

# **Project Title: Dyslipidemia Prevalence, Perception, Treatment, and Awareness in the Tunisian Population: The ATREA Project**

**Organization: Tunisian Association of Study and Research on Atherosclerosis (ATERA)**

Address: Department of Biochemistry, La Rabta University Hospital

Inclusive dates of the project:

04/01/2016 : initiation of data collection

10/04/2019 : End of data collection

15/05/2019: Educational supports elaboration

04/10/2019: preliminary results

10/12/2019: Database cleanup

Project Officer: Prof. Riadh Jemaa, ATERA President

Team members: Riadh Jemaa , Amani Kallel, Imed Ben Ghorbel, Lamia Rais, Rabie Razgallah and al. (see table below)

## **Acknowledgment of ATERA Support:**

- Ministry of Health (Research director: Anis Klouz; Noomene Elkadri )
- National Institute of Health (Director: Pr Hajer skhiri Aounallah)
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Partner's logos



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معهد الوطني للصحة  
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### 1. Structured Abstract:

**Purpose:** The aims of the ATERA survey were to determine the prevalence of dyslipidemia and other conventional risk factors for CHD; the relationship between environmental and lifestyle factors with dyslipidemia, the perception and the knowledge of cardiovascular risk factors by the population, and above all, to strengthen the national strategy for primary and secondary prevention against CHD; in a prospective epidemiological study.

**Scope:**

**Methods:** In this observational cross-sectional study we adopted a two stage stratified sampling method to obtain representative sample of the general Tunisian population. The study included a sample of the population coming from seven tunisian regions (Great Tunis, North East, North West, Central East, Central West, South East and south west) and aged between 25 and 75 years old. The ATERA survey was carried out from January 2016 to April 2019 in a random sampling including 10574 men and women. All the participants signed an informed consent and answered to surveys covering socioeconomic, nutritional and anthropometric measures in addition to biological assessments (Abbotts Architect c8200).

**Results:**

The total studied population was 10574 participants divided into 4658 (44.1%) men and 5916 (55.9%) women. The results of our study show that in Tunisia, a high prevalence of cardiovascular risk factors was observed especially for dyslipidemia (47.9%) followed by hypertension (43.8%) then Diabetes (22.6%). High prevalence of hypertension was discovered fortuitously (53.3%). Besides, the prevalence of prediabetes is very high (16.7%) and increases with age to reach 20.3 to 20.9% from 55 years of age.

In addition, a high prevalence of overweight (36.4%) was found, with 66.1% of subjects having a BMI > 25 kg / m<sup>2</sup>. A high percentage (72.2%) of dyslipidemia was an incidental discovery by the ATERA Survey, especially in women. Only 27.9% of subjects receive lipid-lowering treatment. Ten point three percent of subjects have simultaneous disturbances of CT, TG & HDL (14.8% in men & 6.5% in women). The overall point about alimentation on Tunisians was the disrupted nutritional intake with low fish consumption rate (17.6%), in favor of white meat (59.2%). Delicatessen meats remain lightly consumed (3.0%). Tunisians have very frequent habit of adding sugar (59.0%) and salt (32.4%).

Tunisia has the best olive oil in the world but mixed vegetable oil remains very present in the general population and particularly in the regions of the North West, this is due to its high cost for an average or deteriorated socioeconomic level.

**Conclusion:**

The results of the ATERA survey show a serious situation since we are witnessing an explosion of cardiovascular risk factors and particularly dyslipidemia. Strengthening Tunisian prevention strategies with sophisticated and digital means constitutes a pillar of digital health in favor of anchoring imperative behavioral change to improve the current prevalence of cardiovascular risk factors.

**Key words:** Dyslipidemia, cholesterol, Triglyceridemia, diabetes, Glycated hemoglobin, Hypertension, Obesity, nutrition, intervention, digital tools, behavioural chagement.

## 2- Purpose

The ATERSurvey aimed to analyze the prevalence of dyslipidaemia and other conventional risk factors for coronary heart disease, to determine the perception of cardiovascular risk factors, treatment and awareness in the Tunisian population.

## 3- Scope

Non communicable diseases (NCDs) such as cardiovascular disease (CVD) are the leading cause of morbidity and mortality, accounting for 17.3 million deaths globally each year. This figure is expected to grow to 23.6 million by the year 2030. Eighty per cent of these deaths occur in lower-and middle-income countries (Mendis et al, 2011). The most preventable form of CVD is atherosclerotic cardiovascular disease (ASCVD) (Arnett et al. 2019) which is the largest contributor to the prevalence of important risk factors and varying greatly according to geographical region, sex and ethnic background (Wong, 2014). Assessing the prevalence of risk factors and predictors of this condition is of paramount importance for the prevention and control of the disease and its after effects.

Knowledge of the lipid profile of a population is important for the adoption of preventive and therapeutic measures to combat atherosclerosis (FERENCE et al, 2017).

However, the majority of studies have been done on the European and Asian populations. In Tunisia, there is an increasing spread of chronic diseases, due to environmental and behavioral changes such as the adoption of new eating habits, sedentary housing, the stress of urbanization and working conditions (Ben romdhane et al, 2015). These changes have led increased incidence of cardiovascular disease and other chronic diseases exacerbated by longer life expectancy. There are very few studies on the cardiovascular risk factors epidemiology in Tunisia. Most of them covered a small number of individuals or only one region (Ghannem et al, 1997) except for THES study that included 9000 individuals “Tunisian Health Examination Survey – 2016” conducted by the national institute of health of Tunisia.

Participants: the data of this study were collected as part as a large-scale, cross sectional study conducted between January 2016 and April 2019 to explore the health status of a representative sample of the Tunisian population aged between 25 and 75 years. This population comes from seven regions of Tunisia (great Tunis, North East, North West, central East, central West, South East and south west) We applied two stage stratified (district, household) sampling method to obtain 5851 households (13712 individuals) with a 77.6 % response rate. The ATERA survey was authorized by the national statistics council, which is the proof of ethics committee no.15 / 2015. The entire study was registered on the website [www.clinicaltrials.gov](http://www.clinicaltrials.gov) under the number NCT03799185.

The exclusion criteria: Individuals who are under prescribed treatment for cancer, who have received an organ transplant, who are known to have autoimmune disease, who have severe liver disease, who have chronic renal failure and pregnant women, were excluded before and during the study.

Those eligible to participate included all persons living in the household and aged between 25 and 75 years. The participants giving informed consent answered standard questionnaires assessing social-economic and nutritional personal habits.

Information on medication used for dyslipidemia, hypertension or diabetes was collected. Physical activity was filled using a validated survey. Anthropometric measurements included weight, height and waist circumference.

A biological assessment containing the lipid profile, renal function, hepatic function and the blood cell count were carried out for all the consenters (all these assessments followed a quality control).

## 5- Results

Prevalence and outcomes of cardiovascular risk factors:

As shown in table 1, in a total of 10574 participants, 4658 (44.1%) were men and 5916 (55.9%) were women.

Table 1: distribution of the studied population according to gender

| N                 | MALE |       | FEMALE |       | ALL   |       |
|-------------------|------|-------|--------|-------|-------|-------|
|                   |      |       |        |       |       |       |
|                   | 4658 | 44,1% | 5916   | 55,9% | 10574 | -     |
| <b>REGION</b>     |      |       |        |       |       |       |
| District of Tunis | 1365 | 29,3% | 1651   | 27,9% | 3016  | 28,5% |
| North East        | 841  | 18,1% | 1004   | 17,0% | 1845  | 17,4% |
| North West        | 509  | 10,9% | 598    | 10,1% | 1107  | 10,5% |
| Centre East       | 1049 | 22,5% | 1348   | 22,8% | 2397  | 22,7% |
| Centre West       | 418  | 9,0%  | 531    | 9,0%  | 949   | 9,0%  |
| South East        | 297  | 6,4%  | 535    | 9,0%  | 832   | 7,9%  |
| South West        | 179  | 3,8%  | 249    | 4,2%  | 428   | 4,0%  |

The socio-demographic questionnaire gives us an unexpected reality on the level of education of Tunisians where we find 19.3% of the population who are illiterate with unfortunately a predominance of women with 26%, this despite the efforts made since independence. It is also pointed out that 10.1% of the population only has a university level (Table2).

Table 2 : distribution of the educational level according to gender

|                                     | Men  |        | Women |        | ALL  |        |
|-------------------------------------|------|--------|-------|--------|------|--------|
|                                     | N    | %      | N     | %      | N    | %      |
| Missing                             | 217  | 4,70%  | 368   | 6,20%  | 585  | 5,50%  |
| Illiterate                          | 500  | 10,70% | 1537  | 26,00% | 2037 | 19,30% |
| Koranic school   Courses for adults | 65   | 1,40%  | 75    | 1,30%  | 140  | 1,30%  |
| Primary                             | 1823 | 39,10% | 2077  | 35,10% | 3900 | 36,90% |
| Middle School                       | 521  | 11,20% | 504   | 8,50%  | 1025 | 9,70%  |
| Secondary                           | 1009 | 21,70% | 808   | 13,70% | 1817 | 17,20% |
| University                          | 523  | 11,20% | 547   | 9,20%  | 1070 | 10,10% |

The prevalence of dyslipidemia, hypertension and diabetes was 47.9%, 43.8% and 22.6% respectively (Table 3, 4 and 5).

Table3: distribution of dyslipidemia

|                     | Men  |        | women |        | ALL  |        |
|---------------------|------|--------|-------|--------|------|--------|
|                     | N    | %      | N     | %      | N    | %      |
| <b>Dyslipidemia</b> | 2235 | 48,00% | 2828  | 47,80% | 5063 | 47,90% |
| Known               | 610  | 13,10% | 829   | 14,00% | 1439 | 13,60% |
| Lucky find          | 1625 | 34,90% | 1999  | 33,80% | 3624 | 34,30% |
| Non dyslipidemic    | 2423 | 52,00% | 3088  | 52,20% | 5511 | 52,10% |

Table 4: distribution of hypertension

| Hypertension | Men  |        | Women |        | ALL  |        |
|--------------|------|--------|-------|--------|------|--------|
|              | N    | %      | N     | %      | N    | %      |
| Known        | 907  | 19,50% | 1266  | 21,40% | 2173 | 20,60% |
| Lucky find   | 1245 | 26,70% | 1216  | 20,60% | 2461 | 23,30% |
| Pre HTA      | 1357 | 29,10% | 1563  | 26,40% | 2920 | 27,60% |
| No HTA       | 1149 | 24,70% | 1871  | 31,60% | 3020 | 28,60% |

Table 5: distribution of hypertension according to treatment status

| Hypertension    | Men         |                | Women       |                | ALL          |                |
|-----------------|-------------|----------------|-------------|----------------|--------------|----------------|
|                 | N           | %              | N           | %              | N            | %              |
| Known treated   | 805         | 37,40%         | 1128        | 45,40%         | 1933         | 41,70%         |
| Known untreated | 102         | 4,70%          | 138         | 5,60%          | 240          | 5,20%          |
| Lucky find      | 1245        | 57,90%         | 1216        | 49,00%         | 2461         | 53,10%         |
| <b>TOTAL</b>    | <b>4658</b> | <b>100,00%</b> | <b>5916</b> | <b>100,00%</b> | <b>10574</b> | <b>100,00%</b> |

Table 6: distribution of Diabetes according to gender

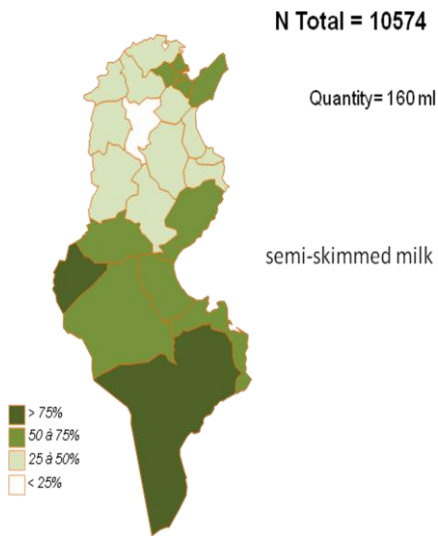
|              | Men         |                | Women       |                | ALL          |                |
|--------------|-------------|----------------|-------------|----------------|--------------|----------------|
|              | N           | %              | N           | %              | N            | %              |
| Diabetes     | 1092        | 23,40%         | 1296        | 21,90%         | 2388         | 22,60%         |
| Known        | 790         | 17,00%         | 933         | 15,80%         | 1723         | 16,30%         |
| Lucky find   | 302         | 6,50%          | 363         | 6,10%          | 665          | 6,30%          |
| Pre Diabetes | 966         | 20,70%         | 1314        | 22,20%         | 2280         | 21,60%         |
| Non diabetic | 2600        | 55,80%         | 3306        | 55,90%         | 5906         | 55,90%         |
| <b>TOTAL</b> | <b>4658</b> | <b>100,00%</b> | <b>5916</b> | <b>100,00%</b> | <b>10574</b> | <b>100,00%</b> |

Table 7: Distribution of obesity classes among tunisians

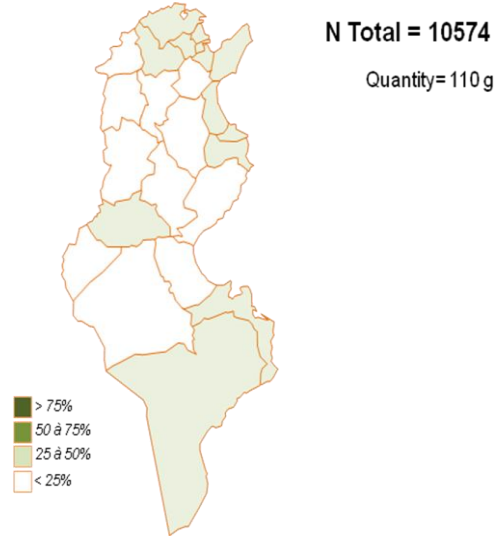
|                               |                  | Men         |                | Women       |                | ALL          |                |
|-------------------------------|------------------|-------------|----------------|-------------|----------------|--------------|----------------|
|                               |                  | N           | %              | N           | %              | N            | %              |
| <b>BMI (Kg/m<sup>2</sup>)</b> | Moy ± ET         | 27.7 ± 5.6  |                | 28.7 ± 6.0  |                | 27.8 ± 5.9   |                |
| <b>BMI Classes</b>            | Leanness         | 158         | 3,40%          | 121         | 2,00%          | 279          | 2,60%          |
|                               | Normal weight    | 1648        | 35,40%         | 1494        | 25,30%         | 3142         | 29,70%         |
|                               | Overweight       | 1791        | 38,40%         | 2059        | 34,80%         | 3850         | 36,40%         |
|                               | Moderate obesity | 753         | 16,20%         | 1444        | 24,40%         | 2197         | 20,80%         |
|                               | Severe obesity   | 180         | 3,90%          | 479         | 8,10%          | 659          | 6,20%          |
|                               | Morbid obesity   | 64          | 1,40%          | 217         | 3,70%          | 281          | 2,70%          |
|                               | Missing          | 64          | 1,40%          | 102         | 1,70%          | 166          | 1,60%          |
|                               | <b>TOTAL</b>     | <b>4658</b> | <b>100,00%</b> | <b>5916</b> | <b>100,00%</b> | <b>10574</b> | <b>100,00%</b> |



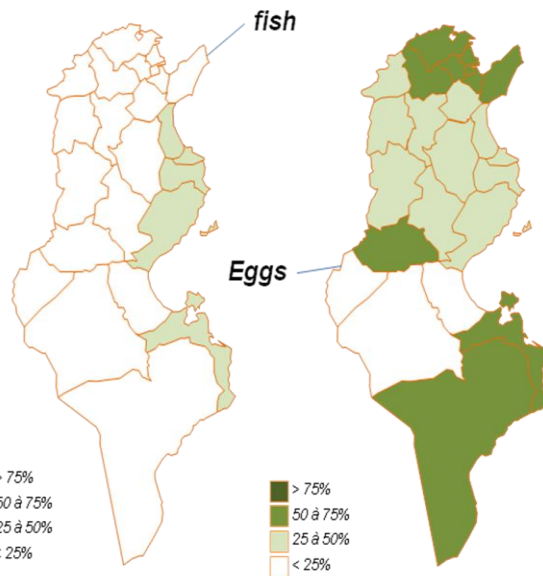
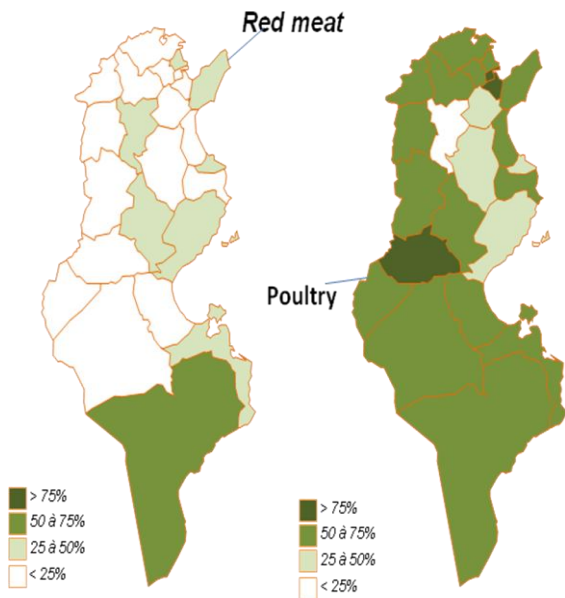
The nutritional questionnaire which was made for all the participants made it possible to map the Tunisians according to their eating habits. The results are shown in the following maps.



Daily consumption of milk  
(52% of the population consumes semi-skimmed milk)



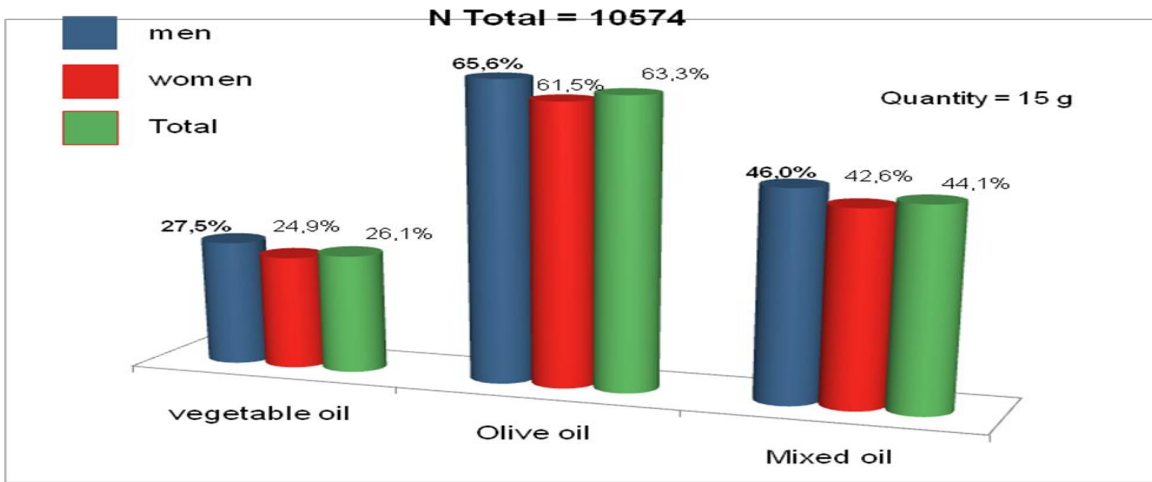
Daily consumption of yogurt  
(28.7% of the population consumes yogurt;  
29.3% for women and 27.9% for men)



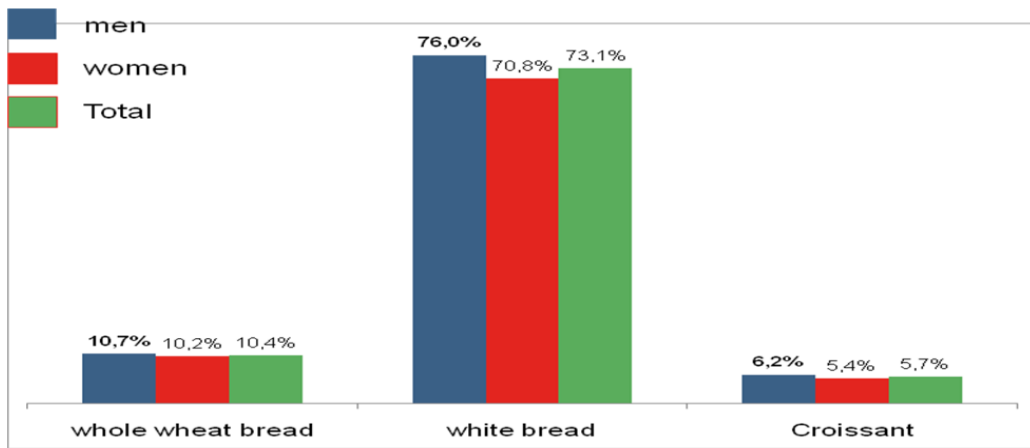
Intakes of meat fish poultry and eggs

The average consumption of red meat is 25.2%, of poultry is 59.2%, of fish is 17.6% and of eggs is 46%.

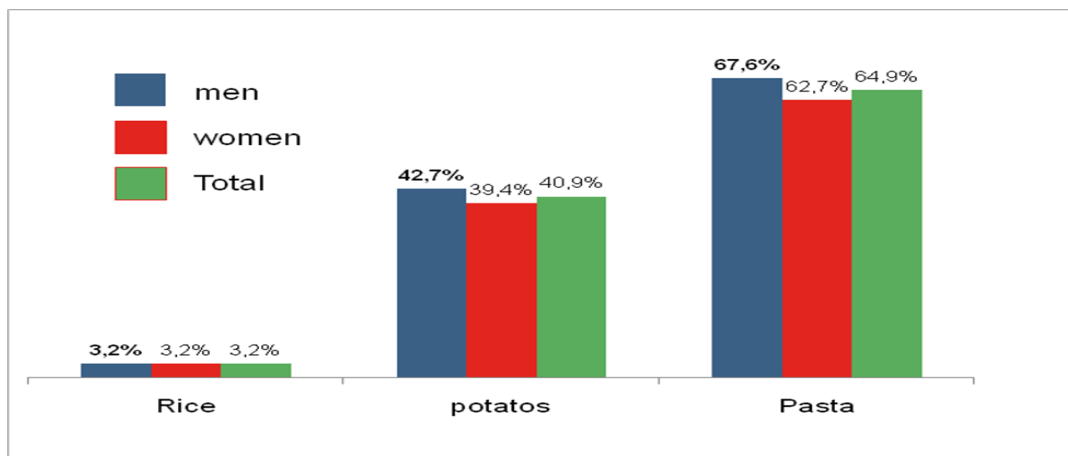




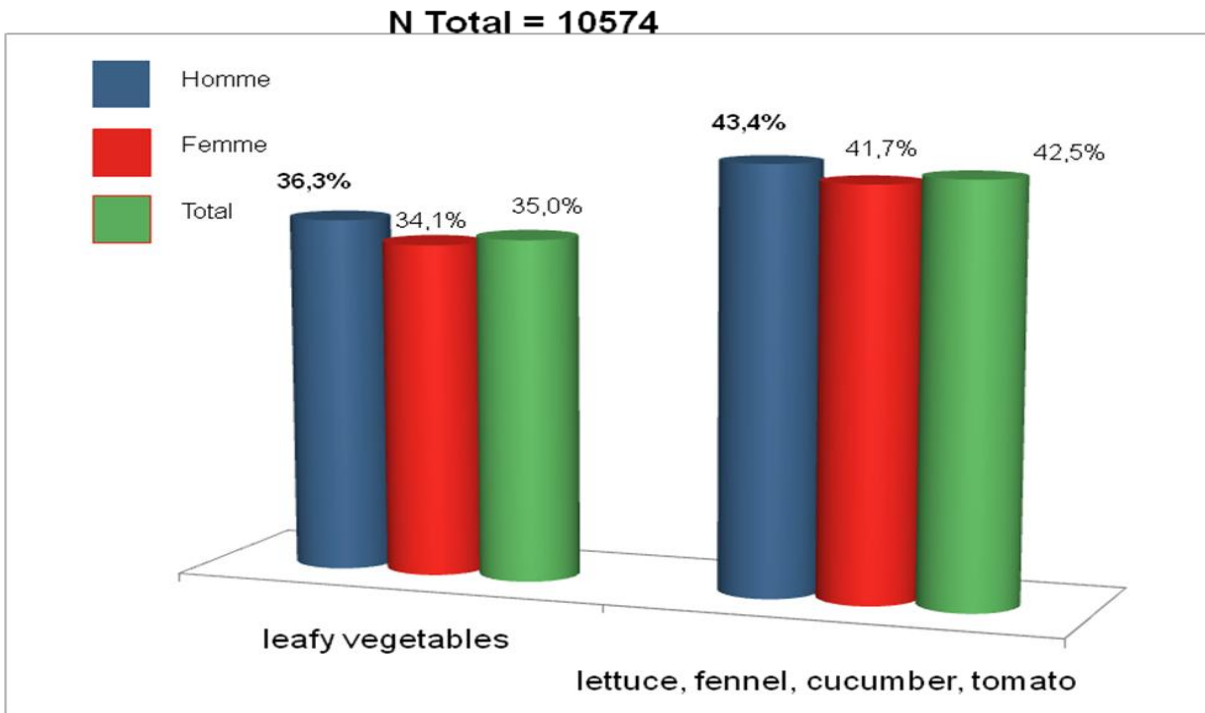
Daily intake of oil: Tunisians consume essentially olive oil



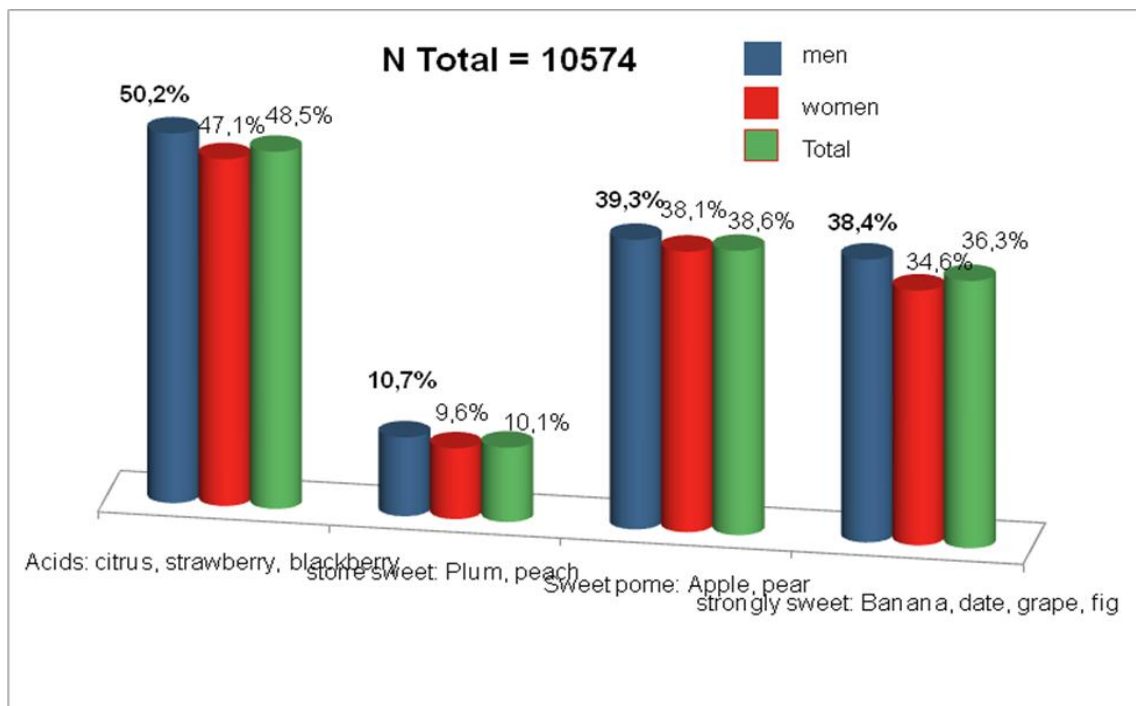
Daily consumption of bread (majority of white bread)



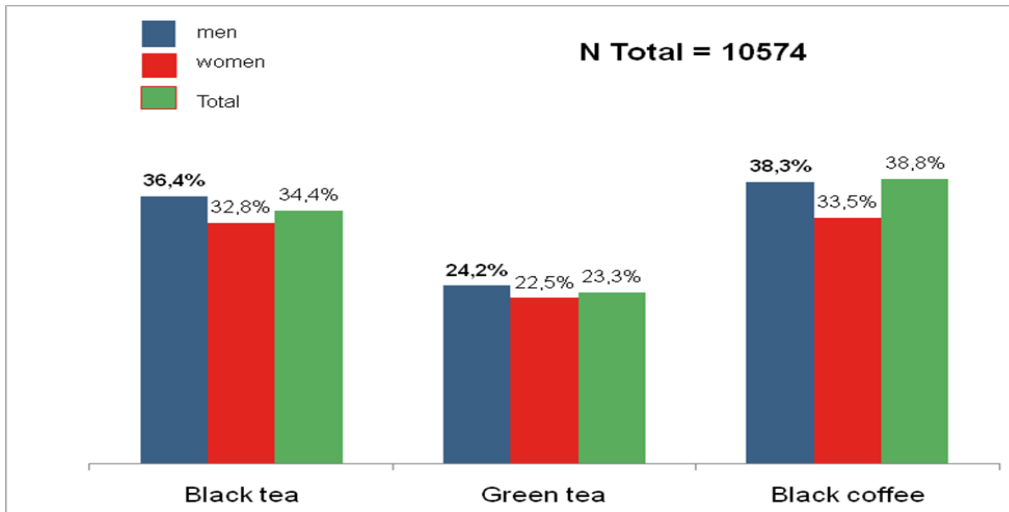
Daily consumption of pasta and starchy foods



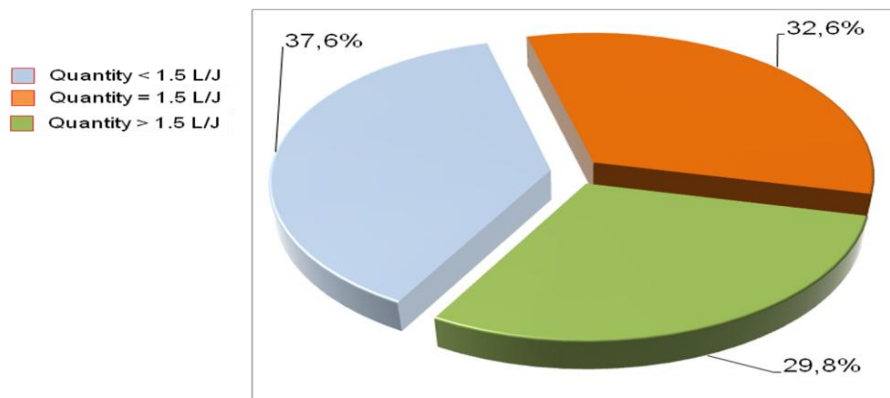
Daily consumption of vegetables



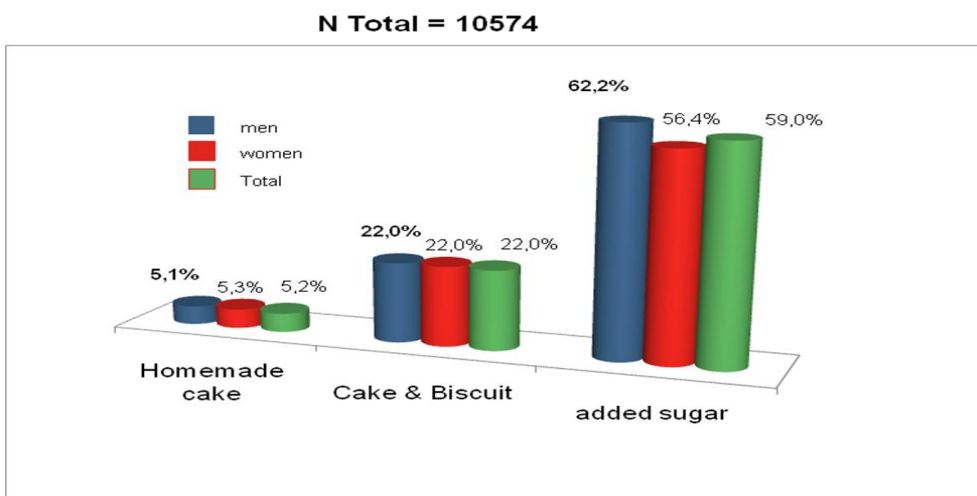
Daily consumption of fruits



Daily consumption of tea and coffee

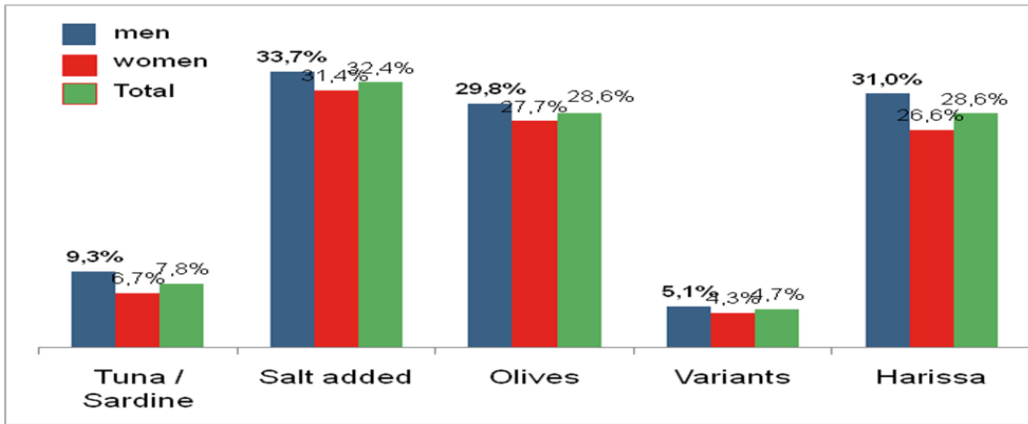


Daily consumption of water



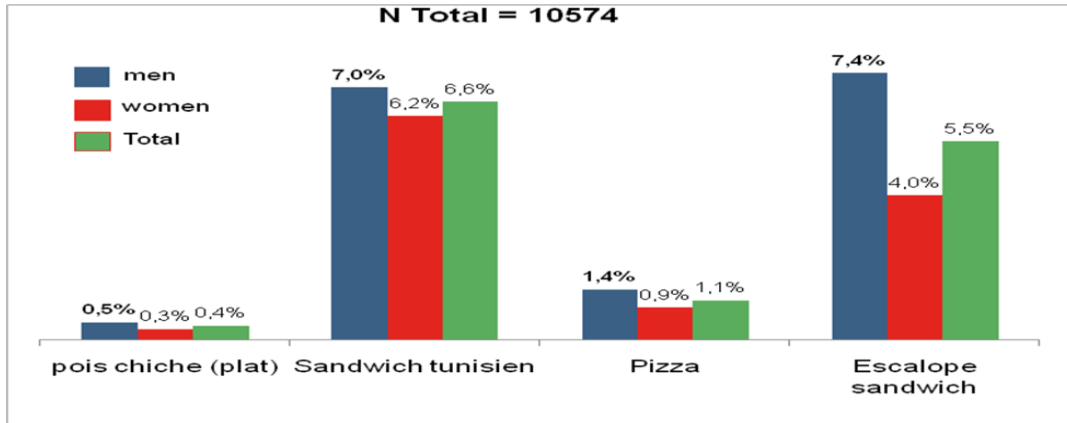
Daily consumption of sugar

N Total = 10574



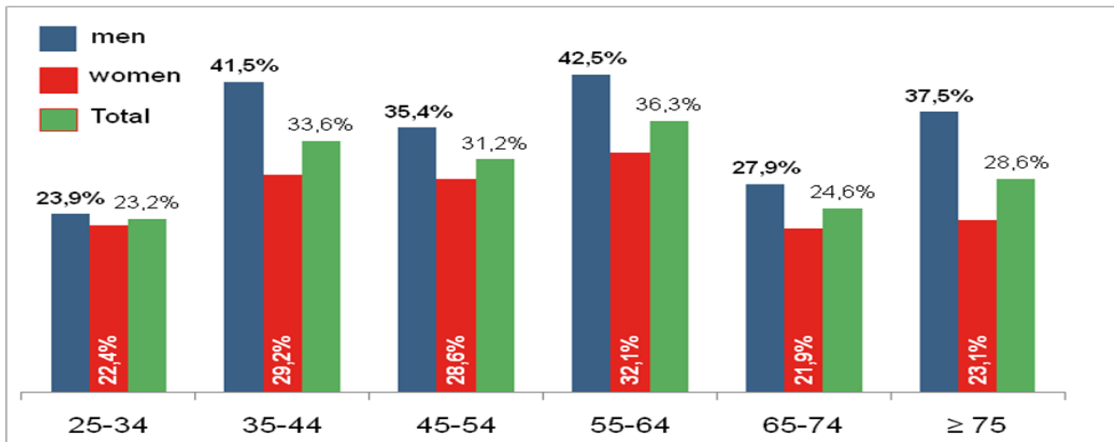
Daily consumption of salting

N Total = 10574



Daily consumption in fast food

N Total = 10574



Snacking in the study population

The strengths of the ATERA survey are as follows:

- the first representative national study on cardiovascular risk factors in Tunisia concerning the 25-75 age group.
- the first study in Tunisia which is based on a biological assessment on a representative series will allow to have Tunisian standards after work according to the procedures of quality standards knowing that a systematic quality control has been carried out for all assessments on the only PLC used.
- the first study which gives the map of Tunisians in terms of food through the nutritional questionnaire.
- the first study which brings together for the same participant a socio-demographic questionnaire, a food questionnaire and a biological assessment.
- the enhancement and the viability of the study: the use of artificial intelligence algorithms and especially via deep learning gives it a unique character in Tunisia in the health field especially via the smart mascot ARAYEK which once adopted by Tunisians will allow to generalize an adopted behavioral change.

## Measures

We used health behavior change models to better understand eating and physical behavior as a way to manage dyslipidemia. The health belief model (HBM) postulates that self-efficacy and perceived risk are essential to behavior change. According to HBM, people who perceive themselves to be at risk for a specific health problem are more likely to be encouraged to change their behavior. Self-efficacy is the resource for change, and people with greater self-efficacy are more likely to engage, persist and maintain behavior.

Social marketing is an important strategy for interventions although it is often preferable to combine with other interventions, especially if the program objective is complex behavior in developing communication strategies, designing campaigns Marketing must be guided by the application of behavioral theories. We are working to introduce new dimensions into therapeutic education, which is specific to raise awareness and motivation for telemedicine treatments and distance learning (e-learning). To this end, training of trainers has been implemented on a specific platform in collaboration with a local medical laboratory, specialized and updated multidisciplinary education courses focused on dyslipidemia.

The Technology Acceptance Model (TAM) is a well-adopted model for predicting and explaining the use of information technology which identifies two relevant beliefs: perceived ease of use and perceived usefulness. Since TAM provided an appropriate theoretical basis for studying the adoption of telehealth systems by patients, we integrated it with deep learning and HBM to create our innovative concept.

So that we have invented a smart mascot that we called "ARAYEK" coming from small artery in arabic.



Figure : ARAYEK smart mascot

Arayek will have the heavy task of motivating the users of a dedicated application to change behavior and to maintain this change. Indeed, by querying the ATERA survey database, we are creating an artificial intelligence algorithm using deep learning with Dacima, we are creating an avatar (ARAYEK) for each user (with the same clinical and biological characteristics). Once the risks are identified the avatar (the player) will be asked to respond to a challenge such as "drop two pounds of weight" or "take a 30 min walk every other day" which will be rewarded with a discount of the products of consumption (healthy food, hiking in a healthy circuit, subscription to a sports hall, sports events, admission to cultural events ...). In other words, ARAYEK will be an essential telemedicine tool for monitoring the health of users of the application which will have the rare characteristic of using both deep learning simulating the user himself and at the same time motivate and get him used to behavioral change via challenges (rewards).

Conclusion :

The results of the ATERA survey show a serious situation since we are witnessing an explosion of cardiovascular risk factors and particularly dyslipidemia. Strengthening Tunisian prevention strategies with sophisticated and digital means constitutes a pillar of digital health in favor of anchoring imperative behavioral change to improve the current prevalence of cardiovascular risk factors.

## 6- List of Publication and products

Publication

R. Jemaa, R. Razgallah, I. Ben Ghorbel, L. Rais, A. Kallel. Prevalence of cardiovascular risk factors in the Tunisian population: The ATERA-survey. <https://doi.org/10.1016/j.acvdsp.2019.09.328>

#### Press releases

[https://lapresse.tn/28834/6e-congres-annuel-sur-latherosclerose-et-les-maladies-cardiovasculaires-la-prevention-face-aux-facteurs-de-risque/?fbclid=IwAR3NCvJk\\_214JVqiXXmIhPSPneNz6xZ6CaJuP\\_lev1gSV1AsGX\\_q\\_dAe-zs](https://lapresse.tn/28834/6e-congres-annuel-sur-latherosclerose-et-les-maladies-cardiovasculaires-la-prevention-face-aux-facteurs-de-risque/?fbclid=IwAR3NCvJk_214JVqiXXmIhPSPneNz6xZ6CaJuP_lev1gSV1AsGX_q_dAe-zs)

<https://lapresse.tn/29086/la-prevalence-des-maladies-cardiovasculaires-en-augmentation-sur-un-rythme-alarmant/>

<https://www.babnet.net/mobile/cadredetail-amp.php?id=172239>

[https://www.cardiologie-pratique.com/services/agenda/6e-congres-sur-latherosclerose?fbclid=IwAR0HRf9ocgaEP\\_F1MvC5doVpirm0IWe8qfniAwaBlp--Zr-VQj7bmUVubRI](https://www.cardiologie-pratique.com/services/agenda/6e-congres-sur-latherosclerose?fbclid=IwAR0HRf9ocgaEP_F1MvC5doVpirm0IWe8qfniAwaBlp--Zr-VQj7bmUVubRI)

[http://www.evenement.tn/evenement/6-me-congr-s-annuel-sur-lath-roscl-rose?fbclid=IwAR3q23HmMTF8d0kmoMluS-tBY9HWKbrr6-zam\\_BZq-G9qrfNe5DA1-UyV4I](http://www.evenement.tn/evenement/6-me-congr-s-annuel-sur-lath-roscl-rose?fbclid=IwAR3q23HmMTF8d0kmoMluS-tBY9HWKbrr6-zam_BZq-G9qrfNe5DA1-UyV4I)

<http://almasderplus.tn/?p=3507&fbclid=IwAR2EoK3QMPcvGZ6brMp-OGBunAQaAsthKoaQS5xvCNriN2xCLmik9OM7BFg>

<https://www.linkedin.com/pulse/atera-%25D8%25AA%25D9%2582%25D8%25AF%25D9%258A%25D9%2585-%25D9%2585%25D8%25B4%25D8%25B1%25D9%2588%25D8%25B9-%25D9%2585%25D8%25B3%25D8%25AD-amani-kallel/?fbclid=IwAR3bLCmBNKqHuesw3Jq98WgxuO7wqzTdn1EcvDwN5XjvaUjinPyrAa-5bA>

<https://ar.tunivisions.net/74668/%d8%aa%d8%b2%d8%a7%d9%8a%d8%af-%d8%a7%d9%86%d8%aa%d8%b4%d8%a7%d8%b1-%d8%a3%d9%85%d8%b1%d8%a7%d8%b6-%d8%a7%d9%84%d9%82%d9%84%d8%a8-%d9%88-%d8%a7%d9%84%d8%b4%d8%b1%d8%a7%d9%8a%d9%8a%d9%86-%d9%81%d9%8a/>



Enlarged steering committee

|  |  |                                     |
|--|--|-------------------------------------|
| Department of Biochemistry, Research of laboratory LR99ES11, la Rabta Hospital, Tunis El Manar University, Tunis | <ul style="list-style-type: none"> <li>- use of laboratory equipment (centrifuge, computers, storage of samples in suitable equipment)</li> <li>- Analysis of biological parameters on the ARCHITECT-C8000 (Abbott) while ensuring the quality control of these parameters.</li> </ul>   | Pr Naziha Kaabachi & Pr Moncef Feki |
| National Institutes of Health and statistics   | <ul style="list-style-type: none"> <li>- Providing the clusters to have a representative sample for the seven studied regions</li> <li>- statistical analyzes, operating results, highlighting the impact of the results</li> </ul>  | Pr. Hajer aounallah Skhiri          |
| National institute of Nutrition  | <ul style="list-style-type: none"> <li>- Preparation and execution of the nutritional survey and results exploitation</li> </ul>   | Pr. Jalila ELati                    |
| Ministry of health (management of Basic care Health : « Direction des Soins de Base de la Santé, DSSB »)         | <ul style="list-style-type: none"> <li>- Permission the use existing infrastructure (local health departments) in the intervention phase of the program.</li> <li>- Strengthen existing instrumental support (documents/presentations)</li> <li>- Awareness : <ul style="list-style-type: none"> <li>•Media attention to Dyslipidaemia.</li> <li>•Federal and State attention to dyslipidaemia and cardiovascular disease</li> </ul> </li> </ul> | Dr. Chokri Hammouda                 |

| Team members                  |                                   |                                      |                                     |
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| Investigator, coordinator and | Pr Riadh Jemaa<br>Dr Amani Kallel | validation of biological assessments | Pr. Sameh Hadj Taieb<br>Pr. Mohamed |

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| Drivers     | Moncef zarrouk<br>Maher Titouhi  | Secretary:        | Marwa Yahya  |
| Accountant: | Imed Gtari   |                   |  |

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