

Prevalence of overweight and obesity in adults from North Africa

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The share of North African immigrants in Europe is growing continuously. In this review, we aimed to systematically analyse and describe the literature on weight status and physical activity in North African adults, both in their home country and after immigration to Europe. Existing data on North African residents and on North African immigrants in Europe were analysed by a systematic search on PUBMED. There is a wide variation among countries in the prevalence of overweight/obesity, with immigrants showing higher values. The overall results revealed a higher prevalence of overweight and obesity in females than in males in North African residents. Females also show higher levels of obesity among immigrants. In particular, literature reports indicate that 1.3–47.8% of North African residents and 3.6–49.4% of North African immigrants in adult age are overweight or obese. Physical inactivity is higher than 20% in males and 40% in females in North African residents. The highest frequency of physically inactive or lightly active people among immigrants was observed in first-generation Sudanese and Moroccans in Amsterdam (males: 57.1%; females: 74.2%), with increasing rates in second-generation females. The results underline a higher health risk in North African immigrants than in residents. Specific public health strategies should be adopted in various populations of North African origin to control the obesity epidemic.

Introduction

The prevalence of nutritional disorders has been increasing worldwide in recent years. This increase, which has been termed a global,^{1–3} is part of a broader nutritional transition characterized by lifestyle and diet changes⁴ in a context of rapid economic development. People living in developing countries, such as those of North Africa, and immigrant populations in developed countries are particularly at risk, and nutritional disorders have become a rapidly growing threat to their public health.

North African residents

In most developing countries, urbanization is a major factor involved in the high prevalence of obesity.^{3,5–7}

Although Africa is the least urbanized continent, its population is becoming increasingly urban and its cities are growing at unprecedented rates. Despite widespread poverty in North African cities, there is easier access to cheap foods with high fat and sugar contents among the urban poor than among the rural population.^{8–11} A more industrial diet has been replacing their traditional diet.^{12–14} Although total energy intake is higher in rural areas, it has a lower contribution from fats and animal products.⁴

Calorie expenditure is also higher in rural people because of agricultural work and lower use of transportation systems; in contrast, urban people ride motorcycles, cars or buses.⁴ Therefore, urbanization, aging and the socio-economic level have been considered the main determinants of low physical activity levels in North African populations.^{14–16} Accelerated urbanization and altered dietary and lifestyle patterns have caused a progressive increase in cardiovascular

risk factors such as obesity, hypertension, diabetes and hypercholesterolemia.^{13–15,17}

Contrary to what occurs in developed countries where low socio-economic status (SES) and poor neighbourhoods are associated with a higher prevalence of obesity and chronic diseases,^{18,19} an inverse or low SES–high adiposity association has been reported in Africa.^{20–22} Female fatness is a cultural symbol of beauty, fertility and prosperity.^{17,23,24} Women with low educational levels do not recognize the risks and health consequences associated with overweight and obesity, as fatness is considered desirable and perceived as related to higher social status.¹⁷

Nevertheless, few studies have examined these associations over time, making it difficult to assess the socio-economic differences in the rate of progression to overweight and obesity in urban Africa.^{11,25,26}

Despite the alarming effects of obesity on health, economy and society, national strategies to combat obesity do not exist in North African countries. Thus far, obesity has not been recognized as a major public health priority, and convincing policy makers about the need to prioritize action to prevent obesity will be a crucial first step.²⁷

North African immigrants

The health status of immigrants is a research field of growing interest. In addition to being important for public health, it allows the formulation of hypotheses on the role of environmental vs. biological determinants of chronic diseases.^{28,29}

Several studies have shown that chronic disease patterns in immigrants rapidly change and become similar to those of their new host country.²⁹ The rates of mortality and morbidity linked to nutrition-related non-communicable diseases (NCDs) are

higher in immigrants than in the native population^{30,31} and also higher than the population of their home country.^{32–34}

Non-Western immigrants living in Western countries partly adopt the so-called 'Western lifestyle', characterized by a high prevalence of cigarette smoking, alcohol intake and physical inactivity, with a consequent increase in overweight.^{35–38} This lifestyle is an important determinant of cardiovascular diseases, diabetes and certain types of cancer.^{2,39} Differences in acculturation and perceived ethnic identity between first- and second-generation immigrants produce changes in behavioural risk factors over time.^{40–42} First-generation immigrants are expected to adopt Western behavioural practices less readily than second-generation ones because of their stronger identification with their ancestral groups and less acculturated position.^{41,43} Nevertheless, according to some authors, Mediterranean immigrants living in Europe appear to be in better health⁴⁴ and have a lower mortality rate than local-born populations,^{31,45–50} especially for nutrition-related NCDs. The origin of this so-called Mediterranean migrant paradox⁵¹ may be linked to a healthier lifestyle, e.g. Mediterranean migrants could have a healthier traditional diet than the local-born population. However, the causes of this paradox are still not well documented.⁴⁹

The aim of this review was to evaluate and compare the prevalence of overweight or obesity in North African populations to identify differences in health risks among countries, between genders and between residents and immigrants in Europe.

Methods

We examined the literature on overweight or obesity status of North Africans living in their own countries or as immigrants in Europe. In particular, we attempted to gather data from experimental or review articles on the overweight/obesity prevalence in people from seven countries of North Africa (mainly Moroccans, Tunisians and Egyptians). In addition, data on physical inactivity (as a risk factor) were collected on these populations where available. Electronic databases were searched from 1984/85 to July 2013 using keyword combinations (North African immigrant adults in Europe AND weight status, North African immigrant adults in Europe AND overweight, North African immigrant adults in Europe AND obesity, North African immigrant adults in Italy AND weight status, North African immigrant adults in Italy AND overweight, North African immigrant adults in Italy AND obesity, Moroccan immigrant adults in Europe AND weight status, Moroccan immigrant adults in Europe AND overweight, Moroccan immigrant adults in Europe AND obesity, Moroccan immigrant adults in Europe AND physical inactivity, Moroccan immigrant adults in the Netherlands AND overweight, Moroccan immigrant adults in the Netherlands AND obesity, Moroccan immigrant adults in the Netherlands AND physical inactivity, Moroccan immigrant adults in Italy AND weight status, Moroccan immigrant adults in Italy AND overweight, Moroccan immigrant adults in Italy AND obesity, Tunisian immigrant adults in Europe AND weight status, Tunisian immigrant adults in Europe AND overweight, Tunisian immigrant adults in Europe AND obesity, Tunisian immigrant adults in Europe AND physical activity, Tunisian immigrants adults in France AND weight status, Tunisian immigrants adults in France AND overweight, Tunisian immigrants adults in France AND physical activity, North African adults AND weight status, North African adults AND overweight, North African adults AND obesity, North African adults AND physical activity, North African adults AND physical inactivity, Egyptian adults AND weight status, Egyptian adults AND overweight Egyptian adults AND obesity, Moroccan adults AND weight status, Moroccan adults AND overweight, Moroccan adults AND obesity, Moroccan adults AND physical activity, Moroccan adults AND physical inactivity, Tunisian adults AND weight status, Tunisian adults AND overweight, Tunisian adults AND

obesity, Tunisian adults AND physical activity, Algerian adults AND weight status, Algerian adults AND overweight, Algerian adults AND obesity, Libyan adults AND overweight, Libyan adults AND obesity, Western Saharan adults AND weight status, Western Saharan adults AND overweight, Western Saharan adults AND obesity, Western Saharan adults AND physical activity, Western Saharan adults AND physical inactivity) to identify North African population studies on the prevalence of obesity. Reference lists of all the papers identified were examined to search for other non-indexed studies. Local studies on this topic, suggested by co-authors of this review, were also examined because of the paucity of data.

In all the studies, obesity was assessed by BMI (as body mass index = weight/height², kg/m²), as this remains the most widely available measure for studying weight status at the population level. The following WHO cut-offs were considered in almost all the studies: BMI ≥ 25 kg/m² defined overweight, BMI ≥ 30 kg/m² defined overall obesity. The tables report the data on the place and year of study, study population, age range, sex, sample size (where possible), diagnostic criteria, results and notes. In the cases where the number of subjects was reported, the χ^2 test was used to assess the difference in the prevalence of overweight and obesity.

Results

North African sample Overweight and obesity

Table 1 shows the data on the prevalence of overweight and obesity in North African populations. Most data regard Moroccans, Egyptians and Tunisians, whereas there are few data on Libyans, Sudanese, Algerians and Western Saharans. In all the samples from different nations, females and urban people have a higher prevalence of overweight and obesity than males and rural dwellers. The only exception is the Egyptian urban sample (1998–99) reported by Galal.⁵² The mean difference between urban and rural environment is of 5.6% (males) and 19.6% (females) for obesity in Tunisia, ~0.4% (females) and 17.2% (males) for overweight and ~19% (females) and 14% (males) for obesity in Egypt, ~6.3% (females) and 5.3% (males) for overweight and ~6.3% (females) and 0.7% (males) for obesity in Morocco.

For females, Moroccans have the highest prevalence of overweight (47.8%), whereas Tunisians have the lowest (12.8%). The prevalence of obesity is extremely high in Egyptians (46.6%)⁵⁵ and low in Moroccans (rural sample 3.7%; national 6.4%).^{4,66}

For males, the highest values of overweight (urban sample 45.3%) and obesity (20.0%) are in Egyptians,⁵² whereas the lowest ones are in Tunisians (overweight: 8.9%)⁶¹ and Moroccans (obesity: rural sample 1.3%; national 1.6%).^{4,66}

Despite the paucity of data and the use of methods that are not always standardized, an increasing trend in the prevalence of overweight/obesity was observed in North Africa over time.

In Egypt, between the 1995 and 2004 surveys, there was a decrease of overweight among female adults from 31.3 to 26.9% and an increase of obesity from 20.5 to 48.2%. Data for large samples of urban women indicate that by 1998 the mean BMI for women was in the obese range (30.08). According to the 2008 Egyptian Demographic Health Survey, the mean BMI of all women aged 15–59 years was 28.9 (40% of them were obese vs. 18% of men). Men have been less studied, but the 1998/1999 survey indicated that 65.3% of urban Egyptian men and 34.1% of those in rural areas were overweight or obese.

In Morocco, obesity and overweight also show an upward trend with a clear gender difference: obesity increased in men from 1.6% in 1984–85 to 4.3% in 1998–99 and from 6.4 to 16% in women. Moreover, it increased from 5.5 to 12.2% in the urban population and from 2.6 to 7.4% in the rural one. The 2000 national survey to determine the prevalence of hypertension revealed that 13.3% of

Table 1 Prevalence of overweight and obesity in North African residents

Sample	Year of survey	Sex	Number	Age (years)	BMI \geq 25 (%)	25.0 \leq BMI \leq 29.9 (%)	BMI \geq 30 (%)
Egypt ²⁶	1992/95	Female	11 097	15–49			21.8
Egypt ⁵²	1994	Female	5395			Urban 36.3 Rural 38.7	Urban 41.7 Rural 27.6
Egypt ⁵²	1998–99	Female	2909			Urban 39.6 Rural 36.5	Urban 45.2 Rural 20.8
Egypt ⁵²	1998–99	Male	1974			Urban 45.3 Rural 28.1	Urban 20 Rural 6
Egypt ⁵³	2000	Female	13 624	15–49	77.2	36.4	40.8
Egypt ⁵⁴	2003–07	Male		25–64			21.8
		Female		25–64			39
Egypt ⁵⁵	2005	Female	17 169	15–49	79.8	33.2	46.6
Egitto ¹³	2005	Male					21.98
		Female					45.46
Egypt ⁵⁶	2005	Male					22.1
		Female					45.6
Egypt ²⁶	2005/2008	Female	23 178	15–49			39.1
Egypt ⁵⁷	2008	Female	5685	15–59	67.8	28.3	39.5
		Male	5573	15–59	52.5	34.3	18.2
Egypt ⁵⁷	2008	Female ^a	14 574	15–49	78	38.4	39.6
Egypt ⁵⁸	2011–12	Female	3226	15–65	66.2		41.6
		Male	1854	15–65	58.8		22.4
Morocco ⁴	1998/99	Male	6875	\geq 20		National 21.1	National 4.3
			4052	\geq 20		Urban 24.1	Urban 4.7
			2826	\geq 20		Rural 17	Rural 3.8
Morocco ⁴	1998/99	Female	7153	\geq 20		National 29	National 16
			4375	\geq 20		Urban 31.1	Urban 19.1
			2778	\geq 20		Rural 25.8	Rural 11.1
Morocco ⁴	1984/85	Male	19 831	\geq 20		National 16.9	National 1.6
			10 597	\geq 20		Urban 19.8	Urban 2.0
			9234	\geq 20		Rural 13.6	Rural 1.3
Morocco ⁴	1984/85	Female	21 695	\geq 20		National 25.5	National 6.4
			11 586	\geq 20		Urban 28.9	Urban 8.7
			10 109	\geq 20		Rural 21.8	Rural 3.7
Tunisia ¹⁷	1987	Male	926	20–60		23.3	6.7
		Female	1834	20–60		28.2	22.7
Morocco ¹⁷	1998	Male	9120	>18		28	5.7
		Female	8200	>18		33	18.3
Morocco ⁵⁹	2000	Male	755	>20		30.6	7.2 ^b
		Female	1047	>20		47.8	19.1 ^b
		Male and Female					Urban 1.4 ^b
		Male and Female					Rural 9.0 ^b
		Male	755	>20			8.2 ^c
		Female	1047	>20			21.7 ^c
		Male and Female					Urban 2.2 ^c
		Male and Female					Rural 10.9 ^c
Morocco ⁵⁴	2000	Male		\geq 20			8.2
		Female		\geq 20			21.7
Morocco ¹³	2002	Male					3.67
		Female					19.03
Morocco ¹³	2005	Male					3.67
		Female					20.52
Morocco ⁵⁶	2005	Male					3.7
		Female					20.6
Morocco ²³	2008	Male	Urban 830 Rural 595 Total 1425	>18		Urban 27.8 Rural 25.2 Total 26.7	Urban 6.1 Rural 5.7 Total 6.0
		Female	Urban 850 Rural 606 Total 1456	>18		Urban 35.6 Rural 29.2 Total 32.5	Urban 23.4 Rural 17.5 Total 20.9
Morocco ⁶⁰	2008	Female	128	28 (26–36)		40.6	15.6
Morocco ¹⁶	2008	Male	1346			26.45	5.94
		Female	1252			32.43	19.33
Tunisia ⁵⁴	1994	Male		\geq 20			12.4
		Female		\geq 20			34.3
Tunisia ³	1996/97	Female			51.7		22.6
Tunisia ⁶¹	2001	Male	4232	>15		8.9	6.1
Tunisia ⁶¹	2001	Female	4344	>15		12.8	18.3
Tunisia ¹³	2002	Male					7.74
		Female					28.78
Tunisia ⁶²	2005	Male	2379	35–70	51.7		13.3
Tunisia ⁶²	2005	Male	1341				Urban 15.5
Tunisia ⁶²	2005	Male	897				Rural 9.9
Tunisia ⁶²	2005	Female	2964	35–70	71.1		37
Tunisia ⁶²	2005	Female	1500				Urban 43.7
Tunisia ⁶²	2005	Female	1225				Rural 24.1

(continued)

Table 1 Continued

Sample	Year of survey	Sex	Number	Age (years)	BMI \geq 25 (%)	25.0 \leq BMI \leq 29.9 (%)	BMI \geq 30 (%)
Tunisia ¹³	2005	Male					7.74
Tunisia ¹³	2005	Female					30.2
Tunisia ⁵⁶	2005	Male					7.7
		Female					30.1
Algeria ¹³	2002	Male					4.52
		Female					11.91
Algeria ⁶³	2004–05	Male	399	>20			10.5
		Female	406				27.8
Algeria ⁵⁶	2005	Male					5.3
		Female					13.5
Algeria ¹³	2005	Male					5.18
		Female					13.44
Libya ¹³	2002	Male					10.74
		Female					21.13
Libya ⁵⁶	2005	Male					11.5
		Female					22.4
Libya ¹³	2005	Male					11.45
		Female					22.52
Libya ⁶⁴	2008–09	Male				36.1	21.4
		Female				29.7	40.1
Western Sahara ⁶⁵	2010	Female	1781	15–49		31.8	21.9
Sudan ⁵⁴	2003–07	Male		25–64			11.7
		Female		25–64			30.7

a: ever married.

b: standard prevalence.

c: crude prevalence.

individuals aged \geq 20 years were obese, 22% among women and 8% among men.⁶⁷

In Tunisia, the National Nutrition Institute survey in 1997 revealed that female obesity was a serious public health problem in that country: the prevalence of overweight and obesity increased from 28.3% in 1980 to 51% in 1997.¹⁷ In 2005, the national prevalence of overweight was 61.5%, high for men (51.7%) but even higher for women (71.1%); the prevalence of overall obesity was 25.4%, 13.3% for men and almost three times higher for women (37.0%).⁶²

The limited literature data available for the other North African nations did not allow us to define a trend over time in the prevalence of obesity.

Physical inactivity

This evaluation is difficult because data on the prevalence of physical activity in the North African region are limited and collected with different criteria. In general, physical inactivity is higher in North African female residents than in males (Table 3). The prevalence of physical inactivity among adults (males plus females) in North African countries varies between 21.6% in Algeria to 86.8% in Sudan.⁵⁴

In Egypt, the STEPS Survey 2011–12 carried out in adults aged 15–65 years shows that 23.3% of males and 42.0% of females have low levels of activity (defined as <600 Metabolic Equivalent, MET-minutes per week), with males practicing higher levels of strong physical activity than females.⁵⁸

Among Moroccans, the prevalence of physical activity is 67.4% in males and 54.6% in females, and its practice decreases with increasing weight status.⁶⁸

The lowest levels of physical inactivity are in Algerians: according to different studies, 42.6% of the population older than 25 years and 21.6% of the population 25–64 years old is inactive.^{69,70}

North African immigrants in Europe

Overweight and obesity

Table 2 shows the data on the prevalence of overweight and obesity in North African immigrants in Europe. The results concern mainly

Moroccans and to a lesser extent Tunisians. No data are available for the other groups.

The highest prevalence of overweight was observed in Hajj pilgrims (Tunisians) in Marseille (France),⁷² the sample consisting of both males and females. For males, Moroccan immigrants in the Netherlands have the highest prevalence,⁷⁵ whereas for females, the highest prevalence is in Moroccan immigrants in Italy.⁷³ Females generally present a higher prevalence of obesity than males. The highest values were observed in Moroccan females in Amsterdam,⁷⁸ whereas the highest prevalence of obesity in males was shown by Moroccans living in Spain.⁷⁹

The comparison between residents in Africa and immigrants in Europe was possible only for Moroccans and Tunisians. Figures 1 and 2 show comparisons for obesity according to the most recent literature data in males and females; we do not report data on overweight because they often refer to different survey years, complicating the graphical representation and interpretation. In Tunisians the comparison is possible only for males; it indicates a higher prevalence of obesity in immigrants in Italy than in residents of Tunisia. Moroccan male immigrants in the Netherlands and Italy also show a significantly higher prevalence of obesity than Moroccan residents ($P < 0.05$). The prevalence of obesity is significantly higher in Moroccan female immigrants in Spain ($P < 0.05$) and the Netherlands ($P < 0.05$) than in females living in Morocco, although the values for Moroccan residents and immigrants in Italy are similar to each other.

Physical inactivity

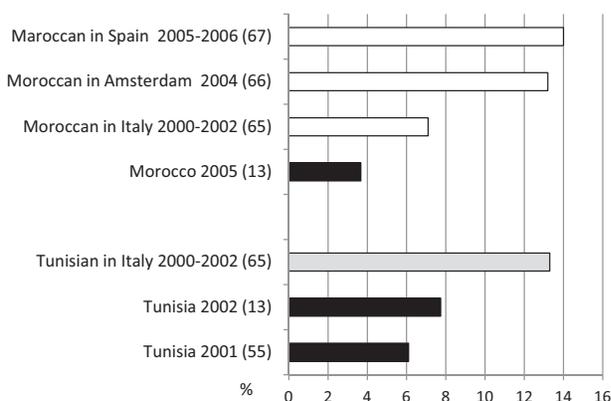
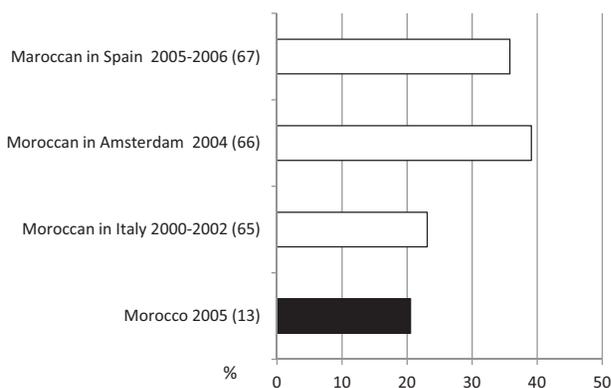
A 47.6% prevalence (Table 3) of total inactivity was reported for Moroccan immigrants in the Netherlands:⁷⁶ 19.8% of them practiced physical activity <1 time/week, 18.3% 2–3 times/week and 14.3% >3 times/week.

According to Hosper et al.,³⁸ the level of physical inactivity (<30 min during \geq 5 days/week) of second-generation vs. first-generation Moroccan immigrants in Amsterdam follows a different trend between genders: lower in men (57.1% first generation vs. 54.6% second generation) and higher in women (74.2% first generation vs. 76.2% second generation). In any case, these values are the highest reported among the considered immigrant

Table 2 Prevalence of overweight and obesity in North African immigrants in Europe

Sample	Year of survey	Sex	Number	Age (years)	BMI \geq 25 (%)	25.0 \leq BMI \leq 29.9 (%)	BMI \geq 30 (%)
Tunisian migrants in France ⁷¹	2004–05	Male	147	50.2 \pm 13.2	46.9		
Hajj pilgrims (Algeria) in Marseil ⁷²	2010	Males and females	262	19–86		45.4	29
Hajj pilgrims (Morocco) in Marseil ⁷²	2010	Males and females	122	19–86		41	31.1
Hajj pilgrims (Tunisia) in Marseil ⁷²	2010	Males and females	87	19–86		49.4	32.2
Moroccan in Italy ⁷³	2000–02	Male	139	42.4 \pm 10.0	51.2	44.1	7.1
Moroccan in Italy ⁷³	2000–02	Female	22	36.3 \pm 9.1	69.3	46.2	23.1
Tunisian in Italy ⁷³	2000–02	Male	18	39.1 \pm 7.3	46.6	33.3	13.3
Moroccan in Amsterdam ⁷⁴	1995	Males and females	176	35.5 (16–64)			24.4 ^a
Moroccan in Netherlands ⁷⁵	1999–2000	Male	289	35–74		47.8	9.0
Moroccan in Netherlands ⁷⁵	1999–2000	Female	116	35–74		43.1	35.3
Moroccan in Netherlands ⁷⁶	2001	Male	232	33.90 \pm 12.44		31.9	10.3
Moroccan in Netherlands ⁷⁶	2001	Female	187	33.90 \pm 12.44		28.3	11.2
Moroccan in Amsterdam ⁷⁷	2003–04	Male	56	18–30		19.6	3.6
Moroccan in Amsterdam ⁷⁷	2003–04	Female	104	18–30		23.1	11.5
Moroccan in Amsterdam ³⁸	2003–04	Male	115	15–30	First generation 9.6 (0.02–19.2) second generation 22.5 (12.5–32.5)		
Moroccan in Amsterdam ³⁸	2003–04	Female	176	15–30	First generation 38.9 (26.2–51.6) second generation 26.5 (16.9–36.1)		
Moroccan in Amsterdam ⁷⁸	2004	Male	192	52.4 \pm 13.2		37.2	13.2
Moroccan in Amsterdam ⁷⁸	2004	Male	192	52.4 \pm 13.2		37.2	13.2
Moroccan in Amsterdam ⁷⁸	2004	Female	161	43.8 \pm 14.1		24.7	39.1
Moroccans in Spain ⁷⁹	2005–06	Male	100	>15			14
Moroccans in Spain ⁷⁹	2005–06	Female	67	>15			35.8

a: BMI > 27.

**Figure 1** Prevalence of obesity (BMI \geq 30 kg/m²) in North African male residents and migrants, starting from the year 2000**Figure 2** Prevalence of obesity (BMI \geq 30 kg/m²) in North African female residents and migrants, starting from the year 2000

groups. Among Tunisian immigrants in France, 36.7% have a sedentary or lightly active lifestyle, 53.1% have an active or moderately active lifestyle and 10.2% have a vigorously active lifestyle.⁴⁹

Discussion

The aim of this review was to assess the prevalence of overweight/obesity in North African adults, either living in their home country or as immigrants in Europe. Not all populations from North Africa are equally represented, as more information is available for Moroccans, Egyptians and Tunisians, while there are few data for Libyans, Sudanese, Algerians and Western Saharans.

There is a consistent difference between men and women in the prevalence of these weight disorders. Females show higher frequencies of overweight and obesity than males in both North African residents and immigrants living in Europe. The gender disparity in overweight and obesity is exacerbated among women in developing countries, particularly in the Middle East and North Africa.⁸⁰ This gender difference in obesity is higher in urban settings but lower among people with higher educational and professional levels.⁶²

In particular, the literature data show that the highest prevalence of obesity is reached in Egyptian females. This could be related to cultural values, as North African populations favour larger body size among women as a sign of fertility, healthiness or prosperity, with particularly alarming rates of obesity in North Africa,⁸¹ especially in Egyptian women.^{3,26} Among males, Egyptians again show the highest values of overweight and obesity.

Despite the limited literature data available, an increasing trend over time in the prevalence of obesity was observed in North African countries, especially in Egypt. Obesity is higher in females than in males and in urban people than in rural ones, in agreement with populations in other parts of Africa.^{6,82}

Accelerated urbanization and changes in dietary and lifestyle patterns (especially physical inactivity) have contributed to the increased prevalence of obesity, hypertension, diabetes and

Table 3 Physical activity level in North African residents and in North African immigrants in Europe

Sample	Year of survey	Sex	Number	Age (years)	Physical inactivity level	Physical activity level
Tunisian migrants in France ⁷¹	2004–05	Male	147	50.2 ± 13.2		Sedentary or light active lifestyle 36.7; active or moderately active lifestyle 53.1; vigorous or vigorously active lifestyle 10.2
Moroccan in Amsterdam ³⁸	2003–04	Male	115	15–30		Insufficient (< 30 min during ≥5 days/week); first generation 57.1 (41.4–72.8); second generation 54.6 (43.5–65.7)
Moroccan in Amsterdam ³⁸	2003–04	Female	176	15–30		Insufficient (< 30 min during ≥5 days/week); first generation 74.2 (64.2–84.2); second generation 76.2 (68.0–84.4)
Moroccan in Netherlands ⁷⁶	2001	Male and Female	447	33.90 ± 12.44		Never 47.6; <1 times/week 19.8; 2–3 times/week 18.3; >3 times/week 14.3
Morocco ²³	2008	Male	1359	>18		Total 67,5 BMI <25 70 BMI 25–29 24,8 BMI >30 5,1 tot 54,6 BMI <25 49,4 BMI 25–29 33,1 BMI >30 17,4 61,3
		Female	1261	>18		
		Male and Female	2620	>18		
Morocco ¹⁶	2008	Male	910			BMI <24,99 low 7,7 BMI <24,99 moderate 21,1 BMI <24,99 high 71,2 BMI 25–29,99 low 13,2 BMI 25–29,99 moderate 27,8 BMI 25–29,99 high 59 BMI >30 low 11,3 BMI >30 moderate 30 BMI >30 high 58,8
			356			BMI <24,99 low 21,5 BMI <24,99 moderate 37,3 BMI <24,99 high 41,2 BMI 25–29,99 low 25,4 BMI 25–29,99 moderate 32,8 BMI 25–29,99 high 41,9 BMI >30 low 27,7 BMI >30 moderate 31,4 BMI >30 high 40,9
			80			
		Female	604			
			406			
			242			
Egypt ⁵⁴	2003–07			≥ 20	50,4	
Egypt ⁵⁴	2003–07			25–64	63	
Egypt ⁵⁸	2011–12	Male	1854	15–65		Percentage with low levels of activity (defined as < 600 MET-minutes per week) 23.3 ; percentage with high levels of activity (defined as 3000 MET-minutes per week) 54.1
		Female	3226	15–65		Percentage with low levels of activity (defined as < 600 MET-minutes per week) 42.0 ; percentage with high levels of activity (defined as 3000 MET-minutes per week) 35.8
Libya ⁶⁴	2008–09	Male			36	
		Female			51,7	
Algeria ⁵⁴	2009			≥ 25	42,6	
Algeria ⁵⁴	2003–07			25–64	21,6	
Sudan ⁵⁴	2003–07			25–64	86,8	

hypercholesterolemia, and thus the risk of cardiovascular diseases, in North African populations.^{13–15,17} Popkin et al.⁸³ reported that diets in low- and medium-income countries are converging on what is often termed the ‘Western diet’, characterized by a high intake of refined carbohydrates, added sugars, fat and foods of animal origin.⁸⁴ New access to technologies and regulatory environments is changing the diets of these low- and middle-income countries, especially in urban areas but also increasingly in rural ones. This

dietary change in many developing countries is likely the basis of the excess weight gain among both genders but affecting women more than men, with a greater increase in triglyceride levels in women.^{80,85}

Studies on North African immigrants in Europe mainly refer to Moroccans and Tunisians, the largest migrant groups. The highest obesity values are in Moroccan females in the Netherlands, particularly in Amsterdam, and in Tunisian males in Italy.

A comparison of the prevalence of overweight and obesity between residents in Africa and immigrants in Europe is difficult due to the lack of data. In general, immigrants show higher frequencies of weight disorders than residents of their home country, with a few exceptions in females. The North African immigrant population also has a higher prevalence of cardiovascular risk factors than the populations of their home countries.^{76,78,79} It must be considered that there are many potential sources of risk accompanying migration or acculturation. The immigration process probably influences health status, especially with respect to chronic diseases. Several studies have shown that immigrants rapidly adopt the chronic disease patterns of their new host country.²⁹ Negative emotions induced by chronic stress contribute to chronically high blood pressure, and there is a positive relationship between hypertension and metabolic imbalance disorders (especially obesity).^{73,86}

Nevertheless, male Tunisian immigrants residing in France enjoy better health with respect to overweight and NCDs than the local French, supporting the hypothesis of a 'Mediterranean migrant paradox' regarding mortality and morbidity in France.⁴⁹ In addition, the comparison between migrants and their non-migrant counterparts in Tunisia suggest that both cultural (alcohol consumption) and environmental factors (physical activity, smoking habits) are involved in the paradox.

In general, all immigrant groups participate in sporting activities less frequently than the native population.⁷⁶ This can be ascribed partly to cultural differences in sports participation among ethnic groups and between men and women, as women participate in sports less frequently than men.^{76,87}

Because overweight and obesity reflect an energy imbalance, the main areas of intervention are dietary intake and energy expenditure, for which the main modifiable component is physical activity.

In North African populations, the reduced work-related energy expenditure in the more labour-intensive occupations, changes in transportation, leisure and domestic production have led to reduced physical activity.^{83,88,89} The transition from agricultural labour (production and subsistence) to salaried labour that occurred towards the end of the 20th century in many developing countries decreased the physical activity of women more than men.

Throughout both North and Sub-Saharan Africa, obesity and physical inactivity in both sexes is associated with high social status, fertility, good health and prosperity.^{17,61,90-92} Furthermore, gender differences in cultural (regional) habits can intensify the gender differences in obesity.¹⁷

Conclusions

This study gives an overview of the available data on the prevalence of overweight and obesity in North African adults, indicating a different distribution among North African countries, between genders and between residents and migrants. The increasing trend of overweight/obesity in both North African residents and migrants highlights the increasing health risks for these people. Few data were found on nutritional status and on factors affecting it in Libyans, Algerians, Sudanese and Western Saharans. Hence, there is a need to update and complete the information on these countries and to continue monitoring the situation to prevent future diseases. The prevalence of obesity is increasing in African immigrants in Europe, generally confirming a tendency to a higher health risk in minority groups than in European natives. The scarce or completely lacking data on mean values of BMI for age, sex and socio-economic classes (especially in North African surveys) indicate an urgent need for research on these topics to plan adequate intervention programmes. Only continuous and accurate surveys of the evolving situation will allow us to provide relevant tools and strategies for health promotion in North African and European countries.

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Key points

- This study compares North African residents and immigrants in Europe, highlighting that immigration to Europe is associated with increased risk of overweight and obesity.
- Compared with men, North Africa-born women show higher prevalence of overweight and lower physical activity.
- These patterns confirm that gender is an important conditioning factor in overweight status both in North African residents and immigrants.
- The development of a health-care organization sensitive to gender, ethnic and cultural diversities is required in Europe.

References

- 1 Popkin BM, Doak CM. The obesity epidemic is a worldwide phenomenon. *Nutr Rev* 1998;56:106-14.
- 2 World Health Organization. Obesity: Preventing and Managing the Global Epidemic. Report of a WHO Consultation. WHO Technical Report Series 894. Geneva: WHO, 2000.
- 3 Beltaifa L, Traissac P, El Ati J, et al. Prevalence of obesity and associated socioeconomic factors among Tunisian women from different living environments. *Obes Rev* 2009;10:145-53.
- 4 Benjelloun S. Nutrition transition in Morocco. *Public Health Nutr* 2002;5:135-40.
- 5 Popkin BM. Urbanization, lifestyle change and the nutrition transition. *World Dev* 1999;27:1905-16.
- 6 Martorell R, Khan LK, Hughes ML, Grummer-Strawn LM. Obesity in women from developing countries. *Eur J Clin Nutr* 2000;54:247-52.
- 7 Subramanian SV, Smith GD. Patterns, distribution, and determinants of under- and overnutrition: a population-based study of women in India. *Am J Clin Nutr* 2006;84:633-40.
- 8 Njelekela M, Kuga S, Nara Y, et al. Prevalence of obesity and dyslipidemia in middle-aged men and women in Tanzania, Africa: relationship with resting energy expenditure and dietary factors. *J Nutr Sci Vitaminol (Tokyo)* 2002;48:352-8.
- 9 Njelekela M, Sato T, Nara Y, et al. Nutritional variation and cardiovascular risk factors in Tanzania—rural-urban difference. *S Afr Med J* 2003;93:295-9.
- 10 Mathe S, Matovu HL, Mossop RT. Nutritional status of an urban community in Zimbabwe. *Cent Afr J Med* 1985;31:59-62.
- 11 Ziraba AK, Fotso JC, Ochako R. Overweight and obesity in urban Africa: a problem of the rich or the poor? *BMC Public Health* 2009;9:465.
- 12 Alwan A. Noncommunicable diseases: a major challenge to public health in the Region. *East Mediterr Health J* 1997;3:6-16.
- 13 Belahsen R, Rguibi M. Population health and Mediterranean diet in southern Mediterranean countries. *Public Health Nutr* 2006;9:1130-5.
- 14 Fahed AC, El-Hage-Sleiman AK, Farhat TI, Nemer GM. Diet, genetics, and disease: a focus on the middle East and north Africa region. *J Nutr Metab* 2012; 109037. PMID: 22536488; DOI: 10.1155/2012/109037.
- 15 Bagchi K. Iron deficiency anaemia—an old enemy. *East Mediterr Health J* 2004;10:754-60.

- 16 Najdi A, El Achhab Y, Nejari C, et al. Correlates of physical activity in Morocco. *Prev Med* 2011;52:355–7.
- 17 Mokhtar N, Elati J, Chabir R, et al. Diet culture and obesity in northern Africa. *J Nutr* 2001;131:887S–2S.
- 18 Sundquist K, Malmstrom M, Johansson SE. Neighbourhood deprivation and incidence of coronary heart disease: a multilevel study of 2.6 million women and men in Sweden. *J Epidemiol Community Health* 2004;58:71–7.
- 19 Lopez RP. Neighborhood risk factors for obesity. *Obesity* 2007;15:2111–19.
- 20 Kuga S, Njelekela M, Noguchi T, et al. Prevalence of overweight and hypertension in Tanzania: special emphasis on resting energy expenditure and leptin. *Clin Exp Pharmacol Physiol*, 2002;29:S23–6.
- 21 Fezeu L, Minkoulou E, Balkau B, et al. Association between socioeconomic status and adiposity in urban Cameroon. *Int J Epidemiol* 2006;35:105–11.
- 22 Christensen DL, Eis J, Hansen AW, et al. Obesity and regional fat distribution in Kenyan populations: impact of ethnicity and urbanization. *Ann Hum Biol* 2008;35:232–49.
- 23 El Rhazi K, Nejari C, Zidouh A, et al. Prevalence of obesity and associated sociodemographic and lifestyle factors in Morocco. *Public Health Nutr* 2010;14:160–7.
- 24 Monteiro CA, Moura EC, Conde WL, Popkin BM. Socioeconomic status and obesity in adult populations of developing countries: a review. *Bull World Health Organ* 2004;82:940–6.
- 25 Durazo-Arvizu RA, Luke A, Cooper RS, et al. Rapid increases in obesity in Jamaica, compared to Nigeria and the United States. *BMC Public Health* 2008;8:133.
- 26 Aitsi-Selmi A, Chandola T, Friel S, et al. Interaction between education and household wealth on the risk of obesity in women in Egypt. *PLoS One* 2012;7:e39507.
- 27 Holdsworth M, El Ati J, Bour A, et al. Developing national obesity policy in middle-income countries: a case study from North Africa. *Health Policy Plan* 2013;28:858–70.
- 28 Uniken Venema HP, Garretsen HF, van der Maas PJ. Health of migrants and migrant health policy, The Netherlands as an example. *Soc Sci Med* 2013;41:809–18.
- 29 Gushulak BD, Macpherson DW. The basic principles of migration health: population mobility and gaps in disease prevalence. *Emerg Themes Epidemiol* 2006;3:3.
- 30 Bollini P, Siem H. No real progress towards equity: health of migrants and ethnic minorities on the eve of the year 2000. *Soc Sci Med* 1995;41:819–28.
- 31 Bos V, Kunst AE, Keij-Deerenberg IM, et al. Ethnic inequalities in age- and cause-specific mortality in The Netherlands. *Int J Epidemiol* 2004;33:1112–19.
- 32 Bjerregaard P, Jorgensen ME, Lumholt P, et al. Higher blood pressure among Inuit migrants in Denmark than among the Inuit in Greenland. *J Epidemiol Community Health* 2002;56:279–84.
- 33 Gadd M, Johansson SE, Sundquist J, Wandell P. Are there differences in all-cause and coronary heart disease mortality between immigrants in Sweden and in their country of birth? A follow-up study of total populations. *BMC Public Health* 2006;6:102.
- 34 Patel JV, Vyas A, Cruickshank JK, et al. Impact of migration on coronary heart disease risk factors: comparison of Gujaratis in Britain and their contemporaries in villages of origin in India. *Atherosclerosis* 2006;185:297–306.
- 35 Lara M, Gamboa C, Kahramanian MI, et al. Acculturation and Latino health in the United States: a review of the literature and its sociopolitical context. *Annu Rev Public Health* 2005;26:367–97.
- 36 Gomez SL, Kelsey JL, Glaser SL, et al. Immigration and acculturation in relation to health and health-related risk factors among specific Asian subgroups in a health maintenance organization. *Am J Public Health* 2004;94:1977–84.
- 37 Abraido-Lanza AF, Chao MT, Florez KR. Do healthy behaviors decline with greater acculturation? Implications for the Latino mortality paradox. *Soc Sci Med* 2005;61:1243–55.
- 38 Hosper K, Nierkens V, Nicolaou M, Stronks K. Behavioural risk factors in two generations of non-Western migrants: do trends converge towards the host population? *Eur J Epidemiol* 2007;22:163–72.
- 39 U.S. Department of Health and Human Services. *Physical Activity and Health: A Report of the Surgeon General*. Atlanta, GA: U.S. Department of Health and Human Services, centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, 1996.
- 40 Lay C, Verkuyten M. Ethnic identity and its relation to personal self-esteem: a comparison of Canadian-born and foreign-born Chinese adolescents. *J Soc Psychol* 1999;139:288–99.
- 41 Clement R, Singh SS, Gaudet S. Identity and adaptation among minority indo-Guyanese: influence of generational status, gender, reference group and situation. *Group Process Intergroup Relat* 2006;9:289–304.
- 42 Marin G, Marin BV. *Research with Hispanics*. Newbury Park, CA: Sage, 1991.
- 43 Schwartz SJ, Pantin H, Sullivan S, et al. Nativity and years in the receiving culture as markers of acculturation in ethnic enclaves. *J Cross Cult Psychol* 2006;37:345–53.
- 44 Khat M, Sermet C, Laurier D. Morbidity in households of North African origin, based on the INSEE health survey, 1991–1992. *Population* 1998;53:1155–84.
- 45 Bouchardy C, Parkin DM, Wanner P, Khat M. Cancer mortality among north African migrants in France. *Int J Epidemiol* 1996;25:5–13.
- 46 Courbage Y, Khat M. Mortality and causes of death of Moroccans in France, 1979–91. *Population* 1996;8:59–94.
- 47 Young CM. Migration and mortality: the experience of birthplace groups in Australia. *Int Migr Rev* 1987;21:531–54.
- 48 Uitenbroek DG, Verhoeff AP. Life expectancy and mortality differences between migrant groups living in Amsterdam, The Netherlands. *Soc Sci Med* 2002;54:1379–88.
- 49 Méjean C, Traissac P, Eymard-Duvernay S, et al. Diet quality of North African migrants in France partly explains their lower prevalence of diet-related chronic conditions relative to their native French peers. *J Nutr* 2007;137:2106–13.
- 50 Razum O, Zeeb H, Akgun HS, Yilmaz S. Low overall mortality of Turkish residents in Germany persists and extends into a second generation: merely a healthy migrant effect? *Trop Med Int Health* 1998;3:297–303.
- 51 Khat M, Darmon N. Is there a Mediterranean migrants mortality paradox in Europe? *Int J Epidemiol* 2003;32:1115–18.
- 52 Galal OM. The nutrition transition in Egypt: obesity, undernutrition and the food consumption context. *Public Health Nutr* 2002;5:141–8.
- 53 El-Zanaty F, Way A. Egypt Demographic and Health Survey 2000. Calverton, Maryland [USA]: Ministry of Health and Population [Egypt], National Population Council and ORC Macro, 2001.
- 54 Mehio Sibai A, Nasreddine L, Mokdad AH, et al. Nutrition transition and cardiovascular disease risk factors in Middle East and North Africa countries: reviewing the evidence. *Ann Nutr Metab* 2010;57:193–203.
- 55 El-Zanaty F, Way A. Egypt Demographic and Health Survey 2005. Cairo, Egypt: Ministry of Health and Population, National Population Council, El-Zanaty and Associates, and ORC Macro, 2006. Available at: <http://www.measuredhs.com>.
- 56 Atinmo T, Mirmiran P, Oyewole OE, et al. Breaking the poverty/malnutrition cycle in Africa and the Middle East. *Nutr Rev* 2009;67(Suppl 1):S40–6.
- 57 El-Zanaty F, Way A. Egypt Demographic and Health Survey 2008. Cairo, Egypt: Ministry of Health, El-Zanaty and Associates, and Macro International, 2009. Available at: <http://www.measuredhs.com>.
- 58 Egypt STEPS Survey 2011–12. WHO STEPS chronic disease risk factor surveillance. Available at: http://www.who.int/chp/steps/2011-2012_Egypt_FactSheet.pdf.
- 59 Tazi MA, Abir-Khalil S, Chaouki N, et al. Prevalence of the main cardiovascular risk factors in Morocco: results of a National Survey, 2000. *J Hypertens* 2003;21:897–903.
- 60 Aboussaleh Y, Farsi M, El Hioui M, Ahami AOT. Transition nutritionnelle au Maroc: coexistence de l'anémie et de l'obésité chez les femmes au Nord Ouest Marocain. *Anthropo* 2009;19:67–74.
- 61 Kamoun M, Hajem S, Imen S, et al. Prevalence of obesity and overweight in Tunisia on 2001. *Tunis Med* 2008;86:649–52.
- 62 El Ati J, Traissac P, Delpeuch F, et al. Gender obesity inequities are huge but differ greatly according to environment and socio-economics in a North African setting: a national cross-sectional study in Tunisia. *PLoS One* 2012;7:e48153. doi: 10.1371/journal.pone.0048153.
- 63 Latifa BH, Kaouel M. Cardiovascular risk factors in Tlemcen (Algeria). *Sante* 2007;17:153–8.
- 64 Elmehdawi RR, Albarsha AM. Obesity in Libya: a review. *Libyan J Med* 2012;7.
- 65 Grijalva-Eternod CS, Wells JC, Cortina-Borja M, et al. The double burden of obesity and malnutrition in a protracted emergency setting: a cross-sectional study of Western Sahara refugees. *PLoS Med* 2012;9:10.
- 66 Rguibi M, Belahsen R. Prevalence of obesity in Morocco. *Obes Rev* 2007;8:11–3.
- 67 Mohamed R, Rekia B. Prevalence of obesity in Morocco. *Obes Rev* 2007;8:11–13.

- 68 El Rhazi K, Nejari C, Zidouh A, et al. Prevalence of obesity and associated sociodemographic and lifestyle factors in Morocco. *Public Health Nutr* 2010;14:160–7.
- 69 World Health Organization: STEPwise surveillance. Non-communicable diseases risk factors. STEPwise data from selected countries in the Eastern Mediterranean Region, 2003–2007. Available at: http://www.emro.who.int/ncd/risk_factors.htm#physical.
- 70 Yahia-Berrouguet A, Benyoucef M, Meguenni K, Brouri M. Prevalence of cardiovascular risk factors: a survey at Tlemcen (Algeria). *Med Mal Metab* 2009;3:313–19.
- 71 Méjean C, Traissac P, Eymard-Duvernay S, et al. Influence of socio-economic and lifestyle factors on overweight and nutrition-related diseases among Tunisian migrants versus non-migrant Tunisians and French. *BMC Public Health* 2007;7:265.
- 72 Gautret P, Bauge M, Simon F, et al. Overweight and obesity in French Hajj pilgrims. *J Immigr Minor Health* 2013;15:215–18.
- 73 Gualdi-Russo E, Zironi A, Dallari GV, Toselli S. Migration and health in Italy: a multiethnic adult sample. *J Travel Med* 2009;16:88–95.
- 74 Reijneveld SA. Reported health, lifestyles, and use of health care of first generation immigrants in The Netherlands: do socioeconomic factors explain their adverse position? *J Epidemiol Community Health* 1998;52:298–304.
- 75 Dijkshoorn H, Nierkens V, Nicolaou M. Risk groups for overweight and obesity among Turkish and Moroccan migrants in The Netherlands. *Public Health* 2008;122:625–30.
- 76 Cornelisse-Vermaat JR, van den Brink HM. Ethnic differences in lifestyle and overweight in the Netherlands. *Obesity (Silver Spring)* 2007;15:483–93.
- 77 Nicolaou M, Doak C, Dam RV, et al. Body size preference and body weight perception among two migrant groups of non-Western origin. *Public Health Nutr* 2008;11:1332–41.
- 78 Ujic-Voortman JK, Baan CA, Seidell JC, Verhoeff AP. Obesity and cardiovascular disease risk among Turkish and Moroccan migrant groups in Europe: a systematic review. *Obes Rev* 2012;13:2–16.
- 79 Guil Sánchez J, Rodríguez-Martín M. Prevalencia de los factores de riesgo cardiovascular en inmigrantes magrebíes de un área semiurbana de Barcelona. *Semergen* 2013;39:139–45.
- 80 Kanter R, Caballero B. Global gender disparities in obesity: a review. *Adv Nutr* 2012;3:491–8.
- 81 Musaiger A. Overweight and obesity in eastern Mediterranean region: prevalence and possible causes. *J Obes* 2011;407237. doi: 10.1155/2011/407237.
- 82 Abubakari AR, Bhopal RS. Systematic review on the prevalence of diabetes, overweight/obesity and physical inactivity in Ghanaians and Nigerians. *Public Health* 2008;122:173–82.
- 83 Popkin BM, Adair LS, Ng SW. Global nutrition transition and the pandemic of obesity in developing countries. *Nutr Rev* 2012;70:3–21.
- 84 Gerbens-Leenes PW, Nonhebel S, Krol M. Food consumption patterns and economic growth. Increasing affluence and the use of natural resources. *Appetite* 2010;55:597–608.
- 85 Knopp RH, Paramsothy P, Retzlaff BM, et al. Gender differences in lipoprotein metabolism and dietary response: basis in hormonal differences and implications for cardiovascular disease. *Curr Atheroscler Rep* 2005;7:472–9.
- 86 Toselli S, Galletti L, Pazzaglia S, Gualdi-Russo E. Two-stage study (1990–2002) of North African immigrants in Italy. *Homo* 2008;59:439–52.
- 87 Van der Meulen R, Beoefening. Rapportage Sport 2003. In: Breedveld K, et al., editors. *Sociaal en Cultureel Planbureau*. Den Haag: The Netherlands, 2003: 79–97.
- 88 Bell AC, Ge K, Popkin BM. The road to obesity or the path to prevention: motorized transportation and obesity in China. *Obes Res* 2002;10:277–83.
- 89 Monda KL, Adair LS, Zhai F, Popkin BM. Longitudinal relationships between occupational and domestic physical activity patterns and body weight in China. *Eur J Clin Nutr* 2008;62:1318–25.
- 90 Sodjinou R, Agueh V, Fayomi B, Delisle H. Obesity and cardio-metabolic risk factors in urban adults of Benin: relationship with socio-economic status, urbanisation, and lifestyle patterns. *BMC Public Health* 2008;8:84.
- 91 Pasquet P, Temgoua LS, Melaman-Sego F, et al. Prevalence of overweight and obesity for urban adults in Cameroon. *Ann Hum Biol* 2003;30:551–62.
- 92 Van der Sande MAB, Ceesay SM, Milligan PJM, et al. Obesity and undernutrition and cardiovascular risk factors in rural and urban Gambian communities. *Am J Public Health* 2001;91:1641–4.