



Research paper

Study of physical activity in obese adolescents in Algeria

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ARTICLE INFO

Keywords:

Adolescents

Physical activity level

Physical activity intensity

ABSTRACT

Objective: Adolescents are meant to spend a large part of their time practicing a hobby or sport, but currently there is a decline in their level of physical activity and sport both inside and outside schools, which can lead to a risk of obesity. The objective of the present study was to examine physical activity in obese adolescents within the school establishments of the province of Bejaia (northeastern Algeria).

Method: To determine the physical activity level (PAL) in the school population, a sample of 3,038 students with obesity comprising 1,635 girls and 1,403 boys was selected. The study focused on (a) the comparison of the intensity of physical activities practiced by girls and boys, (ii) the determination of the duration, intensity, and level of physical activity.

Results: The results show that obese girls are less active than obese boys at all ages (from 11 to 23 years) and in all locations; PALs were steady with increasing age for girls, while PALs increase with age in boys from 17 to 21. We found that some factors are associated with a decrease in PAL, such as the time spent watching television. Doing only 30 min of physical activity once a week is associated with an increase in sedentary behavior. The mean PALs of middle school (1.54) and high school (1.50) girls were lower than those observed for middle school (1.75) and high school (1.65) boys.

Conclusions: Our results show that obese girls are less active than obese boys and spend time watching television and practicing sports only at school.

1. Introduction

The current social environment imposes an inactive lifestyle on children and adolescents [1]. The increase in the number of children and adolescents with overweight and obesity is a global phenomenon that is associated with risks of other chronic diseases (e.g., type 2 diabetes, cardiovascular diseases, and osteoarthritis) [2]. The risk factors for overweight and obesity are accentuated by low activity levels. Obesity appears during childhood and continues into adulthood [3].

Physical activity can be defined as any activity of daily living (adopted as a lifestyle) or a planned activity, which includes sports. Physical activity is essential for the growth and development of children and adolescents, and it has an important role in maintaining weight loss, preventing overweight, and limiting obesity-related health risks [4]. Encouraging and motivating children and adolescents with obesity to engage in physical activity are very important for maintaining physical

activity in adulthood. Physical activity and exercise are vital for the management and/or treatment of childhood obesity and for the maintenance of dietary and behavioral changes [5].

An “obesogenic” environment that limits physical activity, encourages sedentary behaviors, and decreases levels of physical activity may be a key factor in the increased prevalence of overweight, obesity, and the risk of chronic diseases [6]. In adolescents, a decrease in physical activity as part of daily routine has been reported, with many adolescents remaining seated much of the day spending their time watching television or browsing social networks and playing video games. In addition, there is decreased physical education at school and a lower proportion of adolescents go to school on foot — all of these factors may contribute to the increase in obesity [7].

During childhood and/or adolescence, physical activity is conducive to a healthy lifestyle and is a key element in the treatment of childhood obesity and disease prevention, with improved physical activity practice

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<https://doi.org/10.1016/j.arcped.2024.09.009>

Received 20 May 2023; Received in revised form 16 September 2024; Accepted 22 September 2024

Available online 10 January 2025

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playing an important role in many health and lifestyle outcomes. This activity is also linked to other aspects of health, such as diet, smoking, and school performance [8]. Walking is considered an ideal practice that should replace motorized transportation, as walking (going to work or school) is recommended for health promotion [9]. The World Health Organization (WHO) recommends that children and adolescents should do an average of 60 min of moderate- to vigorous-intensity physical activity every day; furthermore, activities that strengthen muscle and bone should be practiced at least 3 days per week [10]. Modifications of social and environmental factors and development of interventions are needed to increase the level of physical activity and sport participation; in addition, effective physical activity programs at the community level to combat obesity among adolescents in daily life are recommended [10]. The objective of the present study was to determine the physical activity level of obese adolescents in the middle and high schools of the province of Bejaia (northeastern Algeria).

2. Method

The study was carried out using a questionnaire to compare and evaluate the intensity of different physical activities practiced by middle and high school girls with those of middle and high school boys. This was a descriptive cross-sectional survey in the form of questionnaires collecting information on the physical activities of students.

2.1. Independent variables

The study was based on a school population of middle and high school students, and hence it was important to have a representative sample of the school population (91,810 enrolled students). We adopted the method of targeted sampling, targeting only students with overweight and obesity from 19 departments of the province of Bejaia (northeastern Algeria). The study was carried out on a sample of 3038 subjects (boys, $n = 1403$; and girls, $n = 1635$) with obesity, aged 11–23 years, who were enrolled in the first year of middle school to the third year of secondary school in all of the schools of Bejaia (160 middle schools and 60 secondary schools) during the 2017–2018 school year. Access to these schools was subject to authorization from the administrative authorities to facilitate the field survey with the help of school screening units (SSU) affiliated with the Directorate of Health and Population (DHP) of the province of Bejaia.

2.2. Dependent variables

2.2.1. Physical activity level

Energy expenditure was assessed from data collected on school activity (number of hours spent at school), daily activities, and leisure time. To calculate the physical activity level (PAL), we classified the various activities into groups corresponding to average PAL, as shown in Table 1 [11]. We first estimated the average time spent on the grouped activities, and then determined the PAL corresponding to each activity. PAL was calculated according to the following formula:

Table 1

Classification of activities by children and adolescents into seven 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, etc.)
G	10	Sports competition

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

The questionnaire had several sections: Section 1 on eating habits, Section 2 on 24-h recall, and Section 3 on physical activity. We evaluated the students' PAL three times a month and chose the day on which they had the practical physical and sports education (PSE) session. We visited the schools and interviewed the students individually in detail about their lifestyle (self-administration).

2.2.2. Assessment of adolescent lifestyles and physical activity

This assessment refers to physical activities (or sports) practiced by adolescents such as regular physical training, frequency of walking or cycling, physical activity for at least 30 min per week, use of community facilities, and the regularity and combination of practices. This part of the assessment was based on the questionnaire of the Clinical Research Institute of Montreal, 2008 (<https://www.yumpu.com/fr/document/read/35395275/questionnaire-sur-les-habitudes-de-vie-ircm>).

2.2.3. BMI Z-score

Anthropometric parameters (weight/height) were measured using a scale (SECA electronic scale) and a height gauge. The height measurements were recorded to the nearest 0.1 cm. The weight was measured with a minimum of clothing and recorded to the nearest 0.1 kg. The measurement techniques were carried out in accordance with the WHO recommendations [12].

Overweight can be expressed as a body mass index (BMI) Z-score, which provides a numerical indication of deviation from the median for gender and age. The BMI Z-score is used in clinical practice to accurately quantify overweight and obesity. The WHO defines overweight as a Z-score $> +1$ SD and obesity as a Z-score $> +2$ SD. The Z-score expresses the number of standard deviations below or above the reference mean or median value for an anthropometric variable [13].

2.3. Statistical analysis

Data entry and analysis were performed using the XLSTAT (version 2009), SPSS (IBM SPSS Statistics 25), and MapInfo (version 8.0) software. Data are presented as means for both genders (girls and boys). The Z test ($p < 0.05$) was used to compare the average intensity of different physical activities for girls and boys. Statistical significance was set at $p < 0.05$. Correlations between the different activity intensities (low and high) were taken into account.

3. Results

The results in Table 2, representing the different activities of middle and high school girls and boys, show that low-intensity activities represent the largest part of activities, for both genders (sleeping and napping, lying down; sitting; standing; light low-intensity activities). The intensity was relatively higher for middle school girls (22.76 ± 3.8 h) and high school girls (23.03 ± 3.28 h) than for middle school boys (20.8 ± 2.8 h) and high school boys (20.92 ± 3 h). On the other hand, high-intensity activities (moderate activities; sports activities; sports competition) represented only 3.17 ± 1.98 h for middle school boys and 4.04 ± 1.95 h for high school boys, while these values were 1.2 ± 0.89 h for middle school girls and 0.92 ± 1.5 for high school girls.

The results in Table 3 represent the percentage of responses to the physical activity questions for middle and high school boys and girls. $>67\%$ of middle school boys, 63% of high school boys, 73% of middle school girls, and 84% of high school girls were physically active at least once a week (at least 30 min). $>97\%$ of middle school boys, 98% of high school boys, 99% of middle school girls, and 97% of high school girls did not practice physical exercises regularly, and only 54% of middle school boys, 53% of high school boys, 52% of middle school girls, and 48% of high school girls walked an average of three times per week.

Table 2
Different activity hours of college and high school boys and girls per day.

	College			High school		
	Boys (n = 849) h	Girls (n = 954) h	p	Boys (n = 554) h	Girls (n = 681) h	p
Sleep and nap, extended rest	10.49 ± 0.88	10.94 ± 1.27	< 0.0001	10.39 ± 0.91	11 ± 0.83	< 0.0001
Sitting position. (TV, computer, homework, meals, transportation)	4.63 ± 0.86	6.16 ± 0.57	< 0.0001	4.81 ± 0.95	6.36 ± 1.21	< 0.0001
Standing position (shopping, cooking, short trips, toilet)	2.85 ± 0.54	2.90 ± 0.64	0.059	2.84 ± 0.58	2.94 ± 0.54	0.002
Light activities of low intensity (games can be active)	2.81 ± 0.52	2.76 ± 1.32	0.080	2.88 ± 0.54	2.73 ± 0.7	< 0.0001
Moderate activities (brisk walking, manual work)	2.32 ± 0.69	1.16 ± 0.25	< 0.0001	2.27 ± 0.76	0.88± 1.20	< 0.0001
Sports activities (club training, physical education and sports, etc.)	0.78 ± 0.96	0.04 0.0001	< 0.0001	1.72 ± 0.92	0.04 ± 0.27	< 0.0001
Sports competition	0.07 ± 0.33	0 ± 0.64	–	0.05 ± 0.27	0.0014 ±0.03	< 0.0001

Fig. 1 shows the physical activity levels by age and gender. We noted that mean PAL for boys was steady from the age of 11 to 16 years, then increased to the age of 21 years. On the other hand, the PAL for girls was steady from the age of 11 years to the age of 21 years.

Table 4 shows the correlations between the different activities for both genders: There was a positive correlation between sleeping, napping, as well as lying down and sitting ($r = 0.308$, and a positive correlation between sleeping, napping, as well as lying down and light activities of low intensity ($r = 0.428$).

A negative correlation was observed between sports competition and sleeping, napping, as well as lying down ($r = -0.66$), and between sports competition and standing ($r = -0.60$).

4. Discussion

Our results indicate that PALs are low in both obese girls and boys. These results are similar to those from several other studies conducted in Algeria among adolescents, which show that both the level and the intensity of physical activity are low [14–18]. This decline in physical activity is also observed in the literature of the Maghreb countries; according to El Haouari et al. [19], physical activity is low in Morocco. In industrialized countries such as Australia, a decline in physical activity was reported among low-income adolescents. According to Butt et al. [20], the intensity of physical activity decreases as age increases in the United States. Adolescence has been identified as the age in which the greatest decline in activity occurs, although sharp declines may also be seen at a younger age. By contrast, declines in PALs in adulthood occur at a much slower rate than in adolescence [21]. Participation in organized sport was at low levels for all ages, and unorganized sport is the major component of activity that is declining. During adolescence, all categories of physical activity decline due to a drop in unorganized sport and vigorous physical activity, with maximum declines in the age group of 15–18 years [22].

In our study we found a difference between the PAL of boys and girls, with boys taking part much more in physical activity (1.31 h) compared with girls (0.04 h); a low intensity of activity was associated with an

Table 3
Questions about physical activity for adolescents.

Questions	College		High school	
	Boys (n = 849) (%)	Girls (n = 954) (%)	Boys (n = 554) (%)	Girls (n = 681) (%)
Do you do regular physical training?	3	1	2	3
- Yes	97	99	98	97
- No				
How often do you walk or bike?				
- 3 or more times a week	54	52	53	48
- 1–2 times / week	22	24	29	25
- Rarely	24	24	18	27
How often do you choose to take the stairs instead of the elevator?				
- Always	19	14	16	17
- Often	36	35	41	37
- On occasion	34	35	33	32
- Never	11	16	10	15
How many times a week do you get at least 30 min of physical activity?				
- ≤ once a week	67	73	63	84
- 2–3/ week	32	25	33	14
- 4 times a week	1	2	4	18
Do you usually feel motivated to be physically active?				
- Always	8	9	8	8
- Often	39	35	37	35
- On occasion	30	37	36	30
- Never	23	19	19	27
Do you agree with 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	6	7	6	7
- A little bit	36	32	32	37
- Considerably	43	50	44	38
- Absolutely	15	21	18	18
Are you too tired to be physically active?				
- Never	6	7	6	7
- On occasion	27	32	32	31
- Often	42	39	39	37
- Always	25	22	23	25
Do you like to be physically active?				
- Very much	8	9	9	8
- Moderately	35	34	39	35
- A little bit	34	40	32	33
- Not at all	23	17	20	24
Do you organize your schedule to include periods of physical activity?				
- Always	5	7	9	7
- Often	35	36	28	35
- On occasion	38	37	41	36
- Never	22	20	22	22
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	5	8	8	6
- Often	28	30	33	32
- On occasion	43	39	35	34
- Never	24	23	24	28
Do you agree with the following statement? “I don’t do physical activity for fear of injury”				
- Not at all	6	7	8	6
- A little bit	33	36	31	31
- Considerably	33	37	38	34
- Absolutely	28	20	23	29

(continued on next page)

Table 3 (continued)

Questions	College		High school	
	Boys (n = 849) (%)	Girls (n = 954) (%)	Boys (n = 554) (%)	Girls (n = 681) (%)
When you have joint problems, do you find alternatives to adapt your exercises and stay active?	5	6	7	5
- Always	30	27	28	29
- Often	35	40	35	33
- On occasion	30	27	30	33
- Never				
Are you practicing the physical activity recommendations to help you lose weight?	4	5	6	6
- Absolutely	25	29	27	25
- Considerably	30	34	35	32
- A little bit	41	32	32	38
- Not at all.				
Do you limit your physical activity for fear of becoming hungrier after a workout?	11	16	14	15
- Never	32	34	28	33
- On occasion	29	29	30	26
- Often	26	21	28	26
- Always				

increase in sedentary behavior. Our results are similar to those in the study by Llorente-Cantarero et al. [23] of children and adolescents of normal weight. Boys were more active than girls during all periods, which is in line with the study by Aubert et al. [24], reflecting the insufficient level of physical activity by children and adolescents across the world; the lower levels of physical activity among girls in comparison with same-age boys; and the decrease in PAL with age. On the other hand, our results are different from the findings by Farooq et al. [25], who reported that physical activity in boys decreased more prominently than in girls. Reduced low-intensity activity induces sedentary behaviors and further increases the risk of sedentary behavior, and these are possible risk factors for obesity. Various recent studies focus on the decline in physical activity of individuals in relation to the developments of modern society [26].

Our results show that PALs in obese girls were steady with increasing age, but PALs in obese boys increased with increasing age; this is due to

the influence of psychological, social, and demographic factors for boys (participation in clubs, evening walks with friends for hours on end), whereas girls mostly stay at home (sedentary life). According to Kohl and Hobbs [27], physical activity is a key component of energy balance and is promoted in children and adolescents as a lifelong positive health behavior. Understanding the potential behavioral determinants necessitates knowledge of the influences from three fundamental areas: (1) physiological and developmental factors; (2) environmental factors; and (3) psychological, social, and demographic factors.

In our study, high school obese students watched significantly more television (6.36 ± 1.21 h/day for girls and 4.81 ± 0.95 h/day for boys) than middle school students (6.16 ± 0.57 h/day for girls and 4.63 ± 0.86 h/day for boys), they were more likely to reduce their level of physical activity. Watching television was identified as a key behavioral factor, with a link between the number of hours spent in front of the television and obesity [28]. In recent years, children and adolescents have reduced the number of hours spent watching television by substituting it with other media such as computers and video games. Studies in Europe and the United States have found positive correlations between computer game use and excessive weight gain. In this study, girls reported more time spent watching television, more time spent in other sedentary leisure activities, and less time spent in physical leisure activities [29].

Most middle and high school girls and boys in our study reported taking part in, at least, weekly (at least 30 min) physical activity. Moreover, most adolescents who do not walk or bike to school decrease their levels of physical activity (Table 3). According to Rennie et al. [30], walking or biking to school increases activity levels.

Although walking to school may represent only one daily activity, it seems that adolescents who actively walk to school have a higher level of activity during the whole school day [30]. Thus, the choice of going on foot to school is a way for children and adolescents to increase and sustain their level of regular physical activity, and it may be necessary to create programs aimed at increasing physical education in schools. A recent review [26], taking into consideration nearly 60 studies, focused on the decrease in the frequency of physical activities in the United States (walking, use of stairs, household activities, gardening work).

Regarding the difficulties associated with obesity (exertional dyspnea, joint pain, fear of ridicule, etc.), which contribute to the reduction in PALs, adolescents are generally less fulfilled with a poorer body

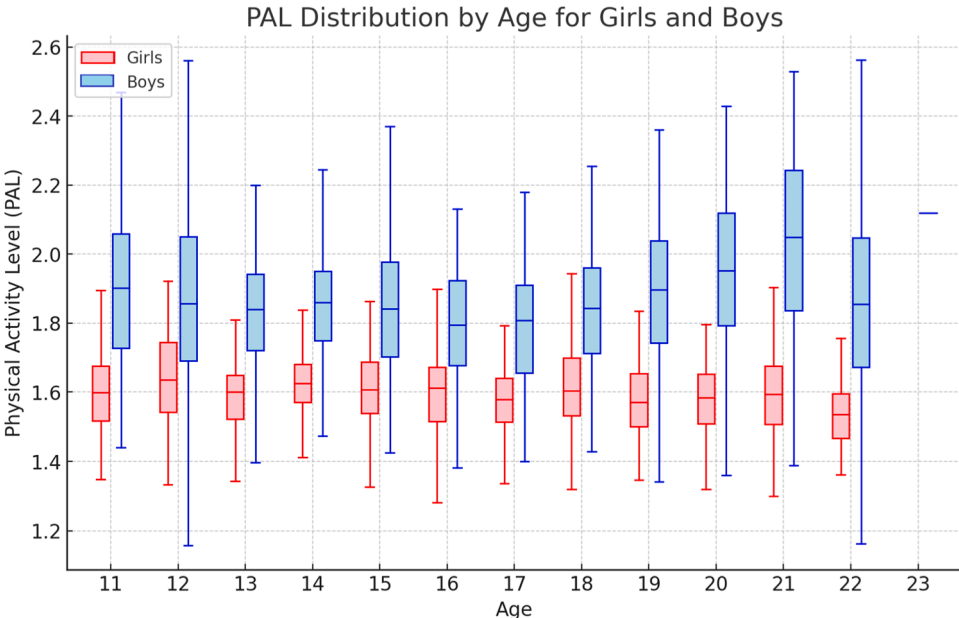


Fig. 1. Physical activity level by age and gender (mean and interquartile range).

Table 4

Transformed correlation variables for girls and boys.

	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	.308*	.305*	.428**	.203	−0.012	−0.066
Sitting position. (TV, computer, homework, meals, transportation)	.308*	1.000	.194	.312*	.079	−0.043	−0.060
Standing position (shopping, cooking, short trips, toilet) ^a	.305*	.194	1.000	.230	.099	.085	.072
Light activities of low intensity (games can be active) ^b	.428**	.312*	.230	1.000	.053	.061	.077
Moderate activities (brisk walking, manual work) ^a	.203	.079	.099	.053	1.000	−0.028	.038
Sports activities (club training, physical education and sports...) ^a	−0.012	−0.043	.085	.061	−0.028	1.000	−0.015
Sports competition ^a	−0.066	−0.060	.072	.077	.038	−0.015	1.000

* $p < 0.05$ (significant correlations).** $p < 0.01$ (highly significant correlations).

image.

According to Meininger et al. [31], numerous studies showed that there is a link between the increase in the prevalence of childhood obesity and the current trend toward greater sedentariness. Children's BMI Z-score was a significant moderator of the effects of specific practices, namely, overall support and general encouragement for physical activity [32].

5. Conclusion

Our findings suggest that obese girls are less active than obese boys. We also show that PALs was steady with age in girls, while PALs increase with age in boys. The extensive time spent watching television, doing only 30 min of physical activity per week, and using transport to get to and from school were identified as sedentary behaviors. Interventions to promote increased physical activity at school and home are greatly encouraged in order to prevent childhood obesity. Future research should modify travel behaviors with respect to walking to school, active play, and high-quality physical education among adolescents for health benefits.

Funding

None.

Declaration of competing interest

The authors declare no conflict of interest.

Acknowledgements

We wish to acknowledge the Ministry of Higher Education and Scientific Research of Algeria and the general directorate of scientific research and technological development (DGRSDT).

References

- [1] Hills AP, King NA, Armstrong TP. The contribution of physical activity and sedentary behaviours to the growth and development of children and adolescents. *Sports Med* 2007;37:533–45.
- [2] Kelly-Irving M, Lepage B, Dedieu D, Lacey R, Cable N, Bartley M, et al. Childhood adversity as a risk for cancer: findings from the 1958 British birth cohort study. *BMC Public Health* 2013;13:1–13.
- [3] Moore LL, Nguyen U-SD, Rothman KJ, Cupples LA, Ellison RC. Preschool physical activity level and change in body fatness in young children: the framingham children's study. *Am J Epidemiol* 1995;142:982–8.
- [4] Tremblay A, Doucet E, Imbeault P. Physical activity and weight maintenance. *Int J Obes Relat Metab Disord* 1999;23(Suppl 3):S50–4.
- [5] Jakicic JM, Otto AD. Physical activity considerations for the treatment and prevention of obesity. *Am J Clin Nutr* 2005;82:226S–9S.
- [6] Joens-Matre RR, Welk GJ, Calabro MA, Russell DW, Nicklay E, Hensley LD. Rural–urban differences in physical activity, physical fitness, and overweight prevalence of children. *J Rural Health* 2008;24:49–54.
- [7] Davidson F. Childhood obesity prevention and physical activity in schools. *Health Educ* 2007;107:377–95.
- [8] Goran MI, Reynolds KD, Lindquist CH. Role of physical activity in the prevention of obesity in children. *Int J Obes Relat Metab Disord* 1999;23(Suppl 3):S18–33.
- [9] MC Lee, Orenstein MR, Richardson MJ. Systematic review of active commuting to school and children's physical activity and weight. *J Phys Act Health* 2008;5: 930–49.
- [10] World Health Organization. Guidelines on Physical Activity, Sedentary Behaviour and Sleep for Children Under 5 Years of Age. Geneva: WHO; 2019.
- [11] Boisseau N. Nutrition et Bioénergétique du Sportif: bases Fondamentales. Paris: Masson; 2005.
- [12] Jelliffe D. The assessment of the nutritional status of the community. *WHO Monogr Ser* 1966;53:50–69.
- [13] Martinez-Millana A, Hulst JM, Boon M, Witters P, Fernandez-Llata C, Asseiceira I, et al. Optimisation of children z-score calculation based on new statistical techniques. *PLoS One* 2018;13:e0208362.
- [14] Belounis R. Evaluation du niveau d'activité physique (NAP) chez les lycéens en surcharge pondérale. *Sci et Pratiques des Activités Physiques Sportives et Artistiques* 2014;3:10–8. <https://www.asjp.cerist.dz/en/article/16604>.
- [15] Belounis R. Le niveau d'activité physique chez les lycéens obèses. *Poli Sci* 2014. <https://doi.org/10.12816/0021455Corpus>. ID: 163361108.
- [16] Chibane S.R., Zireg S. Modes de vie et prévalence de l'obésité et du surpoids chez une population d'enfants scolarisés et leurs parents en milieu urbain, périurbain et rural dans la Commune d'Oum El Bouaghi à l'Est d'Algérie. 12e Colloque Int Francoph Villes Villages Santé Villes-Santé OMS Act. 2016.
- [17] Sersar I, Mekhancha D-E, Vuillemin A, Schneider S, Nezzal L, Dahel-Mekhancha C. Association de l'activité physique et du sommeil avec la composition corporelle des étudiants universitaires algériens. *Sci Sports* 2019;34:73–81.
- [18] Houti L, Hamani-Medjaoui I, Ouhaibi-Djellouli H, Lardjam-Hetraf S, Mediène-Bencheor S. Obésité, activité physique et habitudes nutritionnelles dans la population urbaine de l'Ouest Algérien. *Nutr Clin Metab* 2018;32:308.
- [19] El Haouari M, Ech-Chahbi H, Gouridech S, Fallouky K. Impact du surpoids sur l'intégration dans les cours d'éducation physique et sportive chez des adolescents scolarisés à Taza (Maroc). *Am J Innov Res Appl Sci* 2018:220–5.
- [20] Butt J, Weinberg RS, Breckon JD, Claytor RP. Adolescent physical activity participation and motivational determinants across gender, age, and race. *J Phys Act Health* 2011;8:1074–83.
- [21] Nelson MC, Gordon-Larsen P, Adair LS, Popkin BM. Adolescent physical activity and sedentary behavior: patterning and long-term maintenance. *Am J Prev Med* 2005;28:259–66.
- [22] Van Mechelen W, Twisk JW, Post GB, Snel J, Kemper HC. Physical activity of young people: the amsterdam longitudinal growth and health study. *Med Sci Sports Exerc* 2000;32:1610–6.

- [23] Llorente-Cantarero FJ, Aguilar-Gómez FJ, Anguita-Ruiz A, Rupérez AI, Vázquez-Cobela R, Flores-Rojas K, et al. Changes in physical activity patterns from childhood to adolescence: genobox longitudinal study. *Int J Environ Res Public Health* 2020;17:7227.
- [24] Aubert S, Brazo-Sayavera J, González SA, Janssen I, Manyanga T, Oyeyemi AL, et al. Global prevalence of physical activity for children and adolescents; inconsistencies, research gaps, and recommendations: a narrative review. *Int J Behav Nutr Phys Act* 2021;18:1–11.
- [25] Farooq MA, Parkinson KN, Adamson AJ, Pearce MS, Reilly JK, Hughes AR, et al. Timing of the decline in physical activity in childhood and adolescence: gateshead Millennium Cohort Study. *Br J Sports Med* 2018;52:1002–6.
- [26] Brownstone D, Small KA. Valuing time and reliability: assessing the evidence from road pricing demonstrations. *Transp Res Part A Policy Pract* 2005;39:279–93.
- [27] Kohl HW, Hobbs KE. Development of physical activity behaviors among children and adolescents. *Pediatrics* 1998;101:549–54.
- [28] Crespo CJ, Smit E, Troiano RP, Bartlett SJ, Macera CA, Andersen RE. Television watching, energy intake, and obesity in US children: results from the third National Health and Nutrition Examination Survey, 1988–1994. *Arch Pediatr Adolesc Med* 2001;155:360–5.
- [29] Lakerveld J, Dunstan D, Bot S, Salmon J, Dekker J, Nijpels G, et al. Abdominal obesity, TV-viewing time and prospective declines in physical activity. *Prev Med* 2011;53:299–302.
- [30] Rennie KL, Johnson L, Jebb SA. Behavioural determinants of obesity. *Best Pract Res Clin Endocrinol Metab* 2005;19:343–58.
- [31] Meininger JC, Brosnan CA, Eissa MA, Nguyen TQ, Reyes LR, Upchurch SL, et al. Overweight and central adiposity in school-age children and links with hypertension. *J Pediatr Nurs* 2010;25:119–25.
- [32] Sallis JF, Prochaska JJ, Taylor WC. A review of correlates of physical activity of children and adolescents. *Med Sci Sports Exerc* 2000;32:963–75.