Anaemia prevalence and associated sociodemographic and dietary factors among Palestinian adolescents in the West Bank

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معدّل انتشار فقر الدم وما يرتبط به من عوامل اجتماعية وديموغرافية وغذائية بين المراهقين الفلسطينيين في الضفة الغربية

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الخلاصة: مازال فقر الدم مُشَاهَداً بين الأطفال، وبين النساء في سن الإنجاب في فلسطين. وقد استقصى الباحثون انتشار فقر الدم والعوامل المرتبطة به بين المراهقين في المدارس الفلسطينية (من الفئة العمرية 15-13 سنة) في محافظتَيْ رام الله والخليل، وذلك بقياس مستويات الهيموغلوبين. وقد كان معدّل انتشار فقر الدم أعلى على نحو يُعتدُّ به إحصائياً في الخليل عنه في رام الله بين الفتيان (22.5٪ مقابل 6.0٪ على التوالي)، في حين تشابهت الأرقام في المحافظتَيْن بين الفتيات (9.2٪ و9.3٪ على التوالي). وأظهر تحليل التحوّف الخطي الثنائي الحد أن فقر الدم بين الفتيان يتـرابط ترابطاً مستقلاً بالإقامة في الخليل ومستوى المعيشة الأعلى، في حين تـرابَطَ فقر الدم بين الفتيات بارتفاع مستوى تعليم الوالد. ولم يكن لتناوُل الأغذية الغنية بالحديد، كما سُجِّلَ في الاستبيانات التكرارية الغذائية، تأثير ملموس على انتشار فقر الدم بين كل من الفتيان والفتيات.

ABSTRACT Anaemia still persists among children and women of childbearing age in Palestine. We investigated the prevalence of anaemia and associated factors among Palestinian school adolescents (aged 13–15 years) in Ramallah and Hebron governorates. Haemoglobin levels were measured to assess the prevalence of anaemia. The prevalence of anaemia was significantly higher in Hebron than in Ramallah among boys (22.5% versus 6.0% respectively), while among girls the figures were similar (9.2% and 9.3% respectively). Linear binomial regression analysis showed that among boys, anaemia was independently associated with residence in Hebron and higher standard of living, while among girls, anaemia was associated with higher father's education. Consumption of iron-rich foods, as recorded in food frequency questionnaires, had no significant effects on anaemia prevalence in both boys and girls.

Prévalence de l'anémie et facteurs sociodémographiques et alimentaires associés chez des adolescents en Cisjordanie

RÉSUMÉ L'anémie reste une affection persistante chez les enfants et les femmes en âge de procréer en Palestine. Nous avons étudié la prévalence de l'anémie et des facteurs associés chez les adolescents fréquentant des écoles palestiniennes (âgés de 13 à 15 ans) dans les gouvernorats de Ramallah et d'Hébron. Les taux d'hémoglobine ont été mesurés pour évaluer la prévalence de l'anémie. La prévalence de l'anémie était significativement supérieure à Hébron par rapport à Ramallah chez les garçons (22,5 % par rapport à 6,0 %, respectivement), alors que chez les filles, les chiffres étaient similaires (9,2 % et 9,3 %, respectivement). L'analyse de régression linéaire de type binomial a révélé que chez les garçons, l'anémie était indépendamment associée au lieu de résidence à Hébron et à un niveau de vie élevé, alors que chez les filles, l'anémie était associée à un niveau d'instruction élevé du père. La consommation d'aliments riches en fer, telle qu'indiquée dans les questionnaires de fréquence de consommation alimentaire, n'avait d'effet important sur la prévalence de l'anémie ni chez les garçons, ni chez les filles.

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Introduction

Anaemia is one of the most common nutritional problems in many parts of the world, especially in developing countries [1]. A major health consequence of anaemia includes impaired cognitive and physical development in children [1,2]. Low intake of iron-rich food is a risk factor for stunting [3]. Other consequences include reduced work capacity in adults as well as increased risk of maternal and child mortality and morbidity and poor pregnancy outcome [2]. The main cause of anaemia is iron deficiency due to inadequate intake of bioavailable iron from the diet [4]. Other causes include infectious diseases, deficiencies of micronutrients such as folate, vitamin B12, inherited conditions such as thalassaemia [2] and environmental pollutants such as lead [5].

In Palestine, anaemia still persists among children and women of childbearing age [6,7]. However, studies measuring anaemia prevalence among Palestinian adolescents are rare. The present cross-sectional study aimed to assess the prevalence of anaemia and associated sociodemographic and dietary factors among Palestinian adolescent students (aged 13–15 years) in Ramallah and Hebron governorates in Palestine.

Methods

Study population and sample

The study was a school-based cross-sectional survey conducted in Ramallah and Hebron governorates between March and May 2005. Ramallah governorate (279 730 inhabitants in 2007) is located in the middle of the West Bank [8], while Hebron governorate (552 164 inhabitants) is located in the south [8]. The sample was selected to be representative of the 8th and 9th grade students in these 2 governorates, using stratified single-stage probability proportional-to-size sampling within each governorate in which the class was the primary sampling unit. A list of year 2004–05 students in these 2 grades was provided by the Palestinian Ministry of Education and Higher Education. A total of 65 classes were selected: 34 in Ramallah and 31 in Hebron. All students in the chosen classes were invited to participate in the study.

Questionnaire

Self-administered questionnaires were used to collect information from students and parents about sociodemographic factors and food intake. The questionnaires were piloted and adjusted before the survey. The students' questionnaire was tested for reliability (1-week test–retest) on a different sample of 115 students in the same age group.

Sociodemographic factors

The educational level of the parents was classified as: low (illiterate or less than secondary school education); medium (secondary school education); or high (college or university education). Residence was classified as urban or rural based on the Palestinian Central Bureau of Statistics (PCBS) classification [9]. A household standard of living index was devised based on household possessions. A score of 1 was given to ownership of each of the following items: central heating, family car, family mobile phone, personal mobile phone, indoor bathroom, water pipes, refrigerator, automatic washing machine, colour television, satellite television, video, computer, dishwasher, microwave, vacuum cleaner and Internet connection. The scores were summed to give a standard of living score range of 0–16. Three categories were constructed: "low", ≤ 6; "medium", 7–10 and "high", 11–16. The 1-week test–retest of the ownership of these amenities showed consistent answers ranging between 86.1% and 99.1%.

Onset of puberty was assessed by the question "Have you had your first period?" for girls and "Have you noticed deepening of your voice?" for boys. The 1-week test–retest for the onset of puberty showed consistent answers of 92.3% in boys and 95.2% in girls.

Food frequency list

The student questionnaire had a food frequency list of 42 items without portion sizes except for bread. The food and beverage questions were: "How often do you drink/eat the following items?" The response categories in the food frequency list were converted to frequencies in times/week (in parentheses) and these response categories were: > 4 times/day (35.0), 3–4 times/day (24.5), 1–2 times/day (10.5), 4–6 times/week (5.0), 2–3 times/week (2.5), once/week (1.0), 2–3 times/month (0.5), and seldom/never (0).

The following iron-rich foods and tea scores were included: animal food score [meat from beef, lamb, chicken, liver, kidney, *shawerma* (local dish made from beef or lamb or chicken), sausage, hamburger, cold cuts and eggs]; legumes score [chickpeas, *falafel* (fried broad beans), lentils, broad beans, beans and peas]; green leafy vegetables scores: *molokheya* (Jew's mallow) and spinach, mallow, chicory and garden rocket; tea score (black tea). The scores for the 4 food groups were constructed by the sum of the recoded responses (to weekly frequency intakes) of items included in each score, divided by the number of items. The daily quantity of *taboun* bread (traditional wholewheat bread) consumed was also included.

The 1 week test–retest reliability of the scores among 115 participants showed a Spearman correlation with a range of 0.55–0.65.

Blood analysis & anthropometric measurements

Haemoglobin (Hb) assays were conducted on capillary finger-prick blood samples using a haemoglobin photometer (HemoCue B). Haemoglobin

photometers were calibrated daily using dry standard and liquid controls. Anaemia was defined according to World Health Organization (WHO) cut-offs as Hb level < 12.0 g/dL for girls and < 12.0 g/dL for boys under 15 years old or 13 g/dL for boys aged 15 years and over . Mild anaemia was defined as Hb levels between 9.0 g/dL and the cut-off points, moderate anaemia was Hb 7.0–8.9 g/dL and severe anaemia was Hb < 7.0 g/dL [1].

Students' weight in light clothes without shoes was measured to the nearest 0.1 kg using a portable scale (Seca 780/783), and height without shoes was measured to the nearest 0.1 cm using a portable stadiometer (Seca 220). Underweight was defined according to age- and sex-specific body mass index (BMI) (kg/m^2) as < 5th percentile of the 2000 Centers for Disease Control Prevention (CDC) reference [10]. Stunting was defined according to the age and sex height percentiles as < 3rd percentile [10].

Ethical considerations

Informed consent was obtained from parents, students and school principals. The study was approved by the Palestinian Ministry of Education and Higher Education, the Office of Education of the United Nations Relief and Works Agency for Palestine Refugees in the Near East and the Regional Ethical Committee of Norway.

Statistical analysis

Statistical analysis was performed using *Stata*, version 10.1, to adjust for cluster sampling. Chi-squared tests were used to compare frequencies and *t*-tests to compare means. The sample was weighed according to the sample and population sizes in each governorate (inverse of sampling probability).

A linear binomial regression model was used. We were interested in the effect of both the sociodemographic variables on anaemia and in the effect of nutritional variables adjusted for sociodemographic variables. Hence 2 models were constructed. In model 1 we adjusted for sociodemographic variables and in model 2 we added the nutritional variables to the sociodemographic variables. For model 2, we only reported on the added variables. The modelling process was carried out separately for boys and girls. We tested for all plausible interactions between the variables in the model and checked the linear effects of the covariates. We looked for points of high influence and for predicted values outside 0 and 1 as this model does not constrict the risk of anaemia between these 2 values.

Results

Two schools in Ramallah governorate refused to participate in the study and were replaced by schools with similar characteristics. Of the 2170 students invited, 2032 (93.6%) participated in the study. Only students aged 13–15 years were included in this paper, so the final sample consisted of 1942 students (95.6% of those participating) in this age range. In total, 1863 (95.9%) parents completed the questionnaires. No significant differences were found between responding and non-responding parents ($n = 79$) in terms of standard of living, residence (urban versus rural) or students' age or sex. However, 2.0% of parents' questionnaires were missing in Ramallah versus 5.9% in Hebron ($P < 0.05$).

Background characteristics

Table 1 shows that slightly more of the students were from Hebron, with a higher proportion of girls than boys in both governorates. More students resided in urban areas in Hebron than Ramallah. However, many sociodemographic indicators were better in Ramallah than Hebron: families were smaller, and the mean standard of living index was higher.

The prevalence of underweight was 9.4% and 12.9% among boys and 3.8% and 6.0% among girls in Ramallah and Hebron respectively. The corresponding figures for stunting were 9.2% and 9.4% for boys versus 5.8% and 4.2% for girls in Ramallah and Hebron respectively (data not shown).

Table 2 shows that scores for consumption of iron-rich foods were higher in Ramallah than Hebron. Scores were significantly higher for boys than girls for all food types in Ramallah and for legumes in Hebron. The tea consumption scores were higher in Hebron than Ramallah and higher in boys than girls in both governorates.

Haemoglobin levels & prevalence of anaemia

Figure 1 shows the distribution of Hb levels by governorate and sex. For boys, the curve was shifted towards lower values in Hebron. Mean Hb level was 14.4 g/dL in Ramallah and 13.3 g/dL in Hebron. For girls, the curves were similar with similar mean Hb levels in both areas (13.9 g/dL in Ramallah and 13.7 g/dL in Hebron).

The prevalence of anaemia in boys was significantly higher in Hebron than Ramallah (22.5% versus 6.0% respectively) ($P < 0.0001$), while the rates for girls were similar in the 2 areas (9.3% and 9.2% respectively). No cases of severe anaemia were detected and most of the cases of anaemia (90.8%) were mild. There were large differences between schools in the prevalence of anaemia. In some schools the prevalence was as high as 42%, while in others there were no anaemic students (data not shown).

Anaemia & sociodemographic characteristics

Table 3 shows that in Ramallah there were no significant associations for boys between the prevalence of anaemia and sociodemographic characteristics. In Hebron, however, the prevalence of anaemia was high among 13-year-old

Table 1 Sociodemographic characteristics of the sample of Palestinian adolescents in Ramallah and Hebron governorates

Variable	Ramallah (*n* = 937)		Hebron (*n* = 1005)	
	No.	%	No.	%
Sex				
Boys	437	46.6	457	45.5
Girls	500	53.4	548	54.5
Residence				
Urban	374	41.0	661	67.7*
Rural	538	59.0	315	32.3
Age (years)				
13.0–13.9	388	41.4	330	32.8
14.0–14.9	416	44.4	483	48.1
15.0–16.0	133	14.2	192	19.1
Mother's education				
Less than secondary school	663	72.6	728	77.3
Secondary school	125	13.7	132	14.0
College or university	125	13.7	82	8.7
Father's education				
Less than secondary school	558	61.3	623	66.3
Secondary school	152	16.7	144	15.3
College or university	200	22.0	173	18.4
Family size (no. of persons)				
1–6	242	27.8	117	12.4***
7–8	301	34.6	355	37.7
< 8	327	37.6	471	49.9
Mean (SD)	8.1 (2.5)		8.9 (2.5)**	
Household standard of living[a]				
Low (0–6)	156	18.2	291	29.5**
Medium (7–10)	419	49.0	517	52.4
High (11–16)	281	32.8	179	18.1
Mean (SD)	9.2 (2.9)		8.0 (2.8)**	

[a]Household standard of living score based on the possession of 16 household amenities; each item given a value of 1.
The chi-squared test was used to compare differences between governorates for categorical variables and t-test was used to compare means.
**P < 0.05; **P < 0.01; ***P < 0.001*
SD = standard deviation.

boys (28.9%) ($P = 0.036$) and among those with a low standard of living (28.7%) ($P = 0.012$). A trend of increasing rates of anaemia with increasing family size was noted. In Ramallah, anaemia in girls was significantly associated

Table 2 Consumption of iron-rich foods and tea (mean no. of times/week) by Palestinian adolescents in Ramallah and Hebron governorates

Food consumption	Ramallah		Hebron	
	Boys	Girls	Boys	Girls
	Mean score (SE)	Mean score (SE)	Mean score (SE)	Mean score (SE)
Animal foods	3.0 (0.1)	2.2 (0.1)***	2.2 (0.1)	1.9 (0.1)
Legumes	2.3 (0.1)	1.9 (0.1)**	2.0 (0.1)	1.6 (0.1)**
Green leafy vegetables	1.2 (0.1)	0.9 (0.1)**	1.0 (0.1)	0.9 (0.1)
Taboun bread	1.2 (0.1)	0.9 (0.1)*	0.8 (0.1)	0.9 (0.1)
Tea	16.0 (0.8)	12.5 (0.7)**	19.2 (0.9)	16.5 (1.0)

**P < 0.05 **P< 0.01 ***P < 0.001.*
SE = standard error.

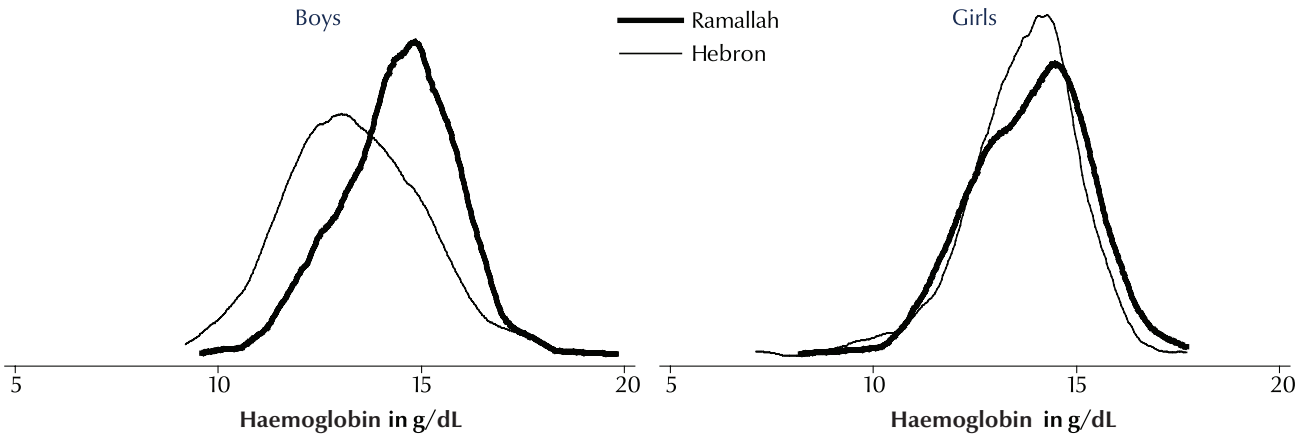

Figure 1 Distribution of haemoglobin levels of Palestinian adolescents in Ramallah and Hebron governorates by governorate and sex

with a high level of father's education ($P = 0.010$), whereas in Hebron no significant associations were found between anaemia and the sociodemographic characteristics of girls.

Anaemia & anthropometric characteristics

The relationship between anaemia and stunting and underweight was significant, especially for boys. A much higher proportion of anaemic boys were stunted than were non-anaemic boys (17.6% versus 7.6%) ($P = 0.005$). Similarly, 20.3% of anaemic boys were underweight versus only 9.8% of the non-anaemic boys ($P = 0.002$) (Table 4).

Regression analysis

The regression model results are shown in Table 5. For boys, model 1 showed that the prevalence of anaemia was 14.4% (constant term) if all the cofactors were at the reference category. Boys from Hebron had 14.7 percentage points (pp) higher prevalence of anaemia compared with their counterparts in Ramallah ($P < 0.001$). By age group 14-year-old boys had a 8.6 pp lower risk of anaemia compared with 13-year-old boys ($P < 0.05$). Boys from high standard of living households had 9 pp lower prevalence of anaemia compared with those from low standard of living households ($P < 0.05$). In model 2, boys from Hebron had 13.8 pp increased risk of anaemia compared with their counterparts in Ramallah (data not shown). None of the consumption scores for iron-rich food showed any significant association with the prevalence of anaemia, but there was a tendency for a lower prevalence of anaemia among boys who ate more animal foods (2.1 pp decrease in anaemia per unit animal food score). Separate models for each governorate did not show any significant associations between dietary factors and anaemia (data not shown).

For girls, the expected prevalence at reference categories for all the co-factors in model 1 was only 1.4% (constant term). Those whose fathers had medium or high educational level had 5.9 pp and 6.7 pp added risk of anaemia compared with those whose fathers had low education ($P < 0.05$). Medium and high levels of mother's education showed a tendency to decrease the risk of anaemia compared with low mother's education but not significantly so. Again, none of the iron-rich food consumption scores in model 2 showed any significant effect on the prevalence of anaemia, but there was a tendency for a lower prevalence of anaemia among girls who ate more legumes (1.1 pp decrease in anaemia per unit legume score).

No significant interactions between the independent variables were detected. All continuous covariates showed linear effects, and no observations with unduly high influence were found. However, some negative results were predicted (7.3% for boys and 0.2% for girls in model 1).

Discussion

This study showed that the rate of anaemia among boys in Hebron (22.5%) was significantly higher than among boys in Ramallah (6.0%). This value was also higher than among girls in both Ramallah and Hebron (around 9%), despite the fact that most of the girls had already reached puberty.

Studies on anaemia among Palestinian adolescents are scarce. Two reports showed that the prevalence of iron-deficiency anaemia was 12.7% among school-age children (aged 6–18 years) in Salfeet governorate [11] and 5.0% among secondary-school students in Jenin governorate. Both these studies reported that a higher proportion of girls were anaemic than boys [12]. A study in Gaza Strip in 2002 on adolescents aged 12–15 years reported that the prevalence of anaemia was 47.9% and 51.3% among boys and girls respectively [13]. This was much higher than

Table 3 Prevalence of anaemia in Palestinian adolescents from Ramallah & Hebron governorates by sociodemographic characteristics

Variable	Ramallah						Hebron					
	Boys (*n* = 437)			Girls (*n* = 500)			Boys (*n* = 457)			Girls (*n* = 548)		
	No.	%	*P*-value[a]	No.	%	*P*-value[a]	No.	%	*P*-value[a]	No.	%	*P*-value[a]
Total	437	6.0	–	500	9.2	0.127[b]	457	22.5	–	548	9.3	< 0.001[b]
Residence												
Urban	197	5.1	0.485	177	10.2	0.646	308	19.8	0.102	353	8.8	0.682
Rural	228	7.0		310	8.7		133	28.6		182	9.9	
Age (years)												
13.0–13.9	180	5.6		208	8.2		180	28.9		150	8.0	
14.0–14.9	192	4.7	0.247	224	9.8	0.802	210	17.6	0.036	273	9.2	0.608
15.0–16.0	65	10.8		68	10.3		67	20.9		125	11.2	
Mother's education												
Low	307	6.8		356	9.8		316	25.6		412	9.5	
Medium	56	3.6	0.432	69	4.4	0.296	67	16.4	0.231	65	10.8	0.916
High	54	3.7		71	11.3		38	15.8		44	9.1	
Father's education												
Low	270	7.0		288	6.6		277	24.6		346	8.4	
Medium	64	6.3	0.326	88	10.2	0.010[c]	59	27.1	0.274	85	11.8	0.443
High	84	2.4		116	13.8		84	16.7		89	11.2	
Family size (no. of persons)												
1–6	129	3.9		113	6.2		58	13.8		59	8.5	
7–8	142	7.8	0.363	159	9.4	0.252	166	22.3	0.193[c]	189	9.0	0.839
8	111	8.1		216	11.1		195	27.2		276	10.1	
Household standard of living[d]												
Low	56	8.9		100	9.0		115	28.7		176	8.0	
Medium	202	7.9	0.182	217	10.1	0.866	231	22.9	0.012[e]	286	10.8	0.308
High	147	2.7		134	9.0		103	13.6		76	6.6	
Onset of puberty												
No	74	5.4	0.800	100	8.0	0.752	92	27.2	0.061	84	7.1	0.442
Yes	363	6.1		391	9.2		364	21.4		464	9.7	

[a] *P for differences between sociodemographic characteristics using the chi-squared test.*
[b] *P for differences between boys and girls in the same governorate using the chi-square test.*
[c] *P for trend = 0.05.*
[d] *Household standard of living score based on the possession of 16 household amenities; each item given a value of 1.*
[e] *P for trend < 0.05.*

Table 4 Prevalence of anaemia in stunted and underweight Palestinian adolescents from Ramallah and Hebron governorates (*n* = 1942)

Variable	% of students with:		*P*-value
	Normal haemoglobin[a]	Anaemia[a]	
Stunting			
All	6.1	11.8	0.012
Boys	7.6	17.6	0.005
Girls	4.9	2.7	0.354
Underweight			
All	7.4	13.6	0.005
Boys	9.8	20.3	0.002
Girls	5.5	3.4	0.388

[a] *Weighted estimates.*

the prevalence of anaemia for boys and girls in our sample. These differences might be explained by a worse economic situation [14], lower nutritional status [15], lower intake of animal foods [16] and a higher rate of parasitic infestations [17] in Gaza.

The prevalence of anaemia among adolescents in other countries in the Eastern Mediterranean region is reported to range from 30% to 55%, with the mild forms of anaemia predominating [18]. These figures are higher than

Table 5 Linear binomial regression model for the relationship between anaemia and selected variables among Palestinian adolescents in Ramallah and Hebron governorates (*n* = 1942)

Variable	Boys				Girls			
	Model 1[a]		Model 2[b]		Model 1[a]		Model 2[b]	
	Coefficient	95% CI	Coefficient	95% CI	Coefficient	95% CI	Coefficient	95% CI
Constant	0.144*	0.025 to 0.262	0.143*	0.021 to 0.265	0.014	–0.066 to 0.093	0.032	–0.058 to 0.122
Region								
Ramallah	0		–	–	0		–	–
Hebron	0.147***	0.085 to 0.210	–	–	–0.004	–0.054 to 0.046	–	–
Residence								
Urban	0		–	–	0		–	–
Rural	0.041	–0.032 to 0.113	–	–	–0.004	–0.054 to 0.047	–	–
Age (years)								
13.0–13.9	0		–	–	0		–	–
14.0–14.9	–0.086*	–0.161 to –0.012	–	–	0.003	–0.052 to 0.059	–	–
15.0–16.0	–0.069	–0.157 to 0.019	–	–	0.016	–0.050 to 0.082	–	–
Mother's education								
Low	0		–	–	0		–	–
Medium	–0.051	–0.175 to 0.072	–	–	–0.023	–0.076 to 0.030	–	–
High	–0.005	–0.107 to 0.098	–	–	–0.014	–0.088 to 0.060	–	–
Father's education								
Low	0		–	–	0		–	–
Medium	0.022	–0.081 to 0.125	–	–	0.059*	0.012 to 0.107	–	–
High	–0.040	–0.129 to 0.050	–	–	0.067*	0.002 to 0.132	–	–
Family size								
1–6 persons	0		–	–	0		–	–
7–8 persons	0.051	–0.027 to 0.130	–	–	0.023	–0.031 to 0.077	–	–
> 8 persons	0.069	–0.001 to 0.139	–	–	0.036	–0.015 to 0.086	–	–
Household standard of living[c]								
Low	0		–	–	0		–	–
Medium	–0.035	–0.102 to 0.032	–	–	0.029	–0.009 to 0.067	–	–
High	–0.090*	–0.166 to –0.015	–	–	–0.006	–0.065 to 0.053	–	–

Table 5 **Linear binomial regression model for the relationship between anaemia and selected variables among Palestinian adolescents in Ramallah and Hebron governorates (*n* = 1942) (*concluded*)**

Variable	Boys				Girls			
	Model 1[a]		Model 2[b]		Model 1[a]		Model 2[b]	
	Coefficient	95% CI	Coefficient	95% CI	Coefficient	95% CI	Coefficient	95% CI
Onset of puberty								
No	0		–	–	0		–	–
Yes	−0.028	−0.096 to 0.039	–	–	0.025	−0.026 to 0.077	–	–
Food and tea scores								
Animal foods	–	–	-0.021	-0.046 to 0.005	–	–	-0.009	-0.027 to 0.010
Legumes	–	–	0.005	-0.013 to 0.023	–	–	-0.011	-0.024 to 0.002
Green leafy vegetables	–	–	-0.007	-0.032 to 0.017	–	–	0.008	-0.009 to 0.025
Bread	–	–	0.031	-0.004 to 0.067	–	–	0.005	-0.011 to 0.021
Tea	–	–	0.002	-0.001 to 0.004	–	–	0.000	-0.001 to 0.002

[a]*Adjusted for sociodemographic variables.*
[b]*Adjusted for sociodemographic and nutritional variables.*
[c]*Household standard of living index was based on the possession of 16 household amenities, each item given a value of 1.*
**P < 0.05; **P < 0.01; ***P < 0.001.*
CI = confidence interval.

the figures in our study, especially for Ramallah governorate. However, some studies reported figures close to our estimates, for example in Egypt [19], Saudi Arabia [20] and Iraq [21]. In other studies, the prevalence of anaemia has been shown to decline sharply after the age of 16 years among adolescent boys, whereas the rate starts to increase after the age of 18 years among girls [21,22].

The higher prevalence of anaemia among boys in Hebron is interesting. Hebron is more disadvantaged than Ramallah in terms of family size and standard of living [23]. Moreover, boys from Hebron were found to be more stunted and more underweight than either boys in Ramallah or girls in Hebron and Ramallah. Regional and sex differences might stem from a variety of sources apart from sociodemographic and nutritional factors, such as hereditary factors, parasitic infestations or environmental pollutants that were not measured in our study. Palestinian boys spend more time outdoors which might predispose them to certain infections that can lead to both anaemia and stunting. Iron deficiency has been associated with high blood lead levels in many studies [5,24]. One study has confirmed high lead levels in children in the West Bank [25].

Low intake of bioavailable iron from the diet is one of the main causes of anaemia [4]. Our results did not show any associations between the level of consumption of selected iron-rich foods and anaemia. This could be due to the fact that we only estimated frequency intake without portion sizes. Frequency of tea intake was not associated with increased risk of anaemia in our study. A similar lack of association was found in another study among Palestinian children [7].

Low intake of iron-rich food is a risk factor for poor physical growth [3]. Anaemia was significantly associated with stunting and underweight in our sample, especially among boys.

We used a linear binomial regression model. The advantages of this model are that it is easy to interpret and it gives the prevalence of anaemia for any covariate combination. The downside of the model is that it is not well known and it might predict values outside 0 and 1, as we found in our study.

The study had several limitations. First, due to cost considerations and to the concern over high refusal rates, Hb was only measured using capillary finger-prick samples. We did not measure serum iron and ferritin, nor could we do Hb electrophoresis. But, as the prevalence of thalassaemia trait in Palestine is low (3.5%) [26], we did not expect that this would contribute substantially to the explanation of anaemia in our sample. We did not have any information on infections or lead levels in our data. Moreover, our dietary data were based on a self-reported food frequency questionnaire and portion sizes were not given. The study was done in 2 governorates in the West Bank and the reported prevalence cannot be generalized to the rest of the West Bank. The strengths of the study include its relatively large sample size, single-stage cluster sampling method, the urban/rural distribution and the high response rate. Although the questionnaire was not validated, it was tested for reliability and the 1-week test–retest reliability of relevant questions was moderate to high.

The findings of this study point to a high prevalence of anaemia among boys in Hebron. Poverty, poor intake of iron-rich food, infections or lead toxicity might be associated factors. Further studies are needed to identify causes of anaemia among boys in Hebron in order to plan proper interventions.

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Adolescent health

There are sound public health, economic and human rights reasons for investing in the health and development of adolescents. Greater investment in adolescent health would help prevent the estimated 1.4 million deaths that occur each year among 10-19 year olds due to road traffic accidents, complications during pregnancy and child birth, suicide, violence, and HIV/AIDS. It would also improve the health and well-being of many millions of adolescents who experience health problems such as depression or anaemia; and promote the adoption of behaviours that help prevent health problems later in life, such as cardiovascular diseases and lung cancer resulting from physical inactivity and tobacco use initiated during adolescence. Finally, investing in adolescent health can prevent problems in the next generation, such as prematurity and low-birthweight in infants born to very young mothers. There is growing recognition of the economic benefits of investing in the healthy development of adolescents, and the economic costs of not doing so. Almost all Member States are signatories to the UN Convention on the Rights of the Child, which clearly states that adolescents have the right to obtain the health information and services they need to survive, grow and develop to their full potential.

Source: *Child and adolescent health and development: progress report 2009: highlights.* Geneva, World Health Organization, 2010