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Regular Users of Supermarkets in Greater Tunis Have a Slightly Improved Diet Quality[1–3]

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Abstract

Despite the recent and rapid expansion of supermarkets in developing countries, their association with diet quality has been hardly studied. The study took place in Tunisia, where incidences of obesity and nutrition-related diseases are rising. The target population was households of the Greater Tunis area where supermarkets are mostly located. Households ($n = 724$) were selected by a 2-stage clustered random sampling. A purposely developed quantitative questionnaire assessed food retail habits. Socioeconomic data were collected at individual and household levels. The diet quality index-international (DQI-I) derived from a FFQ specific for Tunisia measured diet quality. Data analysis by regression or logistic regression models adjusted for energy intake and socioeconomic confounders when relevant. Overall, 60% of the households used supermarkets. Most households still used the nearby grocer; only 26% shopped at the market. Characteristics associated with supermarket use were urban milieu, small-sized households, greater educational attainment, higher economic level, steady income, or easy access. Associations between these variables and using supermarkets as a first shopping place (20% of households) were even stronger. After adjustment for energy intake and socioeconomic and access data, using supermarkets chosen as first food shopping place vs. other retail resulted in a slightly higher DQI-I (63.2 vs. 59.6; $P = 0.0004$). Despite the long-standing presence of supermarkets in Tunis, shopping at supermarkets has not yet spread to the whole population. Supermarkets do not yet markedly modify food consumption in the Greater Tunis. However, a slight improvement of diet quality can be observed among those people who use supermarkets regularly. J. Nutr. 138: 768–774, 2008.

Introduction

There is a recent, but nonetheless rapid, rise of modern supermarkets in many developing countries, including low or middle income Mediterranean countries such as Morocco, Tunisia, and, most recently, Algeria (1,2). What has developed over 50 y in the United States or Europe took place suddenly during a single decade in some developing countries, leading to a real supermarket revolution starting in the late 1990s and early 2000s (3). This literature not only described the sudden spread of supermarkets but also predicted its continuation and acceleration.

The impact of supermarket diffusion on both food producers and suppliers has been well discussed (2,4–8), whereas hardly any research has been conducted to assess the effect on consumers, especially in developing countries. The few studies that have been conducted on the resulting effects of food retail transformation on consumers were more focused on retail access/use and the social patterning of dietary intake (9–12). Among them, only 1 study took place on the African continent, in Kenya (11), but did not investigate how these changes directly affected diet and health. Yet, in the context of rising prevalence of both obesity and noncommunicable nutrition-related diseases in these countries, the hypothesized relations between these food retail mutations and change in diet quality and thus nutritional status, whether detrimental or beneficial to health, have not yet been assessed.

Market globalization has an impact on the food supply system and thereby has double-edged repercussions on diet quality, having the potential to either improve or deteriorate it. On one hand, some studies conducted in the developed world have shown that a positive impact on diet was associated with significant shifts in access to supermarkets (13–15) and that, in some contexts, it can be an important determinant of fruit and vegetable consumption (16). On the other hand, because they can potentially facilitate the diffusion of manufactured foods with high content in fat, salt, and sugar and low nutritional intake, supermarkets are suspected to have a negative impact on diet, because these foods are part of a westernized food consumption pattern (17–19). However, there is no systematic evidence of this phenomenon in the literature. To date, only 1 study conducted in

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Guatemala showed that supermarket purchases had a negative impact on dietary patterns of households (20).

We therefore wanted to explore how supermarkets are associated with diet quality and, thus, potentially with health status, also taking into account socioeconomic characteristics. The study was conducted in Tunisia, a Northern African lower-middle income country that combines the rapid and recent increase of supermarkets as well as the rise of noncommunicable diseases (21,22). We aimed to quantify the use of supermarkets and socioeconomic profiles of their customers and assess association with diet quality.

Subjects and Methods

Context of supermarket mutations in Tunisia

Since the turn of the century, the greatest change in the Tunisian food retail landscape has been the introduction of hypermarkets. This change has led to an increased number of modern-style retail outlets, mostly in and around the capital city, which is the more developed and urbanized area in the country. Indeed, in addition to modernizing their inside layout and commercial methods, long-standing ancient supermarkets have been opening new outlets, nearly doubling their number of outlets for some of brand names (23). Currently, there are roughly 140 modern outlets, 2 of which are hypermarkets. The first one was established in Tunis in 2001 and the other, even bigger, opened at the end of 2005. Other planned large food retailer projects are currently awaiting local authorization to be implanted (23).

In this survey, a clear distinction was made between supermarkets and hypermarkets. The 2 types of self-service retail trade were defined according to their surface area, which, in Greater Tunis, is $<$10,000 m^2 for supermarkets and $\geq$10,000 m^2 for hypermarkets. As well as their greater commercial surface area, both hypermarkets in Greater Tunis differ from supermarkets in that they encompass a shopping mall with a wide range of shops, cafés, and cafeterias, and are doted with a car park. Moreover, contrary to supermarkets, which are spread throughout Greater Tunis, the hypermarkets are located in the periphery of the capital city. For the purpose of this article, supermarkets will refer to both types of food retailers together, whereas a distinction will be made between medium supermarkets (MSM)[7] and hypermarkets, which will be called large supermarkets (LSM).

Study area and sampling

Our study zone was the Greater Tunis area [2,250,800 inhabitants (24)]. Sampling was adapted from a random sample of households from the 2005 TAHINA survey (25), for which the sampling frame was based on the 2004 census by the Tunisian National Institute of Statistics.

That survey used a random, stratified, 2-level (census enumeration area and household), clustered national sample of households for which our study zone was 1 of the strata. In this study, for each household, we identified and interviewed the person mainly in charge of food purchasing. Data were collected in November and December of 2006 at the respondent's residence by thoroughly trained local nutritionists. The Tunisian National Statistical Council reviewed and approved this study (visa no. 11/2006) and all interviewees gave their free informed consent.

Data

Type of food retail outlets, use, and accessibility. From personal interviews ($n = 29$) and focus groups ($n = 4 \times 6$), a quantitative food supply questionnaire was developed, translated into Arabic, pretested, and validated in the target population. This questionnaire included items asking interviewees to recall and rank by order of priority the 3 outlets where they most frequently went for their main food shopping as well as items dealing with time and distance to the outlet.

For each type of outlet, binary variables (yes/no) were computed to code habitual use. From these variables, a 3-category variable of supermarket use was also computed: never used supermarkets, used MSM only (regardless of grocer and market but excluding LSM), and used LSM (regardless of MSM, grocer, or market). For each type of outlet, priority was coded in 3 categories as the outlet being the 1st, 2nd, or 3rd food purchase place/never used or in some analyses, in 2 categories: 1st food purchase place vs. others (i.e. 2nd food purchase place or never use MSM and/or LSM). For supermarkets, MSM and LSM, respectively, easy access (vs. not) was defined as being $<$5 km or $<$30 min from a retail outlet.

Food consumption and diet quality. Detailed food consumption was assessed using a validated 146-item quantitative FFQ adapted to the Tunisian context (26). We used the Tunisian food composition database (27) to convert dietary intake data into nutrient values using Food Processor software v 8.3 (28). Total energy intake (in kcal)[8] was coded in terciles for use in adjusted analyses. The internationally validated Diet Quality Index-International (DQI-I) was computed from nutrient data, because it is oriented toward the double burden of malnutrition and disease (29), which is an issue in Tunisia. The DQI-I score ranging from 0 to 100 (0 being the lowest and 100 the highest level of diet quality) is the sum of 4 categories of scores related to specific aspects of a healthy diet: variety (0–20), adequacy (0–40), moderation (0–30), and overall balance (0–10). DQI-I global and categories scores were used as quantitative variables. Based on a cut-off point defined by Kim et al. (29), a binary variable coding a "good quality diet" (DQI-I $\geq$6) was also used in some analyses. In addition, a 21-food-group classification was purposely defined to encompass some supermarkets' emblematic food products such as cheese, yoghurts, processed foods (including salami), biscuits, cakes, sweets, sodas, fruit, and vegetables. Other food groups of interest were other dairy products, potatoes, pulses, cereals, eggs, meat, poultry, fish, fats, olive oil, vegetable oil other than olive oil, and foods eaten outside home. Quantitative variables expressing consumption in grams per person per day of each food group were used in the analyses.

Socioeconomic data. Socioeconomic and demographic data were collected at both individual (sex, age, matrimonial status, educational attainment, and occupation) and household levels (urban vs. rural area, characteristics of the dwelling, utilities, appliances, vehicles, having a steady income, and possession of a credit card). To assess economic status of the household, correspondence analysis was performed on the matrix of indicator variables coding dwelling characteristics, utilities, and appliances. The score of each household on the first principal component was used as a summary index of relative household wealth (30) and used in analyses after breakdown into terciles of increasing economic level (low, medium, and high). By construction, households were evenly split between the 3 categories of the economic index. This index was preferred to self-declared income, which was also collected but deemed less reliable and also for which the proportion of missing data was higher.

Data management and analyses. Double data entry was performed with EpiData software v 3.1 (31) associated with standard quality checks procedure. Data management, including computation of DQI-I, was performed with SAS system v. 9.1 (32) and Stata software v. 9.2 (33).

Beyond descriptive analyses of socioeconomic and use of supermarket data, the analyses were performed along 2 main lines. With the first type of models, we studied relationships between use of MSM and/or LSM (response variable) and socioeconomic variables. Binary or multinomial logistic regression models (generalized logit) were performed depending on the type of response variable studied (i.e. binary or in 3 categories). A 2nd set of analyses modeled diet quality variables as a function of supermarket use variables, energy intake, and socioeconomic factors. We used linear regression models for DQI-I, variety, adequacy, moderation, and overall balance quantitative scores response variables and binary logistic regression for a "good quality" diet. Thus, the strength of (crude or adjusted when relevant) associations with response variables was assessed by OR for binary response variables, relative risk ratio (RRR) for multinomial response variables, and suitable contrasts between means for continuous response variables. All analyses accounted for characteristics

[7] Abbreviations used: DQI-I, diet quality index-international; LSM, large supermarket; MSM, medium supermarket; RRR, relative risk ratio.

[8] 1 kcal = 4.184 kJ.

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of the sampling design (34) (clustering, sampling weights including also a poststratification on sex, age, and urban vs. rural living environment) using the relevant *svy* commands of the Stata software v. 9.2 (33). Results are given as means or proportion ± design-based standard error. When relevant, design-based (in brackets) of the estimates for parameters of interest are presented. The first type error rate was set at 0.05 for all analyses.

Results

Socioeconomic data

From the 753 households initially selected, 724 were actually surveyed (**Table 1**). The household size was 4.7 ± 0.1 and the number of children per household was 2.5 ± 0.8. A credit card was available for a minority of households. Whereas most of the households (96.5% ± 0.8) owned a refrigerator, only one-third was in possession of a freezer (35.9% ± 4.2) or a car (34.4% ± 4.1). The age of the respondents was 46.2 ± 0.62 y. They were predominantly nonworking females. Whereas over 20% of the persons in charge of food shopping were illiterate, one-third had a primary educational level and less than one-half reached secondary or higher educational attainment.

Use of supermarkets

Type of food retail outlets, use, and accessibility. When investigating use by type and priority order of retail outlets by persons in charge of the main food shopping, 58.8% [51.0–68.0] of the households used supermarkets, i.e. shopped at MSM and/or LSM. One-half of them shopped at MSM and just over one-quarter shopped at LSM (**Table 2**). A total of 32.2% [26.3–38.1] used MSM only, whereas only 17.9% [11.0–24.7] used LSM exclusively. Most persons used the local grocer, whereas only one-quarter shopped at the open-air market.

When looking at use according to hierarchical choice (i.e. 1st, 2nd, or 3rd food purchase place) for MSM and/or LSM, in total, supermarkets ranked 1st for 20.4% [12.8–28.0] and 2nd or 3rd for 39.1% [32.6–45.6] of the households (Table 2).

Whereas very few people (15.7% [9.4–22.0]) declared shopping at the MSM as their 1st place, only twice as many (34.9% [29.2–40.7]) used it as a 2nd or 3rd place. Only 4.7% [2.3–7.1] of the households used LSM as the 1st place and 22.5% [16.8–28.3] as the 2nd place. The grocer ranked 1st food shopping place for three-quarters of the households, whereas only 18.9% [13.7–24.3] used it in 2nd or 3rd position. The open-air market is a 2nd shopping place for most of the households using it, because only 3.9% [1.6–6.2] used it as a 1st shopping place. Whereas access to MSM was easy for 74.1% [65.8–82.5], access to LSM was easy for only 23.9% [14.9–32.9] of households.

Socioeconomic profiles of supermarkets' consumers and nonconsumers. Overall, after adjustment for sex, age, marital status, household size, educational level, occupation, steady income, credit card, economic level of the household, urban environment, and access to supermarkets by multivariate logistic regression (**Table 3**), we found that supermarkets were used more by urban (urban vs. rural: OR = 4.1; $P = 0.007$), small-sized households (small vs. high size: OR = 2.1; $P = 0.005$) people with greater educational attainment (higher vs. illiterate: OR = 5.0; $P < 0.0001$), those with a high economic level (high vs. low: OR = 4.3; $P < 0.0001$) and steady income (yes vs. no: OR = 2.1; $P = 0.01$), and those having easy access to supermarkets (easy vs. uneasy: OR = 1.9; $P = 0.05$). Availability of a credit card in the household was not associated with supermarket use after adjusting for other socioeconomic variables. Also, household ownership of a refrigerator, freezer, or car (as potential markers of different lifestyles or modes of consumption) was assessed, adjusted for other socioeconomic variables; no independent association with supermarket use was found (data not shown).

Looking at MSM and LSM separately in the multinomial logistic regression model, MSM were more likely to attract urban people (urban vs. rural: RRR = 6.4 [2.7–15.1]), those with higher educational attainment (higher vs. illiterate: OR = 6.5 [3.3–14.5]), and those having a steady (yes vs. no: RRR = 1.9 [1.1–3.4]) or high (high vs. low: RRR = 2.1 [1.1–4.1]) economic level. LSM were more likely to be used by people with greater educational attainment (high vs. illiterate: RRR = 3.9 [1.3–11.4]), having a steady income (yes vs. no: RRR = 2.1 [1.0–4.4]), a higher economic level (high vs. low: RRR = 14.8 [7.3–30.1]), from small-sized households (small vs. high: RRR = 3.5 [1.7–6.9]), owning a credit card (RRR = 2.6 [1.2–6.0]), or having an easy access to the LSM (RRR = 2.3 [1.1–5.1]).

There were similar but even stronger relations between use and socioeconomic factors for 1st food purchase place vs. never. Those using supermarkets as the 1st food purchase place vs. those who never go to supermarkets were more urban (urban vs. rural: RRR = 9.6 [1.5–61.8]), smaller sized households (small vs. high: RRR = 4.5 [1.8–11.0]), more educated (high vs. illiterate: RRR = 10.6 [2.8–40.2]), and had a higher economic level (high vs. low: RRR = 9.5 [3.8–24.1]) (detailed data not shown).

Diet quality

Overall diet quality. Considering all the households, the total energy intake was 2858.6 [2750.8–2966.3] (**Table 4**). Overall, the DQI-I was 60.4 [59.6–61.1] over a possible score of 100 and a good diet quality (DQI-I ≥ 60) applied to about one-half of the subjects (52.1% [46.8–57.4]) (Table 4). As for the different categories of the quality of the diet, variety (12.9 [12.4–13.4])

TABLE 1 General features of the sample[1]

Household	Weighted % ± SE	Person in charge of food shopping	Weighted % ± SE
Residence		Age, *y*	
Urban	91.9 ± 3.0	19–34	20.4 ± 1.5
Rural	8.0 ± 3.0	35–49	41.3 ± 2.6
		50–89	38.2 ± 2.6
Household size		Sex	
1–4	49.6 ± 2.9	Female	78.7 ± 1.6
5	21.5 ± 1.8	Male	21.3 ± 1.6
6–14	28.9 ± 3.1		
		Marital status	
		Married	81.7 ± 2.0
Steady income		Other	18.4 ± 2.0
Yes	68.2 ± 3.3		
No	31.8 ± 3.3	Educational attainment	
		Illiterate	24.0 ± 2.5
		Primary	32.9 ± 2.6
Credit card		Training/secondary/higher	43.1 ± 4.0
Yes	14.7 ± 2.4		
No	85.3 ± 2.4	Occupation	
		Working outside home	32.6 ± 2.9
		Not working	67.4 ± 2.9

[1] Values are weighted % ± SE, $n = 724$ (723 for household size and credit card, 722 for educational attainment).

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TABLE 2 Supermarket use by type and priority order[1]

Type of outlet	Subjects who use each type of outlet	95% CI	Type of outlet is 1st food purchase place	95% CI	Type of outlet is 2nd/3rd food purchase place[2]	95% CI
LSM	27.3 ± 3.6	20.1–34.5	4.7 ± 1.2	22.5–7.2	22.5 ± 2.8	16.7–28.3
MSM	50.6 ± 4.0	42.6–58.8	15.7 ± 3.1	9.4–22.0	34.9 ± 2.9	29.2–40.7
Grocer	93.8 ± 1.6	90.5–97.0	74.8 ± 3.8	6.7–8.2	18.9 ± 2.6	13.7–24.3
Market	26.5 ± 2.8	20.8–32.2	3.9 ± 1.1	1.6–6.2	22.5 ± 2.4	17.7–27.4

[1] Values are weighted % ± SE, $n = 724$.
[2] Percentages do not add up to 100, because not all subjects declared having a 2nd or 3rd food purchase place.

and adequacy (32.5 [32.0–32.9]) scored the highest, with observed scores of 81.3 and 64.5%, respectively, of their maximum possible scores. The score for moderation was 13.1 [12.7–13.6], i.e. 43.7% of the maximum possible score. Overall balance was the lowest, with a score of 1.9 [1.6–2.1] or 19% of maximum possible score.

Energy intake and supermarket use. The type of food outlet with total energy intake before (LSM vs. none: +250 [5.8–494.2] and MSM vs. none: +157.4 [−63.3–378.1]) and after adjustment for socioeconomic factors (LSM vs. none: +340.3 [55.8–624.7] and MSM vs. none: +223.6 [−3.7–450]) tended to be associated ($P = 0.06$) (Table 4). Using the supermarket as 1st place for food shopping did not differ before (+207.1 [−112.1–526.2]) of after adjustment (+219.2 [−147.3–585.8]). Following DQI-I, analyses were nevertheless adjusted for energy intake according to the usual practices to control for confounding (35) and known issues of DQI-I related to total energy expenditure.

Diet quality and supermarkets use. Global DQI-I score did not differ according to type of food outlet used (Table 4), whether crude (LSM vs. none: +2.0 [−0.2–4.3] and MSM vs. none: +1.3 [−0.2–2.8]) or adjusted (LSM vs. none: +0.9 [−0.9–2.8] and MSM vs. none: +0.5 [−1.0–2.1]). Before adjustment for energy intake and socioeconomic confounders, the proportion of good quality diets tended to be better for LSM vs. none (OR = 1.9 [1.05–3.6]) as well as MSM vs. none (OR = 1.5 [1.0–2.4]). Adjusting for energy intake and socioeconomic confounders modified the associations for LSM vs. none (OR = 1.6 [0.8–3.0]) or MSM vs. none (OR = 1.4 [0.9–2.2]) only slightly, although the *P*-value ($P = 0.3$) shifted above the 0.05 threshold.

The variety score for LSM vs. none (+2.1 [1.2–3.0]) and MSM vs. none (+1.4 [0.5–2.4]) did differ, but this was mostly explained by energy intake and socioeconomic differences, because they were no longer significant after adjusting for LSM vs. none (+0.4 [0.4–1.2]) and MSM vs. none (+0.3 [−0.5–1.1]). The adequacy score for LSM vs. none (+1.4 [0.3–2.4]) and MSM vs. none (+0.9 [0.01–1.7]) did not differ after adjusting for energy intake and socioeconomic confounders: LSM vs. none (+0.3 [−0.6–1.2]) and MSM vs. none (+0.07 [−0.6–0.7]). The observed detrimental association of supermarket use with the moderation score (LSM vs. none: −1.3 [−2.8–0.2] and MSM vs. none: −0.7 [−1.8–0.4]) was not significant ($P = 0.9$) and in any case the association was completely explained by differences in socioeconomic characteristics. The overall balance score did not differ whether adjusted or not for energy intake and the socioeconomic confounders.

Using supermarkets as the 1st place for main food shopping vs. not resulted in better diet quality on the whole whether assessed by DQI-I global score (+3.6 [3.6–5.0]) or good quality diet defined as DQI-I ≥ 60 (OR = 2.2 [1.4–3.6]). After adjusting for energy intake and socioeconomic factors, the diet quality was still significantly better (+3.0 [1.4–4.6] for total DQI-I score; OR = 2.0 [1.2–3.4] for good quality diet). This underlines that shopping for food at supermarkets as the 1st place is associated with diet quality independently of the confounding effect of energy intake and socioeconomic factors. We found analogous results for the adequacy score, which is better for those whose first purchase place is supermarkets either unadjusted (+1.7 [0.8–2.5]) or adjusted for energy intake and socioeconomic and accessibility factors (+1.5 [0.4–2.6]). On the contrary, the difference in variety score (+1.9 [0.9–2.9]) seemed to be partly due to confounding by energy intake and socioeconomic factors, because it was not significant after adjustment (+1.0 [−0.2–2.1]) ($P = 0.6$). There was no difference for moderation prior to adjustment (+0.2 [−1.1–1.5]), but after adjusting for energy and socioeconomic factors, shopping at supermarkets as 1st place was somewhat beneficial (+1.4 [−0.0–2.9]). The inverse confusion is notably due to much better scores for some items of the moderation component (i.e. cholesterol, sodium, and saturated fat) once adjusted (data not shown). Overall balance did not differ either before ($P = 0.20$) or after adjustment ($P = 0.70$).

Food groups. Before adjusting for socioeconomic confounders, cheese, yoghurts, pulses, fruit, fish, meat, poultry, outside home foods, vegetable fats, cakes, and sodas differed according to type of food outlet frequented. However, most of these food groups were not associated after the adjustment. Frequenting supermarkets as the 1st place for main food shopping vs. not resulted, after adjustment, in significantly higher cheese and fruit consumption and lower vegetable fat consumption only (**Supplemental Table 1**).

Discussion

This study was purposely restricted to the Greater Tunis area and not to all of Tunisia, because this is where supermarkets are mainly located and numerous enough so that the question of potential association between their use and diet quality at the population level might arise. Our results show that supermarkets are used for main food shopping by just over one-half of the persons in charge of purchasing food. It also reveals that they are more regularly used by those with higher income and greater educational attainment. Indeed, low-income households shop at small traditional shops, because they have easier access to them, can buy small amounts, and can benefit from informal credit (data not shown). If this contrasts with Kenya (11), this is consistent with what Rodriguez et al. (10) also found in Argentina where richer and more educated households shop at supermarkets, whereas low-income households chose local shop and convenience stores. Indeed, low-income and/or lack of steady income is known to be not only associated with lower purchasing power but also with less frequent ownership of

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TABLE 3 Use of supermarkets according to socioeconomic characteristics[1]

		Crude estimates		Adjusted estimates[3]	
		OR[2]	95% CI	OR[2]	95% CI
Residence	%	$P < 0.0001$		$P = 0.006$	
Urban	98.6 ± 0.07	14.9	6.02–36.63	4.1	1.5–10.8
Rural	1.4 ± 0.07	1	—	1	—
Household size		$P < 0.0001$		$P = 0.01$	
1–4	58.2 ± 3.3	3.56	2.22–5.71	2.1	1.3–3.4
5	22.6 ± 2.7	2.59	1.56–4.33	1.3	0.7–2.3
6–14	19.2 ± 3.0	1	—	1	—
Economic index		$P < 0.0001$		$P < 0.0001$	
Low	17.4 ± 3.0	1	—	1	—
Medium	37.5 ± 3.4	4.08	2.32–7.17	1.9	1.0–3.4
High	45.2 ± 4.8	14.30	7.95–27.1	4.3	2.4–7.5
Steady income		$P < 0.0001$		$P = 0.008$	
Yes	79.5 ± 2.8	3.65	2.34–5.73	2.1	1.2–3.5
No	20.5 ± 2.8	1	—	1	—
Credit card		$P < 0.0001$		$P = 0.13$	
Yes	21.7 ± 3,1	7.11	3.40–14.85	1.7	0.8–3.6
No	78.3 ± 3,1	1	—	—	—
Access[4]		$P < 0,0001$		$P = 0.049$	
Easy access	86.5 ± 2,9	4,53	2.59–7.93	1.9	1.0–3.5
Not easy	13.5 ± 2,9	1	—	1	—
Age, *y*		$P = 0.25$		$P = 0.84$	
19–34	21.7 ± 2,6	1	—	1	—
35–49	44.6 ± 3,8	1.14	0.75–1.73	1.1	0.6–2.0
50–89	33.7 ± 3,5	0.77	0.47–1.26	1	0.5–1.8
Sex		$P = 0.77$		$P = 0.34$	
Male	21.6 ± 2,3	1	—	1	—
Female	78.4 ± 2,3	0.94	0.62–1.43	1.3	0.7–2.4
Marital status		$P = 0.68$		$P = 0.78$	
Married	82.2 ± 2,8	1.10	0.68–1.79	1.1	0.7–1.8
Other	17.8 ± 2,8	1	—	1	—
Education level		$P < 0.0001$		$P = 0.0001$	
Illiterate	11.7 ± 2,0	1	—	1	—
Primary	27.1 ± 3,2	2.29	1.39–3.75	2.0	1.1–3.4
Training/higher	61.3 ± 3,9	12.09	7.05–20.74	5.0	2.5–10.1
Occupation		$P = 0.0008$		$P = 0.47$	
Working outside home	39.4 ± 4,0	2.15	1.34–3.44	1.3	0.6–2.6
Not working	60.6 ± 4,0	1	—	1	—

[1] Values are weighted % ± SE, ($n = 724$ except for household size and credit card, $n = 723$; educational attainment, $n = 722$; access, $n = 720$ and economic index, $n = 711$).
[2] $n = 703$ (complete case analysis).
[3] Adjusted for sex, age, matrimonial status, household size, educational level, occupation, steady income, credit card, economic level of the household, urban environment, and access to supermarkets.
[4] Less than 5 km or <30 min from a retail outlet.

consumer durables such as a refrigerator for food storage or cars to provide access to supermarkets (36).

An opinion poll conducted by the Tunisian Trade Ministry in 2004 reported that 90% of Tunisian consumers surveyed still used small shops and only 39% used supermarkets (37). Though the proportion of people using supermarkets seems to be growing, small neighborhood grocery shops are still perennial in the Greater Tunis inhabitants' habits, whether it be for main or secondary food supply. Knowing that the first 2 supermarket chains in Tunis date back to 1920 and 1933 and considering that the middle class, which represents the privileged target of modern distribution, constitutes 70% of the Tunisian population (23), we expected that a higher proportion of subjects would frequent supermarkets. Thus, despite the long-standing presence of ancient supermarkets, this food distribution system has therefore not yet become popular and modern supermarket development is still in an initial phase of implementation in Tunisia, during which supermarkets can only be accessible on a regular basis to higher social classes as highlighted in this study. Our results contrast with those studying other developing countries where supermarket implementation is much more recent than in Tunis but spread more rapidly to the entire range of social classes. For instance, in Nairobi, 60% of lowest income people use supermarkets (at least once a month). Although no information is available from that study on food product prices, this could be explained by the fact that processed food is sold much cheaper than fresh fruit and vegetables compared with traditional retailers (11).

With respect to association with diet, our study also shows that, after adjustment, diet quality slightly improved with regular supermarket use. From an analytical point of view, at the

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TABLE 4 DQI-I according to supermarket use[1]

		Type of supermarkets used for main food shopping[2]			*P*-value		Supermarket is first choice for main food shopping		*P*-value	
	All households	None	MSM only[3]	LSM[4]	Crude	Adjusted[5]	Yes	No	Crude	Adjusted[5]
n	715	357	195	163	715	715	106	609	715	715
Energy intake, *kcal*	2858.6 ± 53.5	2737.0 ± 76.8	2894.4 ± 83.1	2987.0 ± 97.1	0.1	0.06	3021 ± 150.8	2814.5 ± 52.1	0.2	0.2
DQI-I global score										
DQI-I (0–100)	60.4 ± 0.39	59.4 ± 0.49	60.7 ± 0.52	61.4 ± 0.95	0.1	0.6	63.2 ± 0.62	59.6 ± 0.38	<0.00001	0.0004
DQI-I ≥ 60	52.1 ± 2.6	44.0 ± 3.3	54.7 ± 4.0	60.6 ± 6.3	0.04	0.3	67.9 ± 4.5	48.0 ± 2.8	0.0007	0.001
Categories of DQI-I										
Variety (0–20)	12.9 ± 0.24	11.9 ± 0.33	13.3 ± 0.36	14.0 ± 0.35	0.0001	0.6	14.4 ± 0.46	12.5 ± 0.23	0.0005	0.3
Adequacy (0–40)	32.5 ± 0.21	31.8 ± 0.33	32.7 ± 0.25	33.2 ± 0.44	0.03	0.8	33.8 ± 0.37	32.1 ± 0.23	0.0003	0.01
Moderation (0–30)	13.1 ± 0.23	13.7 ± 0.36	13.0 ± 0.39	12.4 ± 0.67	0.1	0.9	13.3 ± 0.61	13.1 ± 0.23	0.8	0.05
Overall balance (0–10)	1.9 ± 0.10	2.0 ± 0.15	1.7 ± 0.21	1.8 ± 0.20	0.4	0.5	1.7 ± 0.18	1.9 ± 0.11	0.2	0.7

[1] Values are estimates ± SE.
[2] Regardless of priority choice.
[3] Regardless of grocer and market but excluding LSM.
[4] Regardless of grocer, market, and MSM.
[5] Adjusted for energy intake, sex, age, matrimonial status, household size, educational level, occupation, steady income, credit card, economic level of the household, urban environment, and access to supermarkets (except for energy intake, which was adjusted for socioeconomic factors only).

household level, supermarket use and diet quality are therefore associated, not confounded by socioeconomic factors. Nevertheless, at the population level, socioeconomic factors do potentially mediate the influence of supermarkets on diet as we have shown. It had been hypothesized that supermarkets could be detrimental or beneficial to diet quality, notably with respect to chronic disease. Contrary to Guatemala, we did not confirm that supermarkets in Greater Tunis worsened diet quality but rather improved it slightly. Asfaw (20) explains that supermarkets are a priori not unfavorable, because they offer a greater variety of good quality products. However, this is different when supermarkets spread to the poorer social classes; for them, targeted products are preferentially cheaper and "down market." Supermarkets offer 2 important characteristics that can have potential consequences on diet and may shed some light on why, in our study, their regular frequentation is slightly beneficial and also appeals to more well-off consumers. On one hand, in our preliminary qualitative survey, higher social classes expressed that supermarkets provide access to some new food products (such as avocados, asparagus, kiwis, mangoes, salmon, wholemeal bread, basmati rice, breakfast cereals, low-fat products, etc.) that cannot be found elsewhere (data not shown). Higher social class diets have thus shifted from a limited number of staple products to a more diverse diet through the introduction of new foods that remain either physically or economically inaccessible to most low-income people. On the other hand, for those who were not accustomed to using them, supermarkets also present consumers with a new modality of choice: self-service. They have therefore to learn the process of choosing a product within a range that is based on label information or advertising (38). This might be quite challenging for people who remain illiterate or who are not used to this new modality of choice. Supermarkets hence modify attitudes and representation toward food according to educational and income level as they offer greater availability and quality of food compared with a traditional distribution retail system. They also offer lower price staple food products and therefore allow the purchase of more expensive higher quality or new food products targeted at rich consumers. Lastly, as they allow food purchases grouped together in both space and time, supermarkets permit saving time and stocking products. This can allow planning and improvising meals without impairing diet quality.

Supermarket use has little affect on most food consumption, except for cheeses and fruits. Reardon and Berdegué reported that supermarkets act as a vehicle for the rapid increase in dairy product consumption (39). However, these are only the beginnings of change in Tunis and we therefore cannot conclude yet that food retail transformations do modify food consumption in our population. This is either because, for the consumers concerned, there is a long-standing habit of frequenting supermarkets that has been established in the country for decades or because the proportion of people shopping at supermarkets remains too small. Another possibility could also be that so far, supermarket food availability depends mostly on local products and although new products are available, the portion of imported foods remains small. This is driven by consumers' purchasing power, which, although increasing, remains limited, as witnessed by the frequent use of loans among Tunisians as a method of payment (23). Moreover, it is important to note that some of the newly available food products (e.g. newly launched yoghurts, biscuits, or sodas) in supermarkets can also be found within the same frame of time at the local grocers. Interestingly, Foster and Lunn (40) reported a similar phenomenon regarding the changes in the UK food distribution system in early 1960s. These transformations also had repercussions on the entire independent sector, which was then selling the same food products as the leading supermarket of the time.

Strengths of this study include a population-based survey, the use of in-depth interviews and focus groups to develop the retail habits questionnaire, the use of a FFQ that was validated, and the use of the diet quality index that allows a holistic view of food consumption. However, this study also presents several limitations, such as its cross-sectional design that makes it difficult to interpret observed associations as causal even if care was taken to adjust for relevant confounders. The use of a FFQ to assess food consumption has known accuracy issues, such as potential memory bias and difficulties to estimate consumed food quantities. However, it is likely that these potential biases are no differential with respect to supermarket use, which was the main emphasis of the study. Also, the use of the DQI-I, similar to all diet quality indexes, has only marginal predictive capacity for associations between food consumption and reduced risk of chronic disease and mortality (41). However, this was not directly the purpose of this study.

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This study therefore shows that despite the long-standing presence of supermarkets in Tunis, to date, supermarket use has not yet spread to the whole population. Supermarkets do not yet considerably modify food consumption among the Greater Tunis population. Low-income consumers are not yet affected by supermarkets or its transformations, because they seldom, if ever, shop there. However, a slight improvement of diet quality can be observed among those using supermarkets regularly.

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ERRATUM

Tessier S, Traissac P, Maire B, Bricas N, Eymard-Duvernay S, El Ati J, Delpeuch F (2008). Regular users of supermarkets in Greater Tunis have a slightly improved diet quality. J Nutr. 138:768–774.

In Table 3, column 2, the percentages in the published article refer to the distribution of socioeconomic factors among supermarket users. However, we meant to present the percentages of users within subcategories of the socio-economic factors. In addition, the age categories as listed in Table 3 of the published article were the same as those in the descriptive Table 1. However, the analysis was actually conducted with tertiles of age and these categories differ somewhat from those originally presented. The corrected table follows:

TABLE 3 Use of supermarkets by socioeconomic characteristics[1]

		Crude estimates		Adjusted estimates[3]	
		OR[2]	95% CI	OR[2]	95% CI
Residence	%	$P < 0.0001$		$P = 0.006$	
Urban	63.8 ± 4.2	14.9	6.02–36.63	4.1	1.5–10.8
Rural	10.6 ± 3.9	1	—	1	—
Household size		$P < 0.0001$		$P = 0.01$	
1–4	69.7 ± 3.9	3.56	2.22–5.71	2.1	1.3–3.4
5	62.5 ± 5.2	2.59	1.56–4.33	1.3	0.7–2.3
6–14	39.5 ± 5.4	1	—	1	—
Economic index		$P < 0.0001$		$P < 0.0001$	
Low	30.3 ± 4.0	1	—	1	—
Medium	63.9 ± 4.7	4.08	2.32–7.17	1.9	1.0–3.4
High	86.2 ± 2.8	14.30	7.95–27.1	4.3	2.4–7.5
Steady income		$P < 0.0001$		$P = 0.008$	
Yes	69.6 ± 3.8	3.65	2.34–5.73	2.1	1.2–3.5
No	37.7 ± 5.0	1	—	1	—
Credit card		$P < 0.0001$		$P = 0.13$	
Yes	89.8 ± 3.6	7.11	3.40–14.85	1.7	0.8–3.6
No	54.2 ± 4.1	1	—	—	—
Access		$P < 0.0001$		$P = 0.049$	
Easy access[4]	68.1 ± 3.9	4.53	2.59–7.93	1.9	1.0–3.5
Not easy	32.4 ± 5.1	1	—	1	—
Age, *y*		$P = 0.25$		$P = 0.84$	
19–40	60.9 ± 5.2	1	—	1	—
41–52	63.7 ± 5.4	1.14	0.75–1.73	1.1	0.6–2.0
53–89	53.5 ± 5.4	0.77	0.47–1.26	1	0.5–1.8
Sex		$P = 0.77$		$P = 0.34$	
Men	60.5 ± 5.5	1	—	1	—
Women	59.2 ± 4.4	0.94	0.62–1.43	1.3	0.7–2.4
Matrimonial status		$P = 0.68$		$P = 0.78$	
Maried	59.9 ± 4.5	1.10	0.68–1.79	1.1	0.7–1.8
Other	57.6 ± 6.1	1	—	1	—
Education level		$P < 0.0001$		$P = 0.0001$	
Illiterate	29.2 ± 4.7	1	—	1	—
Primary	49.4 ± 4.7	2.29	1.39–3.75	2.0	1.1–3.4
Training/higher	83.8 ± 2.7	12.09	7.05–20.74	5.0	2.5–10.1
Occupation		$P = 0.0008$		$P = 0.47$	
Working outside home	71.6 ± 4.8	2.15	1.34–3.44	1.3	0.6–2.6
Not working	53.6 ± 4.5	1	—	1	—

[1] Values are weighted percentages of supermarket users among categories of socioeconomic factors ± SE, ($n = 724$ except for household size and credit card, $n = 723$; educational attainment, $n = 722$; access, $n = 720$; and economic index, $n = 711$).
[2] $n = 703$ (complete case analysis).
[3] Adjusted for sex, age, matrimonial status, household size, educational level, occupation, steady income, credit card, economic level of the household, urban environment, and access to supermarkets.
[4] Less than 5 km or <30 min from a retail outlet.