure because of sedentary lifestyle, while the latter causes the increase of the BMI of the individual.

An energy imbalance often characterizes obesity, when an adolescent to excess weight is more frequently due to poor dietary habits that was characterized by exceeding the reference values of consumption of sugars (sweetened beverages and processed foods), salt and fat, and a lower reference to intake of vegetables, fruits and several micronutrients (vitamins, minerals), with a high frequency of consumption at breakfast, lunch, dinner and snacks that

were simultaneously high energy intake and poor quality food and snacking between meals, most of the foods snacked are high energy density foods rich in carbohydrate and fat, the consumption of fast food types and sweetened beverages participate for a large part in the increase in caloric intake and weight gain; These adolescents have sedentary activities that are often accompanied by snacking, and a reduced practice of extracurricular sports.

The lifestyle of schoolchildren is evolving towards a more sedentary lifestyle, where the majority do not reach the level of weekly physical activity required for a beneficial effect on health. Indeed, they spend most of their time sitting at school and their leisure time is spent in front of screens, without physical effort or movement.

The mapping shows that there is a disparity between the parameters studied: the increase in body mass index, low levels of physical activity and consumption of unhealthy foods (DEE, TEI) due to obesity in the sample studied distributed throughout the geographical territory of the wilaya of Bejaia.

The management consisted of:

- Dietary intake assessment is necessary to learn about the nutritional status of adolescents by avoiding snacking between meals, consuming processed foods outside the home and skipping meals, avoiding high energy density foods ;
- Encourage and motivate adolescents to engage in physical activity, increase the level of physical activity and sports participation, and combat sedentary behavior ;
- Nutritional education associated with the promotion of physical activity in schools seems necessary in order to change unhealthy habits and prevent the progression of obesity in children of this age group ;
- There is a lot of talk about obesity in the news and the focus is on the school. The aim is to make students aware of the importance of a healthy diet, physical activity is a way to increase daily energy expenditure and thus contribute to maintaining a stable weight.

This study has its limitations because it is a cross-sectional study, we will be interesting to continue this work over a long period of time, in particular to follow up the 24 h recall (the quantity and quality of food consumed), to analyze biological and precious inflammatory measures, the mechanisms that regulate the total energy intake in children and adolescents to determine health behaviors in youth and future adults.

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Annex

Annex1. Food consumption, 24-hour recall and physical activity questionnaire for middle and high school students

Questionnaire

Nom :
Prénom :
Ecole :
Age :
Sexe :

Indice de Masse Corporelle IMC	
Taille	
Poids	
Rapport d'IMC	

I. Section de Consommation des aliments

1. avez-vous déjà rencontré une diététiste dans le passé ? Oui (année…) □ Non □
2. suivez-vous actuellement un régime alimentaire particulier ? Oui □ Non □

Si oui, lequel ?

3. **Combien de repas prenez-vous par jour ?**

1-2 repas/jour □

3 repas/jour □

Je mange souvent un 4e repas □

4. **Mangez-vous entre les repas ?**

Non/ je mange une collation au besoin □

Je mange généralement en soirée □

Je grignote très souvent entre les repas □

5. **À quelle fréquence mangez-vous au restaurant ? (Sandwicheries, fast food, pizza, rôtisserie……)**

Moins de 1 fois/semaine. □

1-2/semaine. □

3 repas et +/semaine.

□

6. Consommez-vous des repas prêt-à-servir ? (Aliment congelés, pizza, riz et pâtes alimentaires assaisonnés…)

< 1/semaine. □

1-2/semaine. □

> 3/semaine. □

7. Combien de légumes consommez-vous ?

1 portion = 1 légume moyen, ½ tasse légumes frais, surgelés ou en conserve, 1 tasse de laitue, ½ tasse jus de légumes

≤ 1/jour □

2-3/jour □

≥ 4/jour □

8. Combien de fruits consommez-vous ?

≤ 1/jour □

2/jour □

≥ 3/jour □

9. Combien de fois Mangez-vous de viande?

1-2 par jour □

1-2 par semaine □

1-2 par mois □

10. Mangez-vous la peau du poulet ou le gras visible des viandes ?

Jamais □

À l'occasion □

Toujours □

11. Mangez-vous des charcuteries ou des viandes grasses ? (saucisse, les abats, ailes de poulet,, viandes hachées)

Moins de 1 fois /semaine. □

1-2/semaine. □

3 fois et + /semaine. □

12. Mangez-vous du poisson non pané ?

Rarement □

1 fois/semaine □

≥> 2 fois/semaine □

13. Mangez-vous du fromage ?

≤ 2/semaine □

3-4/semaine □

≥ 5/semaine □

14. Mangez-vous les produits litières (lait et yogourt)?

≤ 1/jour □

2-3/jour □

≥ 4/jour □

15. Quels types de matières grasses utilisez-vous le plus souvent ?

Huile végétale ou margarine ou beurre □

Huile, margarine et beurre □

Beurre, crème, □

16. Quelle proportion les produits céréaliers ou les féculents occupent-ils dans votre assiette ? (Pâtes alimentaires, riz, couscous, pomme de terre…)

1/4 de l'assiette □

½ de l'assiette □

Plus de la ½ de l'assiette □

17. Choisissez-vous des produits céréaliers faits de grains entiers ? (Pain de blé entier, céréales à déjeuner riches en fibres, riz brun…)

Rarement □

À l'occasion □

Oui, toujours □

18. À quelle fréquence consommez-vous des produits de boulangerie ?
(Beignes, brioches, croissants). Exclure les muffins maison.

< 1 fois ou moins/semaine □
2 -3/semaine □
> 4 ou plus/semaine □

19. À quelle fréquence consommez-vous des desserts commerciaux ?
(En collation ou au repas : barres tendres, biscuits, crème glacée régulière, gâteaux, pâtisseries, tartes, etc.)

< 2 fois ou moins/semaine □
3 - 4/semaine □
> 5 ou plus/semaine □

20. À quelle fréquence consommez-vous des sucreries ?
(Bonbons, chocolat, miel, confiture…)

3 fois ou moins/semaine □
4-5/semaine □
Tous les jours □

21. Buvez-vous des breuvages sucrés ?
(Jus ou boisson aux fruits, boisson gazeuse ou énergisante, thé glacé, limonade…)

1-2 par jour □
2-4 par semaine □
4 ou plus par semaine □

22. Consommez-vous des soupes, bouillons ou sauces, en sachet ou en conserve?

≤ 1/semaine □
1-2/semaine □
≥ 3/semaine □
Jamais □

23. Consommez-vous des aliments enrobés de sel ?
(Pop corn, noix ou graines salées, etc.)

≤ 1 fois /semaine □
2-3/semaine □
≥ 4/semaine □

24. Ajoutez-vous du sel à vos aliments ?

Rarement □

Souvent / avec certains aliments □

La plupart du temps □

25. Désirez-vous perdre du poids ? Oui □ Non □

II. Rappel de 24h

1. **prenez-vous la prise du petit déjeuner?**

Toujours □

Parfois □

Jamais □

2. **Quels sont les Aliments consommés au cours du petit déjeuner ?**

Gâteaux, biscuits, Chocolat □

Pain □

Biscottes □

Fromage, yaourt □

Confiture, miel □

Beurre, margarine □

Lait seul, Café au lait, Lait au chocolat □

Boissons sucrées □

3. **prenez-vous la prise de la collation ?**

Toujours □

Parfois □

Jamais □

4. **Quels sont les Aliments consommés au cours de la collation ?**

Gâteaux, biscuits, Chocolat □

Pain □

Biscottes □

Fromage, yaourt □

Confiture, miel □

Beurre, margarine □

Charcuteries, friandises □

Boissons sucrées □

Fruit, charcuteries □

5. **Prenez-vous la prise du déjeuner ?**

Toujours □

Parfois □

Jamais □

6. **En générale, quels sont les Aliments consommés au cours du déjeuner?**

Viande, poissons poulet, œufs :

Légumes :

Fruits :

Céréales :

Boissons sucrées :

7. **Avec qui déjeunez- vous?**

Tous les nombre de la famille □ **seul** □ **amis** □

8. **Prenez vous du gouter?**

Toujours □

Parfois □

Jamais □

9. **Quels sont les Aliments consommés au cours du goûter ?**

Gâteaux, biscuits, Chocolat □

Pain □

Biscottes, céréales □

Fromage, yaourt □

Confiture, miel □

Beurre, margarine □

Lait seul, Café au lait, Lait au chocolat □

Boissons sucrées □

10. Prenez-vous la prise du dîner ?

Toujours □

Parfois □

Jamais □

11. En générale, quels sont les Aliments consommés au cours de la dîner ?

Viande, poissons poulet, œufs :

Légumes ;

Fruits :

Céréales :

Boissons sucrées :

12. Est-ce que vous Grignotez- ?

Toujours □

Parfois □

Jamais □

13. Quels sont les Aliments consommés au cours du grignotage?

Gâteaux, biscuits, Chocolat □

Pain, Sandwiche □

Biscottes, céréales □

Fromage, yaourt □

Confiture, miel □

Beurre, margarine □

Lait seul, Café au lait, Lait au chocolat □

Boissons sucrées □

14. A quel raison grignoter-vous ?

En faisant les devoirs □

Lorsque tu as de l'argent □

Lorsque tu es avec des ami(e)s □

En regardant la TV □

Parce que tu as envie de manger □

Parce que tu es gourmand (e) □

III. Section activité physique

1. Combien d'heures passez-vous aux activités suivantes pondant une journée

Catégorie	NAP	Activité	Nombre des heurs à chaque activité
A	1	Sommeil et sieste, repos allongé	
B	1.75	Position assise. (TV, ordinateur, devoir, repas, transport)	
C	2.1	Position debout (toilette, achat, cuisine, petits déplacements)	
D	2.6	Activités légères de faible intensité (jeux peux actifs)	
E	3.5	Activités modérées (marche rapide, travaux manuels.)	
F	5.2	Activités sportives (entrainement en club, éducation physique et sportive...)	
G	10	Compétition sportive	
			Totale 24H

2. Faites-vous un entraînement physique régulier? Oui □ Non □

Annex

QUESTIONS	A	B	C	D
À quelle fréquence vous déplacez-vous à pied ou à vélo ?	La plupart du t	> 3x/semaine	1-2x/semaine	Rarement
À quelle fréquence choisissez-vous d'emprunter les escaliers que l'ascenseur ?	Toujours	Souvent	À l'occasion	Jamais
Combien de fois par semaine faites-vous de l'activité physique pour au moins 30 minutes ?	< 1x/sem	2-3x/sem	4x/sem	5-7 x/sem
Habituellement, sentez-vous motivé pour faire de l'activité physique ?	Toujours	Souvent	À l'occasion	Jamais
reconnaissez-vous dans l'affirmation suivante ? « Présentement, je ne suis pas en forme et je ne sais pas où commencer pour m'améliorer. »	Pas du tout	Un peu	Beaucoup	Tout à fait
Êtes-vous trop fatigué pour faire de l'activité physique ?	Jamais	À l'occasion	Souvent	Toujours
Aimez-vous faire de l'activité physique?	Beaucoup	Moyennement	Un peu	Pas du tout
Organisez –vous votre emploi du temps de façon à inclure des périodes d'activité physiques ?	Toujours	Souvent	A l'occasion	Jamais
Trouvez-vous des solutions alternatives pour demeurer actif lorsque la température extérieure n'est pas clémente et que vous ne désirez pas sortir faire votre activité physique ?	toujours	Souvent	A l'occasion	Jamais
reconnaissez-vous dans l'affirmation suivante ? « je ne fais pas d'activité physique par crainte de me blesser. »	Pas du tout	Un peu	Beaucoup	Tout à fait
Lorsque vous avez des problèmes articulaires, trouvez- vous des alternatives pour adapter vos exercices et demeurer actif ? Couchez ici si cette question ne s'applique pas à vous :	Toujours	Souvent	A l'occasion	Jamais
Mettez-vous en pratique les recommandations en activité physique pour vous aider à perdre du poids ? Cochez ici si cette question ne s'applique pas à vous :	Tout à fait	Beaucoup	Un peu	Pas du tout
Limitez-vous votre pratique d'activité physique par crainte d'avoir plus faim à la suite d'une séance d'exercices ?	Jamais	A l'occasion	Souvent	Toujours

Annex 2. Number of communes in each daira

Daira	Number commun	Communes
1 Adekar	3	Adekar • Taourirt Ighil • Beni Ksila
2 Akbou	4	Akbou • Chellata • Ighram • Tamokra
3 Amizour	4	Amizour • Beni Djellil • Semaoun • Ferraoun
4 Aokas	2	Aokas • Tizi N'Berber
5 Barbacha	2	Barbacha • Kendira
6 Bejaia	2	Béjaïa • Oued Ghir
7 Beni Maouche	1	Beni Maouche
8 Chemini	4	Chemini • Tibane • Souk-Oufella • Akfadou
9 Darguina	3	Darguina • Aït-Smail • Taskriout
10 El Kseur	3	El Kseur • Fenaïa Ilmaten • Toudja
11 Ighil Ali	2	Ighil Ali • Aït-R'zine
12 Kherrata	2	Kherrata • Draâ El-Kaïd
13 Ouzellaguen	1	Ouzellaguen
14 Seddouk	4	Amalou • M'cisna • Bouhamza • Seddouk
15 Sidi-Aich	5	Sidi-Aïch • Leflaye • Tinabdher • Tifra • Sidi Ayad
16 Souk El-Tenine	3	Melbou • Souk El Ténine • Tamridjet
17 Tazmalt	3	Tazmalt • Beni Mellikeche • Boudjellil
18 Tichy	3	Boukhelifa • Tichy • Tala Hamza
19 Timezrit	1	Timezrit

Annex 3. Secondary Schools

Secondary Schools	
1- High school polyvalaux (el-hemmadia) – Bejaia	31- High school 800/200 nouveau barbacha
2- High school chouhada anani ihaddaden-bejaia	32- High school mixte el-kseur
3- High school zennache ihaddaden-bejaia	33- tichnicum saphi hocine el-kseur
4- High school massinissa ighil ouazoug	34- High school berchiche el-kseur
5- High school chouhada stembouli sidi ahmed- bejaia	35- High school toudja – el-kseur
6- High school iben sina-bejaia	36- High school adekar
7- High school les olivier- chouhada chikhoune- bejaia	37- High school martyr ahaddad mohand idir – Timezrit
8- High school houria-bejaia	38- High school taouasse amérouche- sidi-aich
9- High school chouhada mokrane- tarique setif bejaia	39- High school mixte- sidi-aich
10- High school yayci abd el kader (technicum ihaddeden)	40- tichnicum (chouhada 7 beifan) – sidi-aich
11- High school chahid bouderies learbi oued-ghir	41- High school chouhada 7mahraz (meala)- sidi-aich
12- High school sidi ali labhar	42- High school chouhada aouedak arabe- chemini
13 - High school kadi athmane tichy	43- High school aouadjidi tiniri- chemini
14- High school chaban amar Aokas	44- High school mouhali amar Saddouk
15- High school amara ali- Aokas	45-tichnicum (High school chahid ait daouad hassin)- saddou
16- High school tizi nbarbar- Aokas	46- High school amalou- saddouk
17- High school karim balkacem- Souk el-tnine	47- High school bouhamza – saddouk
18- High school malbou - Souk el-tnine	48- High school boukidarslimane- beni-maouche
19- High school ait smail – Darguina	49- High school loujaine kasemi – beni- Maouche
20- High school maouche Idriss bordj mira- Darguina	50- High school du20 Aout 1956- Ouzellaguen
21- High school khaled maseoud- Darguina	51- High school martyr bouzidiali halouan-ouzellaguen
2- High school el mojahide boumaaza bachir Adjewen-kkherra	52- technicum karim belkacem (guandouza)- Akbou
23- High school barkate slimane – Kherrata	53- High school hafssa –akbou
24- High school bordi lakhdare barzakhe- Kherrata	54- High school dabah cherif- Akbou
25- High school tichnicum sameoune cherif- kherrata	55- High school téharkatine – akbou
26- High school achahid soumani madmoud- kherrata	56- High school mohamed boudiaf- Tazmalt
27- High school achik el haddad- Amizour	57- High school foudalla A/Malek- tazmelt
27- High school fatma nseumar- amisour	58- High school chouhada boudjelil –tazmelt
28- High school ait aouenair (feraoun)	59- High school aguoun mohamad yazid (ighil ali)
29- High school arazeki louriss (semaoun)	60- High school chahid akeloul ali ait arzin – ighi- ali
30- High school ben yahya mohamad amezyan barbacha	

Annex 4. Middle Schools

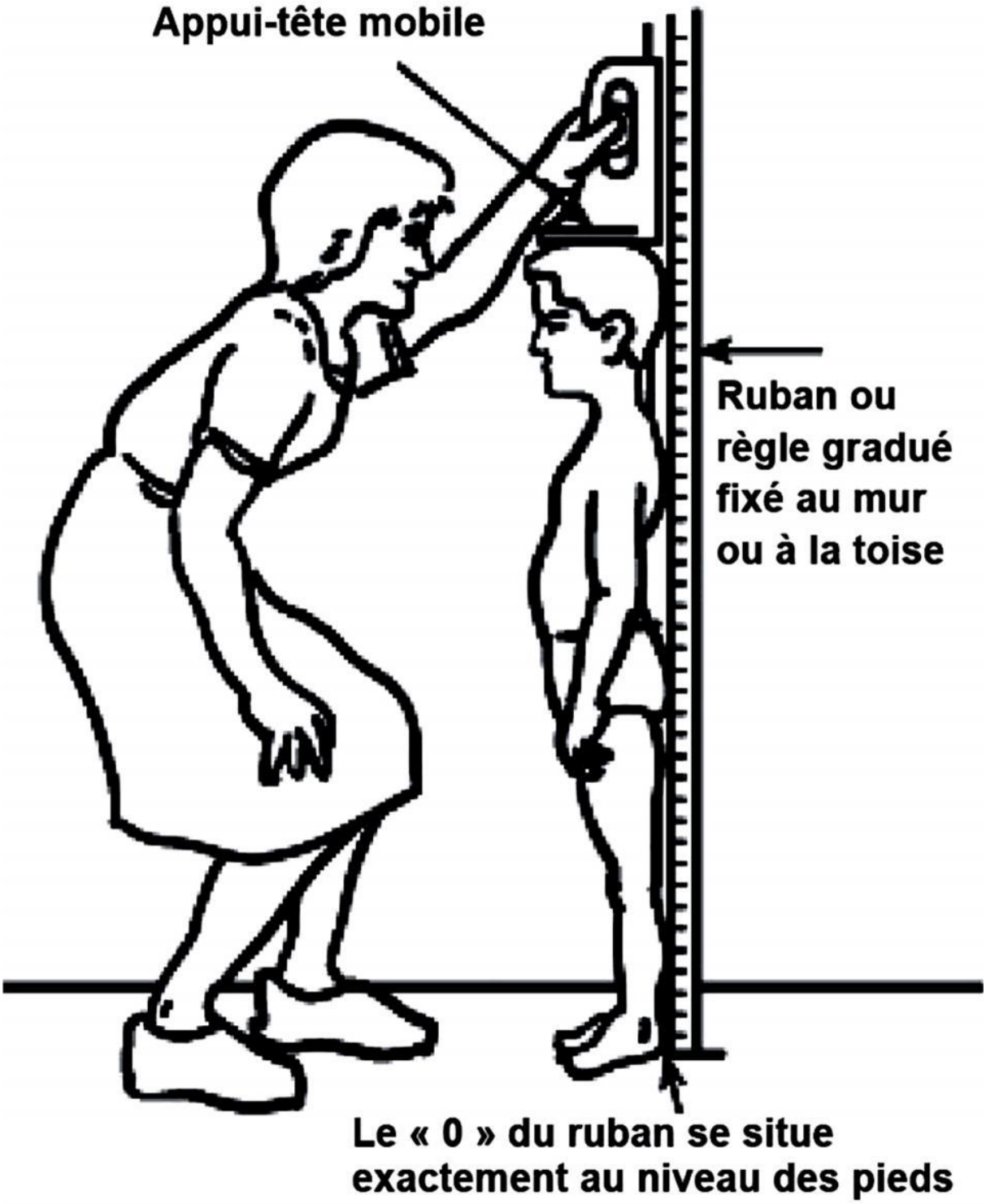
Middle Schools	
1- EMC chouhada beztoute- bejaia	81- EMC tizi thanejithe kandira –Barbacha
2- EMC ibn haddad- bejaia	82- EMC fréres haddad el-kseur
3- EMC iben badis- bejaia	83- EMC les fréres drire – el-kseur
4- EMC mouloud kacem ait belkacem aamriw- bejaia	84- EMC les fréres yahyoui – el- kseur
5- EMC chouhada chaalal naceria 2- bejaia	85- EMC berchiche- el-kseur
6- EMC warouf – bejaia	86- EMC abd elkader (toudja) –el-kseur
7- EMC el hadi zarouki- Bejaia	87- EMC tala hiba (toudja) –el-kseur
8- EMC ighil ouazoug base 6 – Bejaia	88- EMC ben gana arab boubzi (fnaya) – el- kseur
9- EMC sidi ali labhar base 05- bejaia	89- EMC abdoun yahya (ilmaten) –el-kseur
10- EMC chahid mehdi said oued ghir- Bejaia	90- EMC martyr ahrike mohande arab- Timezrit
11- EMC chahid chirifi oued ghir- Bejaia	91- EMC martyr amara hesssin (alhad) – Timezrit
12- EMC bouakeraz base 6 ighil ouazoug – Bejaia	93- EMC taska – timezrit
13- EMC maneul taxiragumez- bejaia	94- EMC djaime – timezrit
14- EMC bournine- bejaia	95- EMC eheddaden abed el hafid – sidi –aich
15- EMC boudjeres slimane (targa ouzamour)- bejaia	96- EMC mohamed said issani – sidi –aich
16- EMC les fréres jodane- bejaia	97- EMC azout et sa fil – sidi –aich
17- EMC iben tumart- bejaia	98- EMC imali elarbi(iflay) – sidi –aich
18- EMC abd elmouemine- bejaia	99- EMC assif el hemmam
19- EMC les fréres amrane- bejaia	100- EMC bni ksila base 6
20- EMC sidi boudarham- bejaia	101- EMC taourirt ighil
21- EMC 4 chemin – bejaia	102- EMC ahbabe arabe (djabla)
22- EMC sidi ahmed base 5- Bejaia	103- EMC boussea tazeout
23- EMC sidi ahmed base 7- Bejaia	104- EMC arezbiboudjemaa
24- EMC mellala- bejaia	105- EMC sidi éyad– sidi –aich
25- EMC achahid kara moktar sidi ali labhar- bejaia	106- EMC teouati takrite– sidi –aich
26- EMC les fréres athemani (tahanout)- bejaia	107- EMC leazizi amar (tenabedar) – sidi –aich
27- EMC tala hamza- bejaia	108- EMC tidjenane– sidi –aich
28- EMC ighil oubarake - bejaia	109- EMC baktache madani (tifra) – sidi –aich
29- EMC des fréres ariouat (boukhlifa)- tichy	110- EMC ikdjane– sidi –aich
30- EMC frires idrire 5 (tichy)	111- EMC gharbi essalah (souk oufala)-chemini
31- EMC bacaro – tichy	112- EMC balyamine mohamed rabeh tahar-chemini
32- EMC hamoudi- tichy	113- EMC chahid chibi rabeh sameoun-chemini
33- EMC berkouk yahia- aokas	114- EMC les fréres bahrour (tidjenan) –chemini
34- EMC emir a/kadar –Aokas	115- EMC tiniri akfadou-chemini
35- EMC ben said –aokas	116- EMC tibane-chemini
36- EMC falkaye hssin- aokas	117- EMC l'indépendence- saddouk
37- EMC tizi nberber – aokas	118- EMC des fréres guanini- saddouk
38- EMC imdene-aokas	119- EMC aitouakli jaouehara massinissa- saddouk
39- EMC base 06 tazrourt –aokas	120- EMC ouada bounezou- saddouk
40- EMC base 07 (souk- el-tnine)-souk-el-tnine	121- EMC biziou- saddouk
41- EMC souk-el-tnine (nouveau) -souk-el-tnine	122- EMC amalou- saddouk
42- EMC Lotta -souk-el-tnine	123- EMC bouhamza base 5- saddouk
43- EMC mérabti ali tizi el-ouad -souk-el-tnine	124- EMC hamouche malek (mahfouda) – Saddouk
44- EMC mixte- souk-el-tnine	125- EMC imoula- saddouk
45- EMC les fallisse -souk-el-tnine	126- EMC malouj kassa (aguamoun) –beni maouche
46- EMC mérabti balkasem malbou -souk-el-tnine	127- EMC kamisse akli- beni maouche
47- EMC chahid btakrabte amar akkache -souk-el-tnine	128- EMC ait ajissa- beni maouche
48- EMC saadi sadik bordj mira-darguina	129- EMC 1 novembre 1954- ouzallaguen

49- EMC martyr frih chrife base 4 bordj mira –darguina	130- EMC chikoune- ouzallaguen
50- EMC du martyr ah hamed-ait-idris – darguina	131- EMC ifri eljemoa- ouzallaguen
51- EMC tizoual base 4- darguina	132- EMC boukhlifa laemara – ouzallaguen
52- EMC taragueraguete- darguina	133- EMC moloud faroun- akbou
53- EMC halmouche said (darguina)	134- EMC danyale mille- akbou
54- EMC ighezar ouftisse- darguina	135- EMC ben barkane youcef- Akbou
55- EMC les fréres boumaeza adjewen- kherrata	136- EMC chouhada (stade)-akbou
56- EMC maizouz belkasem base 06- Kherrata	137- EMC kadoum malek (interna)-akbou
57- EMC abache said marouaha- Kherrata	138- EMC aben ramedan (guandouza)-akbou
58- EMC kadri said dradra- Kherrata	139- EMC base 6-akbou
59- EMC makrani maktar barzakhe – Kherrata	140- EMC teouati el arb-i(ighil oubraki) –Akbou
60- EMC kheniche slimane snadla –Kherrata	141- EMC mahdi saleh (chelatta)-akbou
61- EMC tahiyate ahmad –kherrata	142- EMC daouedine a/errahmane-akbou
62- EMC bilaire kherrata	143- EMC taselnet igherame-akbou
63- EMC badhouche –kherrata	144- EMC sidi ali-akbou
64- EMC 8 mai 1945 –kherrata	145- EMC timekra-akbou
65- EMC 800/300 –amisour	146- EMC abdrahman mira-tazmalt
66- EMC 200/600- amisour	147- EMC baji mohamed taher-tazmalt
67- EMC katib yassin- amisour	148- EMC bounadjar ahsan-tazmalt
68- EMC elamir abdelkader –amisour	149- EMC azouawe emran- tazmalt
69- EMC elmardj aouaman- amisour	150- EMC hammam hamouche (beni malikche)-tazmalt
70- EMC tizi nassebat- amisour	151- EMC massoud rabie (beni malikche)-tazmalt
71- EMC semaoun 300/800 –amisour	152- EMC boudjalil-tazmalt
72- EMC feraoun- amisour	153- EMC bani mansour-tazmalt
73- EMC nouveau feraoun- amisour	154- EMC alaghan-tazmalt
74- EMC tizi ajissa- amisour	155- EMC iben badis -ighil-ali
75- EMC aghebala- amisour	156- EMC aoumeamar mohamad base 5 -ighil-ali
76- EMC tiferitine- amisour	157- EMC machemache brahim mixte base 6 -ighil-ali
77- EMC iben khaldoun –barbacha	158- EMC makhelouf brahim gandouza -ighil-ali
78- EMC base 4 barbacha	159- EMC 11chahid taghilat bouchakfa -ighil-ali
79- EMC maknache saleh kalil –Barbacha	160- EMC chahid bouzidi ahesan-ighil-ali
80- EMC khanache mohamed elsaid barbacha-ait sidi ali barba	

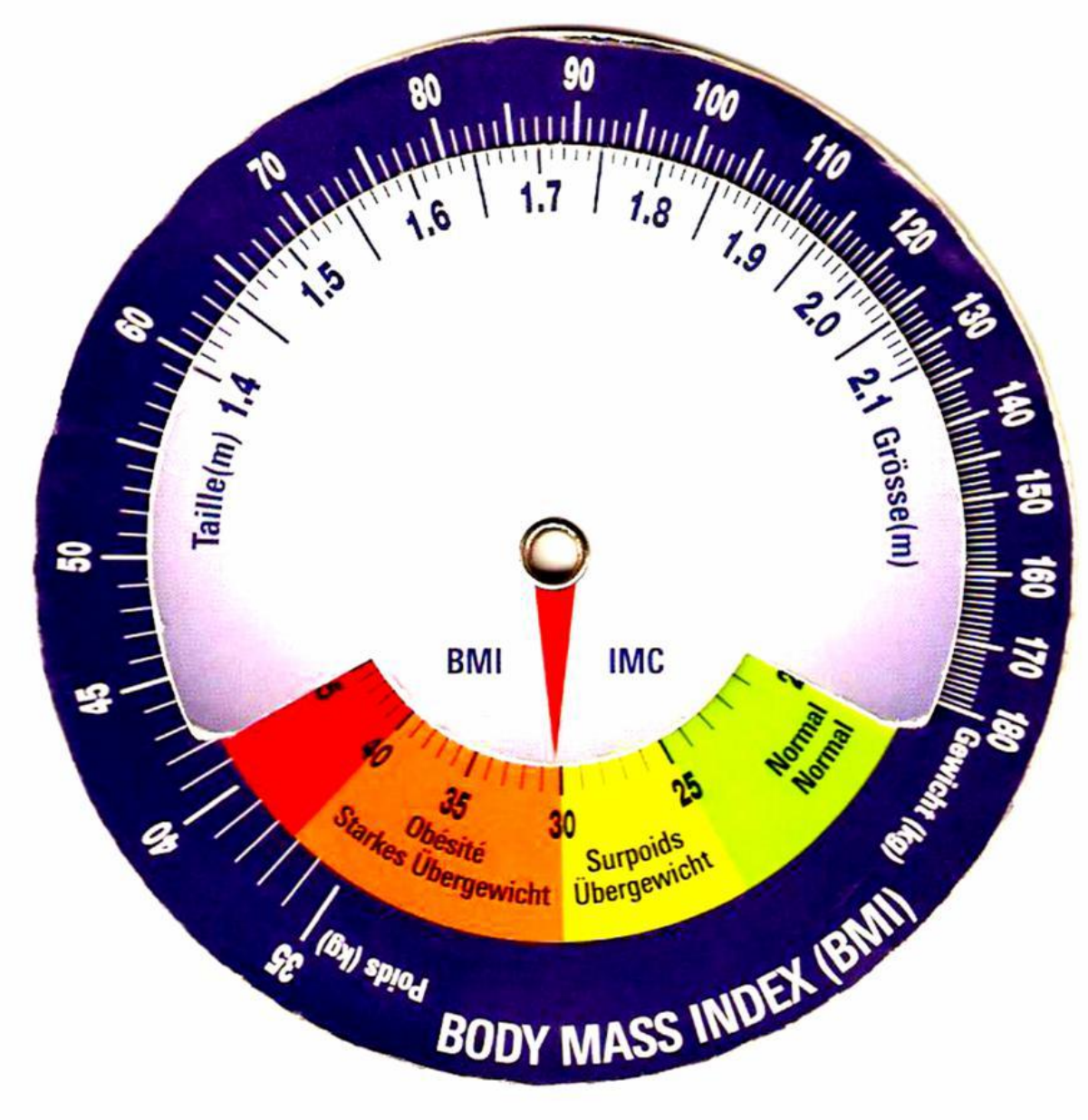
Annex 5. Number of Obese Students in Each Daira

Daira	**N of obese Student**	**N of girls**	**N of boys**
Bejaia	788	410	378
Souk El-Tenine	274	158	116
Aokas	202	99	103
Amizour	172	100	72
Kherrata	167	75	92
Akbou	166	98	68
Darguina	164	83	81
El Kseur	150	87	63
Tichy	136	60	76
Tazmalt	130	59	71
Seddouk	123	72	51
Sidi-Aich	118	67	51
Ouzellaguen	78	43	35
Ighil Ali	77	44	33
Barbacha	72	46	26
Chemini	69	39	30
Timezrit	64	42	22
Adekar	48	29	19
Beni Maouche	40	24	16
sommes	**3038**	**1635**	**1403**

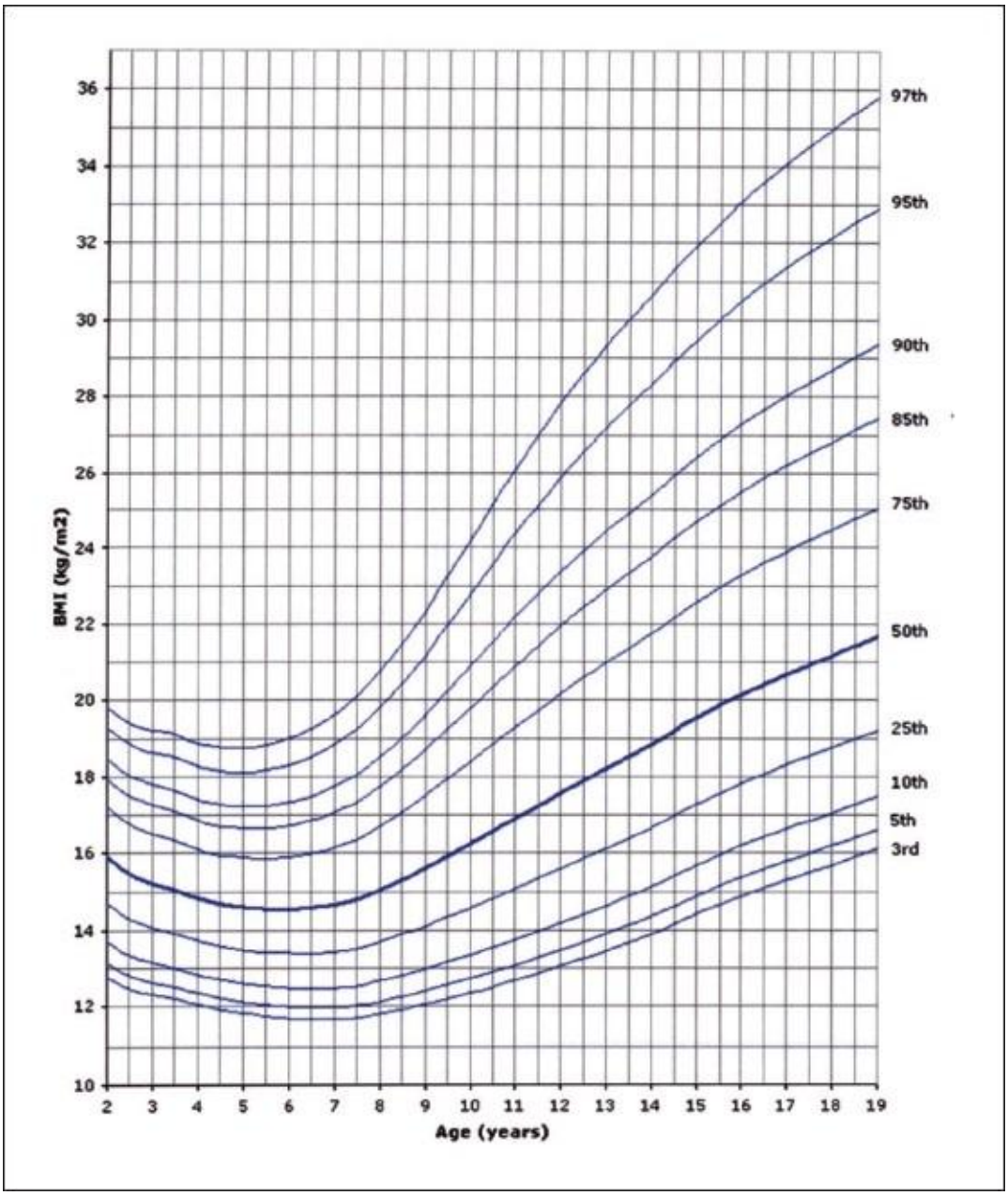
Annex 6. How to measure the height of children and adolescents



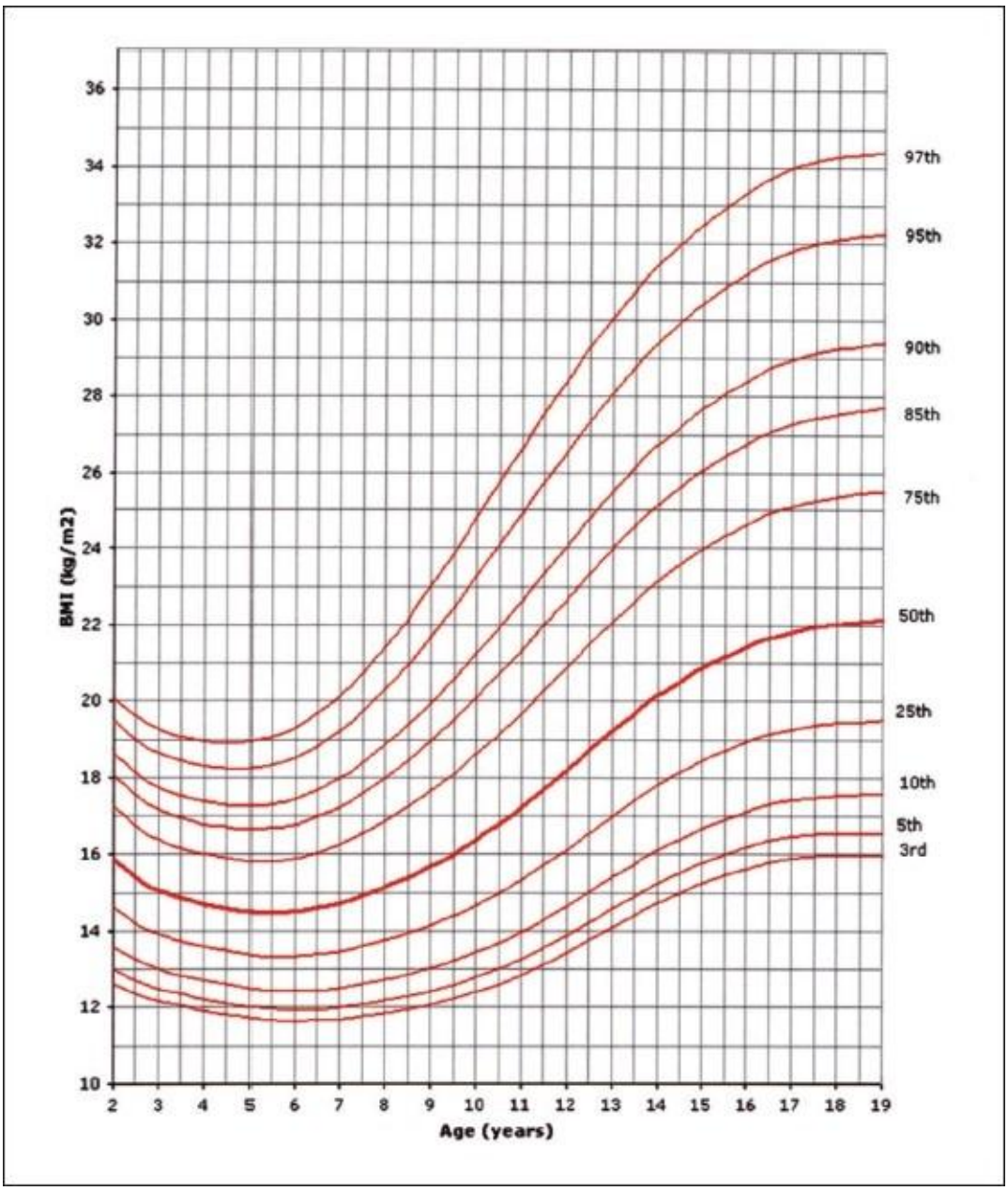
Annex 7. BMI calculation disk



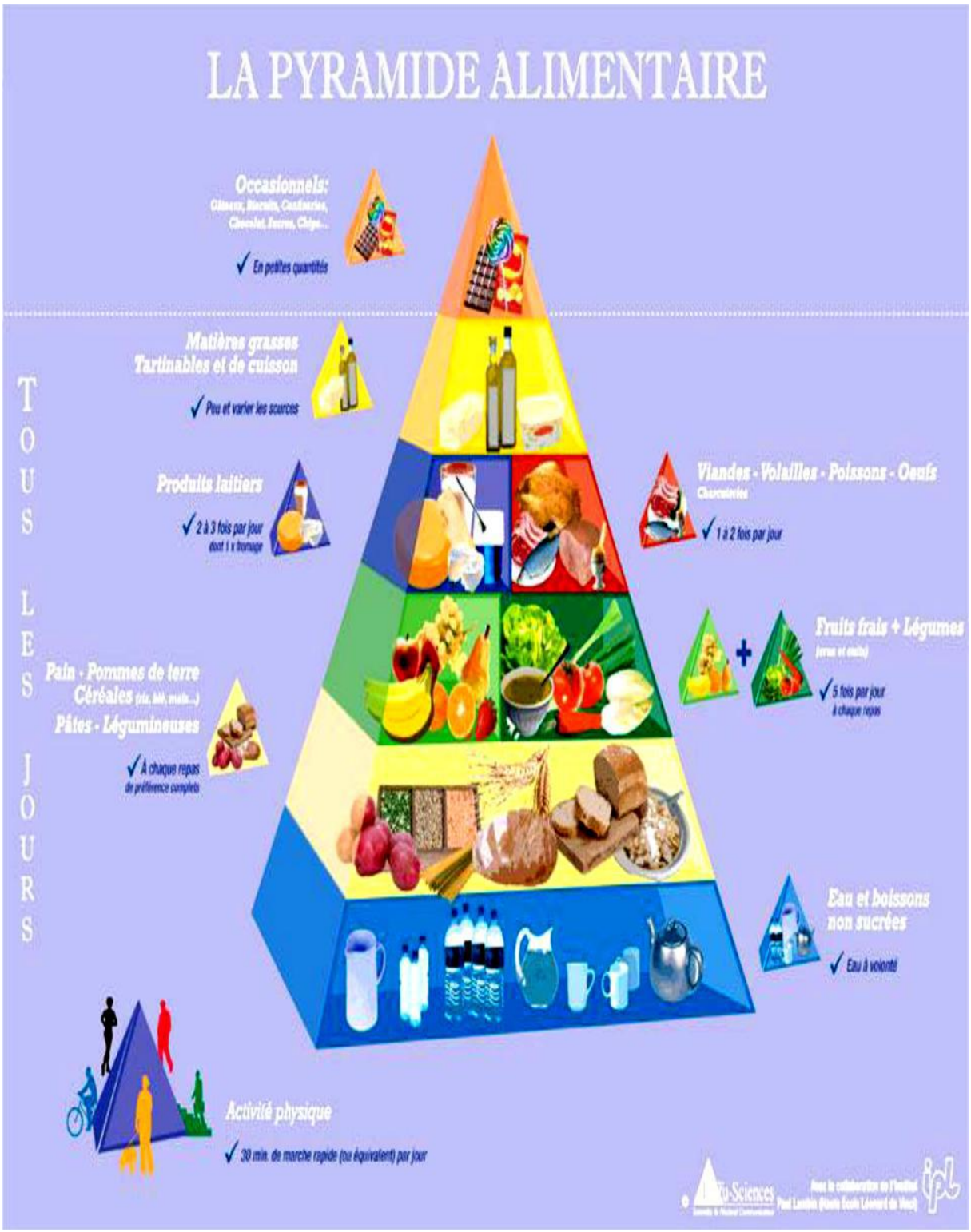
Annex 8. BMI-for-age-percentiles-boys-2-to-19-years



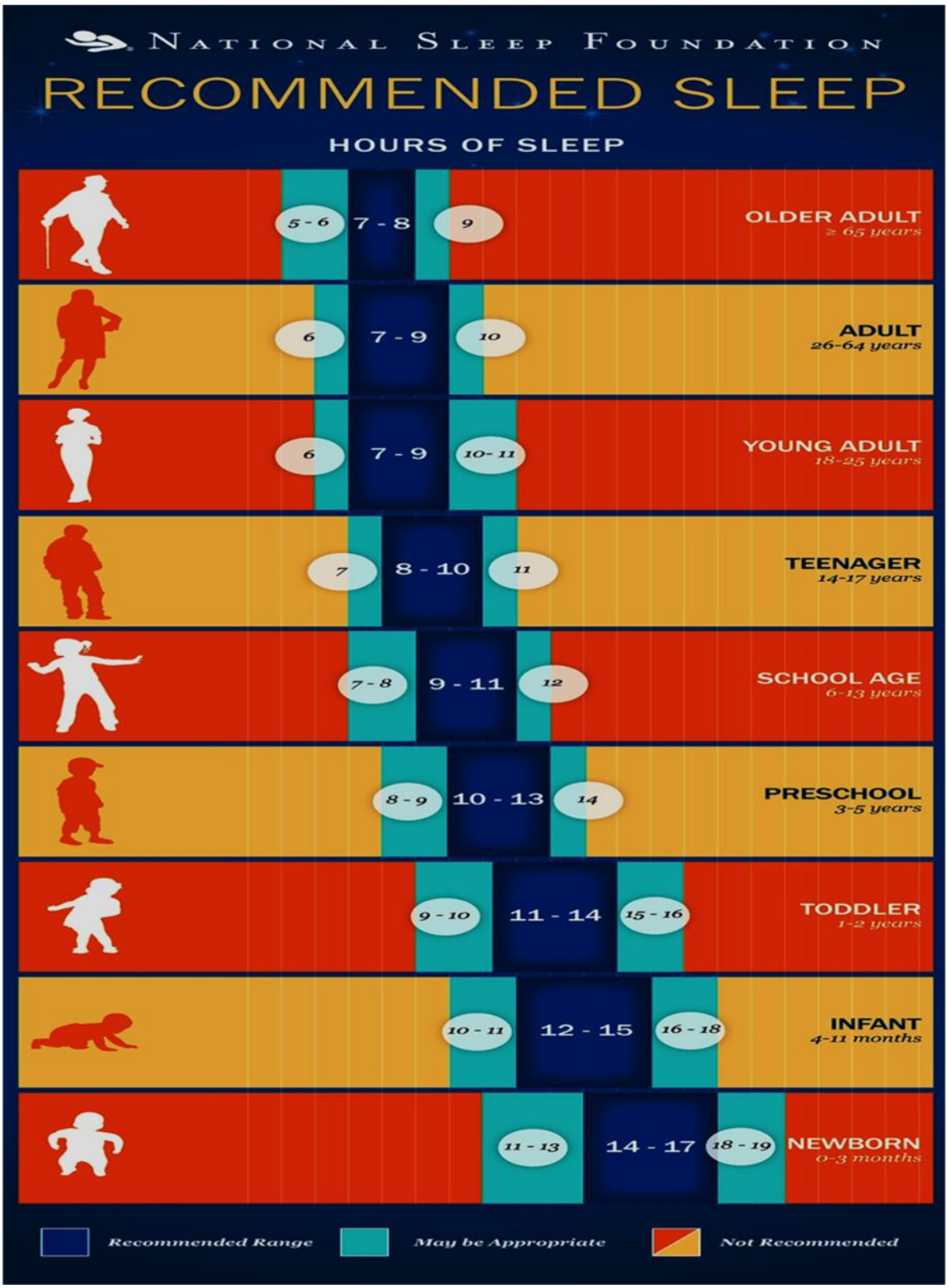
Annex 9. BMI-for-age-percentiles-girls-2-to-19-years



Annex 10. Food pyramid



Annex 11. Recommendation on the number of hours of sleep



Abstract

Obesity and overweight are a major public health problem because of their potential impact on health and their increasing frequency.

Our survey involved 3038 obese adolescents enrolled in all middle and secondary schools in the wilaya of Bejaia over a period that spanned from 2017 to 2018. The overall prevalence of overweight, including obesity, was 3.3%. The risk factors of overweight and obesity found in our study were: increase in BMI values, sedentary, dietary intake of obese adolescents is higher than the expenditure, poor dietary habits that was characterized by exceeding the reference values of consumption of sugars (sweetened beverages and processed foods), salt and fat, and a lower reference to intake of vegetables, fruits and several micronutrients (vitamins, minerals), with a high frequency of consumption at breakfast, lunch, dinner and snacks that were simultaneously high energy intake and poor quality food.

Keywords: Adolescents, Obesity, Overweight, Prevalence, energy intake, energy expenditure.

Résumé

L'obésité et le surpoids constituent un problème majeur de santé publique en raison de leur retentissement potentiel sur la santé et de leur fréquence croissante.

Notre enquête a concerné 3038 adolescents obèses scolarisés dans les tous les établissements moyens et secondaires de la wilaya de Bejaia sur une période qui s'est étalée de 2017a 2018. La prévalence globale du surpoids, obésité incluse, était de 3.3%. Les facteurs de risque du surpoids et d'obésité retrouves dans notre étude ont été : augmentation des valeurs d'IMC, sédentarité, l'apport alimentaire des adolescents obèses est supérieur à la dépense, mauvaises habitudes alimentaire qui était caractérisé par un dépassement de la référence les valeurs de consommation de sucres (boissons sucrées et aliments transformés), de sel et de grasses, et une référence inférieure à apport de légumes, fruits et plusieurs micronutriments(les vitamines, les minéraux), avec une fréquence élevée de la consommation au petit-déjeuner, déjeuner, dîner et des collations qui ont été simultanément des apports élevés d'énergie et pauvres de la qualité l'alimentation.

Mots clé : Adolescents, Obésité, Surpoids, Prévalence, apport énergétique, dépense énergétique.

ملخص

تشكل السمنة وزيادة الوزن مشكلة صحية عامة كبرى بسبب تداعياتها المحتملة على الصحة وتكرارها المتزايد

شمل الاستطلاع الذي أجريناه على 3038 مراهقًا بدينًا مسجلين في جميع المدارس الإعدادية والثانوية بولاية بجاية على مدار فترة امتدت من 2017 إلى 2018. وبلغ معدل انتشار الوزن الزائد والسمنة 3.3٪.

عوامل الخطر لزيادة الوزن والسمنة الموجودة في دراستنا هي: زيادة قيم مؤشر كتلة الجسم ، استهلاك الطاقة للمراهقين الذين يعانون من السمنة المفرطة أكبر من الإنفاق، عادات الأكل السيئة التي تميزت بتجاوز القيم المرجعية لاستهلاك السكريات (السكريات والأطعمة المصنعة)، الملح والدهون، وإشارة أقل إلى تناول الخضار والفواكه والعديد من المغذيات الدقيقة (الفيتامينات والمعادن)، مع كثرة الاستهلاك في وجبات الإفطار والغداء والعشاء والوجبات الخفيفة التي كانت في نفس الوقت مدخولات عالية من الطاقة وسوء جودة الأكل.

الكلمات المفتاحية: المراهقون، السمنة، زيادة الوزن، الانتشار، استهلاك الطاقة، إنفاق الطاقة.