Diet Quality of North African Migrants in France Partly Explains Their Lower Prevalence of Diet-Related Chronic Conditions Relative to Their Native French Peers

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Abstract

Mediterranean migrant men living in France have lower mortality and morbidity than local-born populations for nutrition-related noncommunicable diseases (NR-NCD). We studied diet quality and its influence on NR-NCD in Tunisian migrants compared with 2 nonmigrant male groups: local-born French and nonmigrant Tunisians, using a retrospective cohort study. We performed quota sampling (n = 147) based on age and place of residence. Using logistic regression models, components of the Diet Quality Index-International (DQI-I) were tested as potential mediators for the effect of migration on overweight, hypertension, hypercholesterolemia, type-2 diabetes, and cardiovascular diseases (CVD). The total DQI-I score revealed good overall diet quality (~60/100) for all groups. Migrants scored higher than the French in variety, adequacy, and moderation and lower than Tunisians in overall balance. Migrants displayed a lower prevalence of overweight than French, lower prevalence of diabetes and CVD than Tunisians, and lower prevalence of hypertension and hypercholesterolemia than the 2 nonmigrant groups. No mediator was found for overweight. Diet adequacy, fruits, and vitamin C were mediators of the difference in hypercholesterolemia between migrants and French and the effect on hypertension was mediated by diet adequacy and fiber. Compared with Tunisians, the effect of migration on hypercholesterolemia was mediated by saturated fat. No mediator was found for hypertension, diabetes, or CVD. Despite increasing NR-NCD levels in both France and Tunisia, migrants appear to have conserved some healthy dietary characteristics that partly explain their difference in NR-NCD with local-born French, but other lifestyle factors may contribute to the favorable effect of migration. J. Nutr. 137: 2106–2113, 2007.

Introduction

Migrant health studies are becoming a research domain of growing interest. In addition to their importance for public health, they also help formulate hypotheses on the role of environmental vs. biological determinants of chronic diseases (1,2). The process of immigration is likely to influence health status with respect to chronic diseases. Several studies have shown that immigrants rapidly adopt the chronic disease patterns of their new host country (2). In most host countries, migrants have higher rates of mortality and morbidity linked to nutrition-related noncommunicable diseases (NR-NCD) than the native population (3,4) and also higher than the population of their home country (5–7). However, Mediterranean migrant men living in France appear to be in better health (8) and to have a lower mortality rate (9,10) than local-born populations, especially for NR-NCD. This is consistent with results of studies among similar groups of Mediterranean migrants in other countries (4,11–13). The origin of this so-called Mediterranean migrant paradox (14) may be linked to a healthier lifestyle; e.g. Mediterranean migrants could have a healthier traditional diet than the local-born population. Nevertheless, the causes of this paradox are still not well documented.

The present study focuses on Tunisian migrant men living in Languedoc-Roussillon, a French Mediterranean region that is historically a region of immigration. Tunisia, like other southern
Mediterranean countries, is currently undergoing a rapid nutritional transition in the context of economic development (15), with a prevalence of obesity that has increased almost 2-fold in 7 y (16). Along with other lifestyle changes, the nutrition transition is characterized by a shift in the structure of the diet with increased intake of fat, refined carbohydrates, and animal food products along with decreased total intake of cereals and fiber (17). As a result of these changes, in the countries concerned, there has been a dramatic shift in causes of death with increasing prevalence of NR-NCD, particularly type-2 diabetes, cardiovascular diseases (CVD), hypertension, stroke, and certain forms of cancer (17).

The overall purpose of this study was to describe the diet structure of Tunisian migrants living in the south of France compared with 2 nonmigrant groups, local-born French living in the same environment and nonmigrant Tunisians, and to analyze its effect on NR-NCD to assess whether differences in diet quality could explain their differential health status.

Methods

Design and sampling
A retrospective cohort study compared Tunisian migrant men age ≥ 18 y ("migrants") and 2 nonmigrant male groups: French individuals born in France ("French") and Tunisians living in Tunisia ("Tunisians"). Exposed subjects (migrants) were defined as individuals who were natives of Tunisia and who had been residing in the south of France (Languedoc-Roussillon region) for more than 1 y at the time of the survey.

As French law does not allow access to nominative files with ethnic status, random sampling was not possible. Thus, using the French National Institute of Statistics database, we performed quota sampling based on age and place of residence. Frequency matching was used to select the nonexposed subjects. The local-born French group was matched for age and socio-professional category. The nonmigrant Tunisian group was matched for age and geographical origin. The sample size (n = 150) of each group was calculated to enable detection of an OR of 0.3 for migrants vs. nonmigrant subjects (migrants) were defined as individuals who were natives of Tunisia and who had been residing in the south of France (Languedoc-Roussillon region) for more than 1 y at the time of the survey.

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Data collection
Data were collected in 2004–2005 in France and Tunisia by interviewers who were bilingual in French and Arabic. We trained and standardized interviewers for anthropometric, blood pressure, and food consumption measurements.

Health assessment. Blood pressure was measured twice using an automatic sphygmomanometer (Omron M5-I) validated by the French Health Security Agency. Hypertension was defined using WHO/International Society of Hypertension cut-offs (18); systolic pressure ≥ 140 mm Hg and/or diastolic pressure ≥ 90 mm Hg. The group of hypertensive individuals also included people who declared they were receiving antihypertensive treatment.

All anthropometric measurements (standing height, weight, and waist circumference) were measured twice according to standard procedures (19). Overweight was defined according to the WHO classification as BMI ≥ 25 kg/m² (20). Central obesity was defined according to WHO cut-offs limits as waist circumference ≥ 94 cm (21).

Status with respect to NR-NCD (type-2 diabetes, CVD, and hypercholesterolemia) was evaluated from participants’ answers to questions about specific health items in the questionnaire.

Assessment of dietary intake and diet quality index. To assess usual dietary intake during the past month, a validated quantitative FFQ (22) was adapted to Tunisian habits.

After creation of a food composition table from a database compiled from the USDA food composition database (23) and the French food composition table (24), which was relevant for both France and Tunisia, dietary intake data were converted into nutrient data using ESHA Food Processor software (version 8.3; ESHA Research).

As there is no internationally acknowledged recommendation for the classification of food groups, we defined 11 food groups: cereals, vegetables, fruits, nuts/beans, fats, sugar, milk products, meat, fish, eggs, and others (coffee, tea, and condiments). The percentage contributions of these 11 food groups to total energy intake were calculated from the mean daily intake (grams) of each food group.

To evaluate the quality of diet, we used the Diet Quality Index—International (DQI-I) based on the methods of Kim et al. (25). The DQI-I score focuses on 4 major aspects of a healthy diet: variety, adequacy, moderation, and overall balance. In each of the 4 categories, there were specific components of diet to be assessed (Fig. 1). The high-energy low-nutrient-dense (HE-LND) foods subcomponent assessed how much a person’s energy supply depends on low nutrient density foods, which provide only energy but insufficient nutrients. Scores for each component were summarized in each of the 4 main categories and the scores for all 4 categories were summed, resulting in the total DQI-I score, ranging from 0 to 100 (0 being the lowest and 100 the highest level of diet quality). Global and components scores were also coded in terciles for analytical purposes. For all components of the score, we followed the guidelines given in Kim et al. (25) except for the level of intake that defines the highest score for adequacy of iron, calcium, and vitamin C, which was derived from the recommended food intakes for the French population (26).

Statistical analysis
Values in the text are means ± SD. Percentage contributions of food groups to total energy and mean DQI-I scores were compared according to migration status using univariate linear regression models accounting for frequency matching. If exposed or nonexposed data on key variables was missing, the whole pair was deleted.

The hypothesized relations between exposure (i.e. migration status), outcome variables, and explanatory factors were tested using the analysis framework presented in Figure 1; migration could protect from overweight and NR-NCD through factors that are not considered in this study, or through dietary factors, which are the main focus of this study. The strength of association between migration status and overweight or

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morbidty was assessed by the OR estimated in univariate conditional regression models. Only the outcome variables for which association with migration status was significant were retained. Finally, the potential mediators of the effect of migration on these outcome variables were tested one-by-one, using conditional logistic regression models (27). First, the total DQI-I score was tested, then categories of DQI-I (variety, adequacy, moderation, and overall balance), and finally, the components of each category (Fig. 1). Each model was adjusted for energy intake (in terciles), because some nutrients, such as total fat, are thought to act via their contribution to energy production.

To assess to what extent migration status effect on NR-NCD was mediated by components of diet quality, we compared the association (OR) between the migration status and the outcome variable estimated with and without control of each potential mediator. The magnitude of the mediating effect was estimated by the degree of discrepancy between the 2 estimates as measured by the mediating effect ratio (MER), defined as:

\[
\text{MER} = \frac{\text{OR model with only migration status} - \text{OR model with potential mediator}}{\text{OR model with potential mediator} - \text{OR model with potential mediator}}
\]

We applied a quantitative criterion to see whether dietary variables had a mediating effect. To do so, we chose a rather severe reduction threshold (∼20%) that constitutes an important change in the estimate.

The first type error rate was set at 0.05. Data entry and quality checks were performed using Epidata (version 3.1; Epidata Association) and data management and statistical analyses were performed using SAS (version 9.1; SAS Institute). The LOGISTIC procedure with the Strata data management and statistical analyses were performed using Epidata (version 3.1; Epidata Association) and data management and statistical analyses were performed using SAS (version 9.1; SAS Institute).

### Results

Three of the migrants surveyed subsequently withdrew their consent and 2 migrants surveyed did not answer the FFQ, so subjects for whom values were missing were excluded, leaving 145 exposed (migrants) and 145 matched nonexposed populations (145 French and 145 Tunisians) for the final analysis.

#### Socioeconomic characteristics

The age of the migrants was 50.2 ± 13.2 y; due to the matching procedure, this did not differ from the French (49.8 ± 13.9 y; P = 0.80) or Tunisian subjects (52.3 ± 16.3 y; P = 0.21). The migrants’ length of residence in France was 22.0 ± 12.0 y (range: 1–57 y) and the interquartile range was 13–31 y. The migrants had a lower level of education (20% of migrants attended university) than the French (25.2% attended university; P = 0.0001) and a lower economic level, assessed by a summary economic index (29) (P = 0.0001). The level of education did not differ between migrants and Tunisians (P = 0.07), but the migrants had a higher economic level (P = 0.0001).

#### Dietary characteristics

The mean total energy intake of the migrant population was 15,019 ± 6445 kJ/d. Migrants and their nonmigrant peers did not differ; local-born French had a mean total energy intake of 13,949 ± 4330 kJ/d (P = 0.09) and nonmigrant Tunisians had 16,076 ± 6082 kJ/d (P = 0.13).

With respect to energy intake, migrants consumed significantly higher percentages of vegetables, fruits, and nuts/beans and significantly lower percentages of sugar, dairy products, and meat than local-born French (Fig. 2). Compared with Tunisians, migrants consumed significantly higher percentages of fruits, dairy products, and meat and significantly lower percentages of vegetables, sugar, fish, and eggs (Fig. 2).

In all groups, the mean percentage contributions of protein and fat were higher than the recommended values and carbohydrates contributed <55% of total energy (Table 1). Migrants had a significantly higher mean percentage contribution of fat than French and a significantly lower mean for carbohydrates than their Tunisians peers.

Fiber intake was higher than 30 g among migrants and in the Tunisian group and significantly lower among the French (Table 1). More than 7% saturated fat was consumed in all groups; migrants had a significantly lower mean than French but a higher mean than Tunisians. All groups were above the recommended value for sodium intake and cholesterol intake, but migrants and Tunisians had a considerably lower sodium intake than the French group.

#### Dietary quality

The total DQI-I score in the 3 groups was between 57.8 ± 6.6 and 64.4 ± 6.8 points out of a maximum possible diet quality score of 100 points (Fig. 3) (Supplemental Table 1). The score was higher for migrants than for French and migrants and Tunisians did not differ (P = 0.08) (Fig. 3). For all

### TABLE 1

<table>
<thead>
<tr>
<th>Nutrients</th>
<th>Recommended values</th>
<th>Tunisian migrants, n = 145</th>
<th>Local-born French, n = 145</th>
<th>Tunisians, n = 145</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protein</td>
<td>≥10%</td>
<td>15.2 ± 2.7</td>
<td>15.5 ± 2.9</td>
<td>14.8 ± 2.9</td>
</tr>
<tr>
<td>Fat</td>
<td>15–25%</td>
<td>37.4 ± 6.4</td>
<td>36.6 ± 7.5*</td>
<td>35.9 ± 7.2</td>
</tr>
<tr>
<td>Carbohydrate</td>
<td>55–65%</td>
<td>47.3 ± 6.4</td>
<td>48.9 ± 7.9</td>
<td>49.3 ± 7.3*</td>
</tr>
<tr>
<td>Saturated fat</td>
<td>≤7%</td>
<td>11.1 ± 2.8</td>
<td>14.1 ± 5.8*</td>
<td>8.6 ± 2.2*</td>
</tr>
<tr>
<td>Sodium</td>
<td>≤2.4 g</td>
<td>3.3 ± 1.6</td>
<td>4.2 ± 1.5*</td>
<td>3.6 ± 1.9</td>
</tr>
<tr>
<td>Cholesterol</td>
<td>≤0.3 g</td>
<td>0.5 ± 0.3</td>
<td>0.4 ± 0.2</td>
<td>0.4 ± 0.3</td>
</tr>
</tbody>
</table>

1 Values are means ± SD. Frequency matching was taken into account. *Different from migrants, P < 0.05.
2 Recommendations used for DQI-I construction.

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Fig. 2 Percentage contributions of food groups to total energy in Tunisian migrants vs. local-born French and Tunisians. Values are means and error bars indicate SE; n = 145 in each group. The analysis took frequency matching into account. *Different from migrants, P < 0.05.
scores apart from saturated fat, which was significantly lower, and HE-LND foods, which was significantly higher among migrants. In the overall balance category, the migrants’ scores were significantly lower than those of French and Tunisians for the macronutrient ratio (Supplemental Table 1). Again, the fatty acid ratio score was significantly greater in Tunisians than in migrants, but these scores were very low in all 3 groups.

**Effect of migration and mediating factors on overweight and NR-NCD.** Previous analyses showed differences in the health status between migrants and their nonmigrant counterparts. Migrants displayed a lower prevalence of overweight (46.9%), hypertension (8.3%), and reported hypercholesterolemia (2.8%) than local-born French (63.5%; \( P = 0.005 \); 51.7%; \( P < 0.0001 \); and 18.6%; \( P < 0.0001 \), respectively), but central obesity (\( P = 0.81 \)), declared diabetes (\( P = 0.26 \)), or reported CVD did not differ (\( P = 0.18 \)). After taking into account all potential dietary mediators of the effect of migration on overweight, the migration status OR (OR = 0.53 [0.33–0.84]) was almost unchanged, indicating that no straightforward mediating effect was found. The favorable effect of migration status on hypertension appears to be partly mediated through the adequacy category (Table 2), with a small decrease in the association between migration status and hypertension. In the adequacy category, the fiber subcomponent also appeared to be an intermediate variable of the effect of migration status on hypertension. The favorable association between migration status and hypercholesterolemia decreased slightly (MER = −22%) when the adequacy score was introduced. This association between migration status and hypercholesterolemia also appeared to be partly mediated through subcomponents (fruits and Vitamin C scores) of the adequacy score (Table 2).

When migrants were compared with Tunisians, the migrants presented less hypertension (8.3 vs. 43.4%; \( P < 0.0001 \)), hypercholesterolemia (2.8 vs. 11.7%; \( P = 0.005 \)), diabetes (3.4 vs. 15.9%; \( P = 0.001 \), and CVD (3.4 vs. 9.0%; \( P = 0.04 \)). Migrants were marginally less overweight (46.9%) than Tunisians (57.9%; \( P = 0.05 \). Central obesity did not differ (\( P = 0.71 \)) in each group, 51.7%; \( P = 0.26 \), the migrants did not differ (\( P = 0.18 \)). After taking into account all potential dietary mediators of the effect of migration on overweight, the migration status OR (OR = 0.53 [0.33–0.84]) was almost unchanged, indicating that no straightforward mediating effect was found. The favorable effect of migration status on hypertension appears to be partly mediated through the adequacy category (Table 2), with a small decrease in the association between migration status and hypertension. In the adequacy category, the fiber subcomponent also appeared to be an intermediate variable of the effect of migration status on hypertension. The favorable association between migration status and hypercholesterolemia decreased slightly (MER = −22%) when the adequacy score was introduced. This association between migration status and hypercholesterolemia also appeared to be partly mediated through subcomponents (fruits and Vitamin C scores) of the adequacy score (Table 2).

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mediating effect was found (results not shown). Our results (Table 3) showed a favorable association between migration status and hypercholesterolemia, which seems to be partly mediated through the saturated fat score, with decreased association between migration status and hypercholesterolemia.

**Discussion**

Our objective was to explore the hypothesis of Darmon and Khlat (30) that the diet of Mediterranean migrants may protect them from chronic diseases compared with local-born French. In addition, we investigated the influence of the diet on the difference in NR-NCD between migrants and nonmigrant Tunisians.

This study provides some evidence that Tunisian immigrants presently residing in the south of France enjoy better health than their French counterparts, which would be consistent with the existence of a Mediterranean migrant paradox in France (8–10). Results of the comparison between migrants and nonmigrant Tunisians not only showed that migrants were less affected by NR-NCD than Tunisians, but they also were in concordance with rather high levels of obesity and NR-NCD in Tunisia, which is a growing public health problem (31,32).

In addition to comparing the diet quality between groups, our results showed that some components of diet quality can partly explain the health advantages of migrants. The total DQI-I score of migrants, reflecting overall diet quality, lies between that of French and that of Tunisians. However, there were few differences between the groups. Not surprisingly, the 3 groups, all natives of the Mediterranean basin, seem to share certain dietary characteristics. Their total DQI-I scores reached ~60 points, revealing good overall quality according to Kim’s criterion (25), and are similar to scores observed in the USA and China. Despite comparable overall diet quality, the investigation into the 4 main categories of the DQI-I revealed differences between migrants and local-born French but also marked similarities between migrants and Tunisians.

Compared with French, migrants had a greater diet variety, probably resulting from a higher consumption of nuts/beans. Diet adequacy of migrants reflects better compliance with prevailing recommendations to ensure a healthy diet than their French peers. A previous French national survey showed that North African migrants in France consumed more vegetables than local-born French but similar quantities of fruit (33). So these characteristics of adequacy have thus been conserved and even intensified. Even if the mediating effect of the adequacy score was not outstanding, it can be assumed that the conservation of a healthier diet through better diet adequacy was sufficient to provide some protection from hypertension and hypercholesterolemia in migrants. Indeed, reductions in blood pressure and total serum cholesterol or LDL cholesterol have been found with increased intakes of components of diet adequacy, such as fiber (34,35) and vitamin C (36), and also fruits and vegetables (37–39). The higher fiber intake of migrants, above the recommended range, had a direct mediating effect for the difference between migrants and French with respect to hypertension. As a matter of fact, an inverse relationship between dietary fiber intake and blood pressure (34,40) or the development of hypertension (41) was identified. Our findings for migrants also suggest that their higher intake of vitamin C, and particularly of fresh fruits as sources of vitamin C, could partly protect them from the onset of hypercholesterolemia compared with local-born French. We cannot straightforwardly explain the direct effect of the fruit intake score on hypercholesterolemia, because, to our knowledge, no study has been made on the effect of fruit intake alone on serum lipids. However, fruit and vegetable consumption was shown to decrease the total and/or LDL cholesterol level in most available studies (38,42), although not in all (43). Vitamin C has a possible beneficial effect on

<table>
<thead>
<tr>
<th>TABLE 2</th>
<th>Effect of migration status vs. local-born French and of dietary factors for hypercholesterolemia and hypertension(^1,2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variables in models</td>
<td>OR(^4)</td>
</tr>
<tr>
<td>-----------------</td>
<td>-----------------</td>
</tr>
<tr>
<td>Hypercholesterolemia</td>
<td></td>
</tr>
<tr>
<td>Migration status</td>
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</tr>
<tr>
<td>Migration status, diet adequacy</td>
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</tr>
<tr>
<td>Migration status, fruits</td>
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</tr>
<tr>
<td>Migration status, vitamin C</td>
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</tr>
<tr>
<td>Hypertension</td>
<td></td>
</tr>
<tr>
<td>Migration status</td>
<td>0.06</td>
</tr>
<tr>
<td>Migration status, diet adequacy</td>
<td>0.07</td>
</tr>
<tr>
<td>Migration status, fiber</td>
<td>0.07</td>
</tr>
</tbody>
</table>

\(^1\) Frequency matching was taken into account; \(n = 145\) /group.

\(^2\) The numbers of subjects who had hypercholesterolemia and hypertension were, respectively, 4 and 12 in migrants and 27 and 75 in local-born French.

\(^3\) Adjusted for energy intake.

\(^4\) OR rounded to second decimal place for display; MER are computed on precise OR values.

<table>
<thead>
<tr>
<th>TABLE 3</th>
<th>Effect of migration status vs. Tunisians and of dietary factors for hypercholesterolemia(^1,2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variables in models</td>
<td>Adjusted migration status effect(^3)</td>
</tr>
<tr>
<td>-----------------</td>
<td>-----------------</td>
</tr>
<tr>
<td>Hypercholesterolemia</td>
<td></td>
</tr>
<tr>
<td>Migration status</td>
<td>0.17</td>
</tr>
<tr>
<td>Migration status, saturated fat</td>
<td>0.22</td>
</tr>
</tbody>
</table>

\(^1\) Frequency matching was taken into account; \(n = 145\) /group.

\(^2\) The numbers of subjects who had hypercholesterolemia were 4 among migrants, 17 among Tunisians.

\(^3\) Adjusted for energy intake.

\(^4\) OR rounded to second decimal place for display; MER are computed on precise OR values.
blood lipids. The association of vitamin C level and an improvement in blood lipids and the lipoprotein profile has been observed in several epidemiological studies (44,45), even though intervention trials failed to show any significant effect of vitamin C on blood lipids (46,47).

Migrants displayed greater moderation in intake of foods and nutrients that are related to chronic diseases than French, but the overall balance scores did not differ. The goal of overall balance in diet was poorly met in all groups. It seems that, for all groups, carbohydrates were replaced by fat compared with the “healthy diet” represented by the recommendations. The mean values of macronutrients were relatively similar to other Mediterranean countries such as Algeria or Greece (48). Even if the contribution of total fat to energy intake was higher, migrants had a lower saturated fat intake than the French, which is due to greater consumption of olive oil by migrants. The supply of olive oil in Tunisia is much higher than in France (49). The traditionally high consumption of olive oil increased total fat intake but resulted in a high monounsaturated fatty:saturated fat ratio and migrants apparently conserved this consumption behavior.

The diet variety, diet adequacy, and moderation scores of migrants were equivalent to that of Tunisians and consequently did not provide a satisfactory explanation for the health advantages of migrants. Moreover, migrants scored lower in overall balance. They consumed more saturated fats and less olive oil than their Tunisians peers and consequently had a lower saturated fat score. This may result from the onset of hypercholesterolemia rather than represent a protective effect on levels of blood lipids, i.e. a reverse causal relationship. Indeed, the percentage of individuals who fell within the recommended category for saturated fat consumption was 12% among normal persons and 38% among individuals with hypercholesterolemia; after diagnosis, these individuals may have been respecting the nutritional advice given by a general practitioner to limit their intake of saturated fat.

In all 3 groups, diet was characterized by high diet variety and high adequacy, which is a sign of the availability of a wide range of foods that followed the rapid economic development of Tunisia in the last 20 y. However, the diet of the 3 groups was also characterized by lack of moderation and unbalanced diet, which are important dietary risk factors of chronic diseases. The question that arises is whether these features will worsen or amplify the health advantages of migrants in the immediate future.

Results on the association of migration with overweight (migrants vs. local-born French) or hypertension, type-2 diabetes, and CVD (migrants vs. nonmigrant Tunisians) did not reveal any meaningful mediating effect, indicating that other mediating factors than dietary ones play an important role in these associations. For instance, type-2 diabetes is affected by other aspects, such as maternal diabetes (50). Likewise, blood pressure is influenced by gene-environment interactions (51) or stress (52). Socioeconomic status could have a potential effect on health advantages and also on diet quality of migrants, given that migrants enjoyed a better economic level than Tunisians. However, a specific analysis (results not shown) revealed that socioeconomic conditions did not explain the protective effect of migration status either on health outcomes or on the quality of the diet. Further work will be required to explore differences in other explanatory factors and their complicated interactions as well as their cumulative effects (53) to better understand the health advantages of Tunisian migrants in the south of France.

In addition, a selection bias is another possible explanation for the Tunisian migrant morbidity paradox. Indeed, Tunisian migrants (North African migrants) in France have undergone a considerable selection process. Darmon and Khlat (30) explained that migrants probably come from the healthier sections of the population of their country of origin, as they are subjected to positive selection, either via self-selection or a selection related to mandatory health controls on arrival in their new host country.

Our results should of course be interpreted taking into account the characteristics of the study. Concerning selection bias, the nonrandom nature of the sample may be an issue, but the quota sampling strategy was the only possible solution in migrant populations in France. Also, the data collected using FFQ is not as accurate as data gathered using precise recall methods, although the results are strictly comparable between groups. The use of DQI-I to assess the influence of diet quality on NR-NCD could be a further issue. The DQI-I has not yet been tested to evaluate the link between diet quality and the risk of chronic diseases, even if it focuses on chronic diseases (25). The difference in the length of residence of migrants could influence estimation of diet quality. However, given that most migrants in the sample had lived in France for a long time, recent migration did not much bias the assessment of the diet quality of the migrant group as a whole.

Despite the active nutrition transition in Tunisia, our findings are consistent with the existence of a Mediterranean migrant paradox in France (30). Our study demonstrated that a group of Tunisian migrants exhibited better diet quality than their French counterparts, whereas their diet profile was very similar to the diet profile of nonmigrant Tunisians. Thus, these migrants seem to have conserved some healthy diet characteristics. On the one hand, differences in some of these characteristics partially explain the relatively better health of Tunisian migrant men than of their French peers and our data provide a credible argument that cultural factors such as dietary patterns (better diet adequacy, higher consumption of fruits) influence the health of migrants compared with local-born populations. On the other hand, similarities in diet quality between migrants and nonmigrant Tunisians indicate that environmental dietary changes are not sufficient to explain differences in NR-NCD between migrants and nonmigrant Tunisians. Despite increasing levels of obesity and NR-NCD in France and Tunisia, the continuation of traditional dietary patterns favorable to health could protect migrants, but other lifestyle factors also appear to be involved in the origin of the paradox. Moreover, the diet of migrants was characterized by lack of moderation and an unbalanced diet and these features are important dietary risk factors that contribute to the onset of chronic diseases. It remains to be seen if this Tunisian migrant paradox will persist in the future. More comprehensive and larger-scale research concerning health and associated factors among migrants is needed. Investigations into ethnic health and associated life-styles contribute important knowledge about the prevention of morbidity and mortality in the worldwide context of increasing NR-NCD.

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