

Research



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Imane Achouri,  Youssef Aboussaleh, Rachid Sbaibi, Ahmed Ahami

Corresponding author: Imane Achouri, Behavioral Neurosciences and Nutritional Health Unit, Nutrition and Health Laboratory, Department of Biology, Faculty of Sciences, University Ibn Tofail, BP 133 14000 Kenitra, Morocco. achourimane@gmail.com

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Anthropometry, food consumption and iron deficiency anemia, among primary school children (6-15 years) in Kenitra city (North-Western Morocco)

Imane Achouri^{1,&}, Youssef Aboussaleh¹, Rachid Sbaibi¹, Ahmed Ahami¹

¹Behavioral Neurosciences and Nutritional Health Unit, Nutrition and Health Laboratory, Department of Biology, Faculty of Sciences, University Ibn Tofail, BP 133 14000 Kenitra, Morocco

&Corresponding author

Imane Achouri, Behavioral Neurosciences and Nutritional Health Unit, Nutrition and Health Laboratory, Department of Biology, Faculty of Sciences, University Ibn Tofail, BP 133 14000 Kenitra, Morocco

Abstract

Introduction: the problem of malnutrition among children is a phenomenon associated with a rapid nutrition transition in Morocco and all developing countries. The objective of this study is to evaluate the nutritional status by anthropometry, food consumption and iron deficiency anemia among primary school children aged 6-12 years in Kenitra city (Morocco). **Methods:** the survey covered 271 students (55% of boys and 45% girls) aged 6 to 12. Information concerning food consumption patterns, socioeconomic status and other lifestyle factors was obtained using questionnaires and interviews. Anemia was defined when haemoglobin < 11.5 g/dl. **Results:** the results showed that, 6.3%, 2.2% and 17.3% children were stunted, thin and overweight respectively. No significant association was found between gender and nutritional status of children. 16.2% children were anemic and food consumption found not to be varied and below recommendations. **Conclusion:** the finding in this study showed that overweight and obesity occurred more frequently than the various forms of under nutrition in the population studied. The finding support the urgent need to improve the nutritional status of children by implementing preventive strategy for the problem of malnutrition among school-aged children.

Introduction

Malnutrition is the most important public health problem that affects many children in the world and in developing countries [1]. It is the cause of at least half of infant mortality worldwide. The undernutrition alone is responsible for over a third of these deaths [2]. The rates of stunting among children under five years of age are also very high in many Southern and Eastern Mediterranean countries: 26.3% in Albania, 14.9% in Algeria, 28.9% in Egypt, and 22.5% in Morocco [3]. Iron deficiency and iron deficiency anemia are considered to be a major form of malnutrition throughout the world, it contributes towards 50% of the approximated 600 million global anemia cases in preschool and

school-aged children [4]. The World Health Organization reported that just over 2 billion people are anemic. The prevalence of anemia among students is 25.4% with the highest rate among preschool-aged children (47.4% all over the world and 67.6% in Africa) [5].

Morocco is passing through a rapid changes in diets and lifestyles that have taken place with globalization and urbanization [6]. This change has negative consequences even if access to food is grown and the food is more diverse, the problem of inappropriate diet and chronic diseases related to diet are always increased [7]. In developing countries like Morocco, anthropometry, despite its inherent limitations, remains the most practical tool for assessing the nutritional status of the community [8]. The objective of the present study is to evaluate the nutritional status, by Anthropometry, iron deficiency anemia and food consumption among primary school children aged 6-15 years in Kenitra city (Morocco).

Methods

Place and the sample of study: a cross-sectional descriptive survey was conducted among 271 school children aged (mean=10.75±1.40 years), ranged between 6 and 15 years, in three primary schools located in different zones , in Kenitra city, in the North West of Morocco.

Anthropometry

Anthropometric measurements: the children's height and weight were measured according to the WHO's guideline [9], with minimal clothing and without shoes. Weight was measured to the nearest 0.1 kg with an electronic scale. Children's height was measured to the nearest 0.1 cm with a wooden stadiometer placed on a flat surface.

Indices and anthropometric indicators: the anthropometric indices of the study population were Height-for-Age (H/A) and Body Mass Index-for-Age (BMI), weight, height, and age data were used to calculate z-scores in accordance with the

world health organization (WHO) growth references 2007 for 5 - 19 years [9], using the WHO AnthroPlus Software (Version 10.4, 2010) [10].

The anthropometric indicators of stunting and thinness were defined as Height-for-Age (HAZ) and Body Mass Index-for-Age (BAZ) Z-scores < -2 , respectively, according to the World Health Organization (WHO) [10].

Food consumption

24-hour dietary recall

The 24-hour dietary recall interviews were conducted in the schools using face-to-face interactive interview. One 24-h dietary recall was collected for each study participant. The participant is first asked for a quick list of foods consumed during the past 24 hours. Then starting with the first food item listed, the interviewer probes for details of the food consumed, including amounts and additives.

Iron deficiency anemia: to evaluate iron deficiency anemia we used five blood tests:

The four following blood analysis: haematocrit (Hct) (%), mean corpuscular volume (MCV) (fl), mean corpuscular haemoglobin (MCH) (pg), mean corpuscular haemoglobin concentration (MCHC) (g/dl) and serum iron ($\mu\text{g/dl}$), were measured by 5-ml blood sample, collected by antecubital venipuncture and drawn into a container with EDTA for red blood cells (RBC) using an automated cell counter (MS9-5S, Osny, France) by trained and experienced laboratory technicians in private laboratory of medical analysis under suitable conditions.

The last test: hemoglobin (g/dl) level is determined by cyanmethemoglobin method using a Drabkin reagent (D5941) containing potassium ferricyanide $\text{K}_3\text{Fe}(\text{CN})_6$ and potassium cyanide (KCN). The potassium ferricyanide converts haemoglobin to methemoglobin. The potassium cyanide then combines with the methemoglobin to form the stable cyanmethemoglobin; the colour intensity is

measured spectrophotometrically at 540 nm. The cut-off value for the determination of anemia was defined as blood Hb concentration $< 12\text{g/dL}$ in children of 12-14 years and $< 11.5\text{g/dL}$ in children aged 6-11 years [11].

Statistical analysis: the statistical analysis was performed using the software IBM SPSS Statistics version 21 (Statistical Package for the Social Sciences). The results are given as figures and tables. Logistic regression was used to investigate the relation between haemoglobin and other haematological parameters. $P < 0.05$ was considered as statistically significant.

Results

Anthropometry

The mean Z score of height for age was -0.24 ± 1.17 and BMI for age was 0.14 ± 1.02 . The Table 1 shows the anthropometric characteristics of the sample. Table 2 presents the anthropometric indices (Height for age and BMI for age z scores) depending on the age and sex of the children studied. The percentage of the height / age < -2 for girls and boys is 8.5% and 4.2% respectively. The percentage of the BMI / age < -2 is 2.3% and 5.6% for girls and boys respectively (Table 2). The prevalence of stunting and thinness decreases with age.

Food consumption

Daily food consumption

According to Figure 1, fruit and vegetable consumption is low. More than half of the children studied don't consume vegetables daily. Only 10% eat it every day. Fruit consumption is less important than vegetables. Only 7.4% consume fruits daily (Figure 1). The consumption of dairy products is generally low. Only 26% of children drink milk daily. Sugar consumption is very important in the majority of children. It is observed that 37.3% eat sugar every day (Figure 1).

Breakfast consumption: Figure 2 shows that 49% of children eat breakfast regularly and 35% skip it at least 2 or 3 times a week.

Iron deficiency anemia

Prevalence and factors influencing Hb levels

In the present study, 16.2% of children were anemic. The mean haemoglobin concentration was 12.45g/dl \pm 0.9. Backward-stepwise multiple regression analysis (Table 3) was used to identify the factors influencing haemoglobin levels. Haematocrit (Hct), mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH), and mean corpuscular haemoglobin concentration (MCHC) were significantly related to haemoglobin levels. The overall F-ratio for all variables was 37.57 and was highly significant ($P = 0.000$) (Table 3).

Discussion

The study sample consists of 271 children whose 55% girls and 45% boys. The average age of children was 10.75 ± 1.40 . The finding in this study showed that overweight/obesity occurred more frequently than the various forms of under nutrition (stunting, and thinness) in the population studied. Overall, 6.3%, 2.2% and 17.3% were stunted, thin and overweight respectively. The same result was reported by Aboussaleh *et al.* who found that 7.6% of school children were thin [12]. El Hioui *et al.* reported that 8.9% of school children were stunted stunted in rural region of Kenitra [13], this result is comparable to our finding. In the present study, stunting is higher in girls (8.5%) than in boys (4.2%), but without statistical significance. The relationship between stunting and gender in the previous studies varied. While some similar studies demonstrated a higher prevalence among males [14, 15], others demonstrated a higher prevalence among female [16]. According to some studies conducted in some sub-Saharan African countries, there is important and positive association of stunting with haemoglobin concentration [17, 18]. Another large study in Shaanxi Province, China, found HAZ associated with

anemia in school-aged children [19]. The prevalence of stunting and Thinness in the present study decreased with age in both sexes but without statistical significance. This result is comparable to the national survey reported by the Ministry of Health which was decreased from 29% to 23.4% [20]. This may be due to inappropriate child diet, or the onset of puberty which is characterized by a weight and growth fluctuation.

In the present study, the overall prevalence of overweight/obesity was 17.3%, similar finding were seen among school children aged 5 to 12 years in Pakistan which found that 17% were overweight [21]. According to a systematic review carried out by Musaiger *et al.* the prevalence of overweight and obesity among school children in the Eastern Mediterranean region ranged from 7% to 45% between 1990 and 2011 [22]. Another study conducted in Marrakech city in Morocco among 1814 school children (8 - 15 years), reported that the prevalence of overweight and obesity were 8% and 3% respectively based on WHO reference [23]. Thus, this considerable difference in the proportion of overweight and obesity in different regions is may be due to the high prevalence of stunted children that are more vulnerable to be overweight, and cutoff used to estimate overweight and obesity. The percentage of overweight/obesity was higher in boys (18.3%) than in girls (16.3%) but without statistical significance. This finding is consistent with the results reported in India, and Pakistan [21, 24]. There is no significant relationship between nutritional status and gender of the children studied ($P > 0.005$). Same result was found in a previous studies conducted in Morocco [25] and in India [26] that showed malnutrition also had no sex predilection.

Only 10% of children eat vegetables daily. Fruit consumption is less important than vegetables (7.4%). These rates are below the recommendations of the WHO and FAO who insist on the daily intake of five servings of fruits and vegetables a day to prevent chronic diseases [27]. Consumption of dairy products is generally low. Only 26.7% of children drink milk daily, the majority

consume it less than once a week (25%); these rates are lower than the recommendations illustrated by the pyramid of US food guide suggested a daily intake of three servings per day [28]. Furthermore, this study showed that the consumption of meat and poultry is very low (6.5% per day) which are a source of heme iron. There are two forms of dietary iron: non-heme and heme iron. Non-heme iron takes the simplest form of free iron atoms such as ferric (Fe³⁺) or ferrous (Fe²⁺) iron. Non-heme iron is obtained from foods such as grains, legumes, fruits and vegetables [29]. It was reported that the consumption of animal source foods was associated with a decreased risk of stunting and underweight, and also the existence of iron deficiency anemia among school age children [30]. Furthermore, a study that was carried out by Dror and Allen, reported that consuming animal source foods not only decreased stunting but also improved other anthropometric indices toward the reduction of morbidity and mortality among undernourished children [31].

The consumption of sugars in the present study was higher (37.3%) than the recommended proportions which generally should not exceed 10% of carbohydrate intake [32]. Excessive intake can cause behavioural problems in children [33]. Breakfast is the most important meal of the day. In school children, breakfast improves concentration and school performance [34]. In our study, breakfast is often skipped by 35% of children and never taken by 16% of them. Similarly, a study conducted in the United States among children aged 6 to 11 years, showed that 26% of them, skipped their breakfast while 22% never eat it [35]. Previous studies have shown that only 19% of children (age range: 6-12 years) skipped their breakfast and 4% never eat it [36]. These rates are lower than our finding. This could be explained by the difference in the study area, the food consumption, and the greater number of children from low socioeconomic status in the sample. Overall, there is an association between breakfast consumption and body weight. Some studies [37-39] reported that breakfast skippers are more likely to have the body mass index (BMI) or weight higher

than children who consumed breakfast regularly. A high significance between haemoglobin and serum iron was observed according to our correlation test, this result can demonstrate that iron status was to be a major determinant of haemoglobin and hence anemia, similar result was reported by El Hioui *et al.* [40]. Anemia was detected in 16.2% of children in the present study, which was slightly higher than the prevalence found by El Hioui *et al.* (12.2%) in rural Kenitra in Morocco [40]. Another study carried out in the same region in 2003 among 377 children aged 6 to 15 years old indicated a prevalence of 35% [41]. This difference in the prevalence of IDA in these regions may be due to differences in study setting, sample size, inappropriate of food choices and practices, and the difference in socioeconomic and cultural development.

Conclusion

In the present study, a rapid rise in overweight and obesity among Moroccan primary school children was observed, and about 16.2% of children were anemic. The finding support the urgent need to improve the nutritional status of the schoolchildren by implementing preventive strategy for the problem of malnutrition among school-aged children and make their parents aware of the healthy nutritional habits and the body's requirements from the different nutrients.

What is known about this topic

- *In Morocco, malnutrition is widespread public health problem;*
- *Iron deficiency anemia is one of the most frequent health problems in the world and it's an indicator of both poor nutrition and health problem;*
- *A varied diet rich in fruits and vegetables is recommended to prevent both deficiencies and chronic diseases linked to nutrition.*

What this study adds

- *The evaluation of nutritional status, iron deficiency anemia and food consumption*

among primary school children in Kenitra city (North-Western Morocco);

- The present study approved the impact of the national iron fortification project among primary school age children in Kenitra city, which is the improvement in the mean rate of haemoglobin and the decrease in the prevalence of anemia;
- Further studies are needed among primary school age children and strategies are necessary to improve the nutritional status and reduce the problem of anemia.

Competing interests

The authors declare no competing interests.

Authors' contributions

All authors contributed sufficiently to this work, discussed the results and commented on the manuscript at all stages. I. Achouri: performed experiments, analyzed data and wrote the manuscript. Y. Aboussaleh: supervised the analysis of the manuscript and involved in its preparation. R. Sbaibi: involved in statistical analysis and manuscript preparation. A. Ahami: critical revision of the article and writing the supplementary information. All authors read and approved the final draft of the manuscript.

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References

1. Ergin F, Okyay P, Atasoylu G, Beser E. Nutritional status and risk factors of chronic malnutrition in children under five years of age in Aydin, a western city of Turkey. *Turk J Pediatr.* Jul-Sep 2007;49(3): 283-9. [PubMed](#) | [Google Scholar](#)
2. Black RE, Allen LH, Bhutta ZA, Caulfield LE, De Onis M, Ezzati M *et al.* Maternal and child undernutrition: global and regional exposures and health consequences. *The Lancet.* 2008 Jan 19;371(9608): 243-60. [PubMed](#) | [Google Scholar](#)
3. UNICEF. Monitoring the situation of children and women. statistics by country - nutrition country profile. 2016. [PubMed](#) | [Google Scholar](#)
4. Organization WH, others. Worldwide prevalence of anaemia 1993-2005: WHO global database on anaemia. 2008. Accessed on 28 Feb 2016.
5. De Benoist B, McLean E, Egli I, Cogswell M. WHO global database on anaemia. Geneva WHO. 2009 Apr;12(4): 444-54 Epub 2008 May 23. [PubMed](#) | [Google Scholar](#)
6. Benjelloun S. Nutrition transition in Morocco. *Public Health Nutr.* 2002 Feb;5(1A): 135-40. [PubMed](#) | [Google Scholar](#)
7. Soualem A, Ahami AOT, Aboussaleh Y, Elbouhali B, Bonthoux F. Le comportement alimentaire des préadolescents en milieu urbain au nord-ouest du Maroc. *Rev Francoph Clin Comport Cogn.* 2008;13(4): 39-46. [PubMed](#) | [Google Scholar](#)
8. OMS. Utilisation et interprétation de l'anthropométrie. Rapp D'un Com OMS D'experts Genève Organ Mond Santé. 1995.
9. Organization WH, Organization WH, others. Growth reference data for 5-19 years. Geneva World Health Organ. 2007.

10. WHO. Multicentre Growth Reference Study Group: WHO Child Growth Standards: Length/height-for-age, weight-for-age, weight-for-length, weight-for-height and body mass index-for-age: Methods and development. Geneva WHO, 2006. 2007. **Google Scholar**
11. Organization WH, others. Iron deficiency anaemia: assessment, prevention and control: a guide for programme managers. 2001. Accessed on 28 Feb 2016.
12. Aboussaleh Y, Ahami AOT. Comparaison des mesures anthropométriques des enfants scolaires selon leur milieu de résidence?: Etude dans la province de Kenitra au Nord Ouest du Maroc. 2005. Accessed on 14 May 2016.
13. El Hioui M, Soualem A, Ahami AOT, Aboussaleh Y, Rusinek S, Dik K. Caractéristiques sociodémographiques et anthropométriques en relation avec la performance scolaire dans une école rurale de la ville de Kenitra (Maroc). *Antropo*. 2008 Aug;5(2): 62-6. **PubMed | Google Scholar**
14. Tee E, Khor S-C, Ooi H-E, Young S-I, Zakiyah O, Zulkafli H *et al*. Regional study of nutritional status of urban primary schoolchildren. 3. Kuala Lumpur, Malaysia. *Food Nutr Bull*. 2002 Mar;23(1): 41-7. **PubMed | Google Scholar**
15. Oninla SO, Owa JA, Onayade AA, Taiwo O. Comparative study of nutritional status of urban and rural Nigerian school children. *J Trop Pediatr*. 2007 Feb;53(1): 39-43. **PubMed | Google Scholar**
16. Chowdhury SD, Chakraborty T, Ghosh T. Prevalence of undernutrition in Santal children of Puruliya district, West Bengal. *Indian Pediatr*. 2008 Jan;45(1): 43-6. **PubMed | Google Scholar**
17. Rana SR, Sekhsaria S, Castro OL. Hemoglobin S and C traits: contributing causes for decreased mean hematocrit in African-American children. *Pediatrics*. 1993 Apr;91(4): 800-2. **PubMed | Google Scholar**
18. Verhoef H, West CE, Veenemans J, Beguin Y, Kok FJ. Stunting may determine the severity of malaria-associated anemia in African children. *Pediatrics*. 2002 Oct;110(4): e48. **PubMed | Google Scholar**
19. Luo R, Kleiman-Weiner M, Rozelle S, Zhang L, Liu C, Sharbono B *et al*. Anemia in rural China's elementary schools: prevalence and correlates in Shaanxi province's poor counties. *Ecol Food Nutr*. Sep-Oct 2010;49(5): 357-72. **PubMed | Google Scholar**
20. MS. Enquête sur la population et la santé familiale (EPSF) 2003-2004. 2005.
21. Mushtaq MU, Gull S, Abdullah HM, Shahid U, Shad MA, Akram J. Prevalence and socioeconomic correlates of overweight and obesity among Pakistani primary school children. *BMC Public Health*. 2011 Sep 25;11: 724. **PubMed | Google Scholar**
22. Musaiger AO, others. Overweight and obesity in eastern mediterranean region: prevalence and possible causes. *J Obes [Internet]*. 2011. Accessed on 31 May 2016.
23. Sebbani M, Elbouchti I, Adarmouch L, Amine M. Prévalence de l'obésité et du surpoids chez les écoliers de primaire à Marrakech, Maroc. *Rev D'Épidémiologie Santé Publique*. 2013;61(6): 545-549. **Google Scholar**
24. Ramachandran A, Snehalatha C, Vinitha R, Thayyil M, Kumar CS, Sheeba L *et al*. Prevalence of overweight in urban Indian adolescent school children. *Diabetes Res Clin Pract*. 2002 Sep;57(3): 185-90. **PubMed | Google Scholar**
25. Hioui ME, Farsi M, Aboussaleh Y, Ahami AOT. Prévalence du déficit staturo-pondéral chez les enfants préscolaires à Kenitra (Maroc). *Antropo*. 2009;(19): 40-5. **Google Scholar**
26. Srivastava A, Mahmood SE, Srivastava PM, Shrotriya VP, Kumar B. Nutritional status of school-age children-A scenario of urban slums in India. *Arch Public Health*. 2012 Apr 17;70(1): 8. **PubMed | Google Scholar**
27. WHO/FAO. Report of the joint WHO/FAO expert consultation Diet, nutrition and the prevention of chronic diseases WHO Technical Report Series, No. 916 (TRS 916). 2004.
28. United States Department of Agriculture/United States Department of Health and Human Services. 2000.

29. Neumann CG, Bwibo NO, Murphy SP, Sigman M, Whaley S, Allen LH *et al.* Animal source foods improve dietary quality, micronutrient status, growth and cognitive function in Kenyan school children: background, study design and baseline findings. *J Nutr.* 2003 Nov;133(11 Suppl 2): 3941S-3949S. **PubMed** | **Google Scholar**
30. Djokic D, Drakulovic MB, Radojicic Z, Crncevic Radovic L, Rakic L, Kocic S *et al.* Risk factors associated with anemia among Serbian school-age children 7-14 years old: results of the first national health survey. *Hippokratia.* 2010 Oct;14(4): 252-60. **PubMed** | **Google Scholar**
31. Dror DK, Allen LH. The importance of milk and other animal-source foods for children in low-income countries. *Food Nutr Bull.* 2011 Sep;32(3): 227-43. **PubMed** | **Google Scholar**
32. Rovillé-Sausse F, Hernandez V. Comportements alimentaires et statut nutritionnel des enfants d'origine maghrébine vivant en France. *Antropo.* 2004;(7): 89-97.
33. Kohlboeck G, Sausenthaler S, Standl M, Koletzko S, Bauer C-P, Von Berg A *et al.* Food intake, diet quality and behavioral problems in children: results from the GINI-plus/LISA-plus studies. *Ann Nutr Metab.* 2012;60(4): 247-56. **PubMed** | **Google Scholar**
34. Grantham-McGregor S. Can the provision of breakfast benefit school performance? *Food Nutr Bull.* 2005 Jun;26(2 Suppl 2): S144-58. **Google Scholar**
35. Mahoney CR, Taylor HA, Kanarek RB, Samuel P. Effect of breakfast composition on cognitive processes in elementary school children. *Physiol Behav.* 2005 Aug 7;85(5): 635-45. **PubMed** | **Google Scholar**
36. Taleb S, Agli AN. Obésité de l'enfant: rôle des facteurs socioéconomiques, obésité parentale, comportement alimentaire et activité physique, chez des enfants scolarisés dans une ville de l'Est Algérien. *Cah Nutr Diététique.* 2009;44(4): 198-206. **Google Scholar**
37. Siega-Riz AM, Popkin BM, Carson T. Trends in breakfast consumption for children in the United States from 1965-1991. *Am J Clin Nutr.* 1998 Apr;67(4): 748S-756S. **PubMed** | **Google Scholar**
38. Keski-Rahkonen A, Kaprio J, Rissanen A, Virkkunen M, Rose RJ. Breakfast skipping and health-compromising behaviors in adolescents and adults. *Eur J Clin Nutr.* 2003 Jul;57(7): 842-53. **PubMed** | **Google Scholar**
39. Sjöberg A, Hallberg L, Höglund D, Hulthén L. Meal pattern, food choice, nutrient intake and lifestyle factors in The Göteborg Adolescence Study. *Eur J Clin Nutr.* 2003 Dec;57(12): 1569-78. **PubMed** | **Google Scholar**
40. Hioui ME, Ahami AOT, Aboussaleh Y, Rusinek S, Dik K, Soualem A *et al.* Risk factors of anaemia among rural school children in Kenitra, Morocco. 2008. Accessed on 22 May 2016.
41. Zimmermann MB, Zeder C, Chaouki N, Saad A, Torresani T, Hurrell RF. Dual fortification of salt with iodine and microencapsulated iron: a randomized, double-blind, controlled trial in Moroccan schoolchildren. *Am J Clin Nutr.* 2003 Feb;77(2): 425-32. **PubMed** | **Google Scholar**

Table 1: anthropometric characteristics

Parameters	Mean values ± standard deviation	
Weight in Kg	34,26	± 8,66
Height in cm	139,07	± 9,03
Height for age Z-score	- 0,24	± 1,17
BMI for age Z-score	0,14	± 1,02

Table 2: anthropometric indices of nutritional status in children, by age and sex

	Height for age			BMI for age			
	<-2 Z	~ -2 Z	P	<-2 Z	> -2 Z; < +1 Z	>+1 Z	P
	Stunting	Normal stature		Thinness	Normal	Overweight and obesity	
Sex							
Girls	11 (8.5%)	118 (91.5%)	0,14	2 (1.6%)	106 (82.2%)	21 (16.3%)	0,69
Boys	6 (4.2%)	136 (95.8%)		4 (2.8%)	112 (78.9%)	26 (18.3%)	
Total	17(6.3%)	254 (93.7%)		6 (2.2%)	218 (80.4%)	47 (17.3%)	
Age (years)							
≤ 10	13(10.7%)	109 (89.3%)	0,007	6 (4.9%)	96 (78.7%)	20 (16.4%)	0,023
> 10	4 (2.7%)	145 (97.3%)		0	122 (81.9%)	27 (18.1%)	
Total	17(6.3%)	254 (93.7%)		6 (2.2%)	218 (80.4%)	47 (17.3%)	

Table 3: stepwise multiple regression for haemoglobin concentration of school-aged children in Kenitra

Variable	B	ES	β	T	P	95% CI for B
Hct (%)	0.324	0.005	0.759	63.16	0.000	(0.313, 0.334)
MCV (fl)	-0.058	0.009	-0.309	-6.05	0.000	(-0.076, -0.039)
MCH (pg)	0.180	0.027	0.449	6.454	0.000	(0.125, 0.236)
MCHC (g/dl)	0.201	0.024	0.247	8.232	0.000	(0.152, 0.249)
Serum iron (µg/dl)	0.033	0.036	0.011	0.930	0.354	(-0.038, 0.104)

B-Ordinary least-squares regression coefficient; SE-Standard error of B; Beta-standardised β coefficient; T-Observed t value; P-Significance level; CI-confidence interval. Model summary: Multiple R = 0.9; R² = 0.98; adjusted R² = 0.964; F-Ratio = 37.57; P = 0.000.

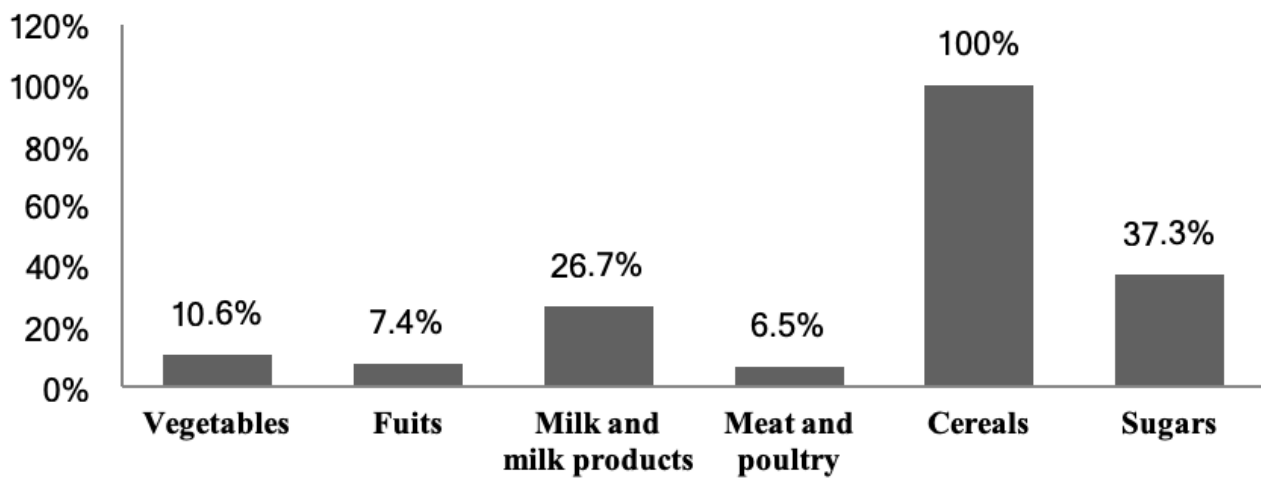


Figure 1: frequencies of food consumption per day

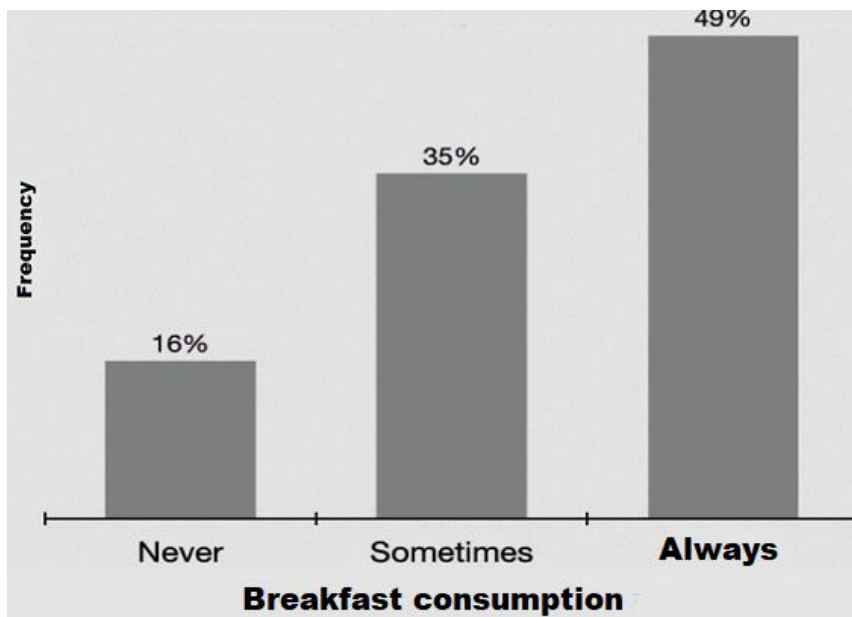


Figure 2: frequency of breakfast consumption