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ORIGINAL RESEARCH

# Lifestyle Change, Nutrition Transition and Cardiovascular Risk in Settat Region, Morocco

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Video abstract

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**Introduction:** Morocco, a north African country undergoing a significant nutritional transition, with a clear shift from traditional dietary patterns towards those of the Western model. This transition has a profound impact on the health of its population, most notably in the rise of chronic illnesses and mainly cardiovascular diseases. The following cross-sectional study examines risk factors associated with these nutritional and lifestyle changes and their effects on cardiovascular risk among adults residing in Settat, central Morocco.

**Subjects and Methods:** The study was conducted between January 20th and April 25th, 2023, involving 981 participants aged 20 and above who attended health centers in Settat. Risk factors were assessed using a questionnaire encompassing sociodemographic, health, clinical, dietary, and lifestyle data. To estimate cardiovascular risk, the National Health and Nutrition Examination Survey "NHANES" risk score was employed.

**Results:** Abdominal obesity, a sedentary lifestyle, hypertension, hyperglycemia, and hypercholesterolemia stood out as the most prevalent risk factors, with percentages of 44.3%, 69.7%, 17.6%, 15%, and 26.5%, respectively. As per the "NHANES" risk score, 22.8% were projected to face a cardiovascular risk exceeding 20% within the following five years. This risk was notably linked to the population's sedentary lifestyle and the dietary habits oscillating between the traditional Moroccan pattern and the Western one, marking the nutritional transition.

**Conclusion:** The high prevalence of cardiovascular risk factors underlines the substantial impact of lifestyle changes and nutritional transitions on cardiovascular risk. Consequently, this situation calls for immediate action to devise and deploy strategies aimed at promoting healthy lifestyle choices. Raising awareness about the critical importance of maintaining such a lifestyle is imperative to mitigate the risks and prevent the onset of cardiovascular diseases.

**Keywords:** Nutritional transition, lifestyle change, cardiovascular incidence, cardiovascular risk, settat, Morocco

## Introduction

The annual mortality rate from cardiovascular diseases (CVD), the leading cause of death globally, has escalated from 10% at the dawn of the 20th century to over 30% in the current era, with projections indicating a continued increase. By 2030, it is expected that there will be over 23.6 million CVD-related deaths, with a staggering 80% predicted to occur in developing countries.[1,2] The last few decades have marked a significant epidemiological shift in these regions, driven by unfavorable lifestyle changes, an aging population, and rapid urbanization.[3,4] Morocco, mirroring many developing nations, has experienced a demographic and epidemiological transition, evidenced by declining fertility rates, increased longevity, and a growing elderly population.[5,6]

Simultaneous to these demographic shifts, a notable nutritional transition has unfolded. Traditional diets, rooted in the consumption of cereals, vegetables, and fruits, have long safeguarded a nutritional balance due to their rich composition of valuable nutrients – primarily fibers, vitamins, and natural sugar. However, there has been a shift towards Western dietary patterns, forsaking these nutritious elements for diets characterized by a scarcity of nutrients, an abundance of animal-based fatty acids, refined sugars, and processed foods.[7] This dietary evolution, in concert with a surge in sedentary lifestyles,[8–10] is

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contributing to a rise in cardiovascular risk.[11,12] Obesity, hyperglycemia, hypertension, and dyslipidemia—all closely linked to poor diet and inadequate exercise—are prevalent comorbidities.[13,14]

Settat, a town with a rural heritage located in Morocco's core, has experienced a gradual rise in urbanization, with figures climbing from 27.5% in 1994 to 31.2% in 2004, and 34.3% in 2014.[15] This urbanization has likely affected dietary and lifestyle habits, influencing body metrics across the population. National studies have highlighted a significant uptick in the prevalence of overweight and obesity among Moroccans from all genders over the past twenty years, with a more pronounced increase in urban locales.[16,17] This research endeavors to evaluate the cardiovascular risk within the Settat population and to corroborate the hypothesis that the epidemiological shift is directly impacting cardiovascular risk through examining the associations between cardiovascular risk factors and the dietary and lifestyle changes among adults in Settat.

# Subjects and Methods

## Study Population

This cross-sectional epidemiological survey was conducted between January and April 2023, and executed across health centers in all five communes of Settat/Morocco to ensure a strategic and exhaustive sampling that encompasses both Moroccan men and women who have at least been residing in Settat for a year and who are aged over 20. To maintain the specificity of the study, pregnant women, individuals with pre-existing heart disease, and those not meeting the aforementioned criteria were excluded. This careful selection process was designed to accurately reflect the impact of lifestyle and nutritional transitions on the cardiovascular health of our target population.

## Ethical Considerations, Questionnaire, and Study Variables

The study was ethically approved by the research committee of Hassan First University and was structured following the ethical principles outlined in the Helsinki Declaration. Prior to the questionnaire administration, participants were introduced to the significance and purpose of the survey. After obtaining informed consent from each participant, a one-on-one interview between the surveyor and the respondent was conducted, comprising four main segments:

- Demographic and socio-economic data: This section included information on age, gender, origin, marital status, and educational level providing a demographic backdrop for the analysis.
- Lifestyle data: This segment involved dietary habits, assessed through a list of the most consumed foods in accordance with Moroccan dietary practices (Cereals, Meats, Fruits, Vegetables, Dairy products, and Sugars). The Food Frequency Questionnaire (Moroccan version),[18] previously validated in a separate study, was employed to gauge the frequency of food consumption over the preceding 7 days. Each food item was categorized into three frequency classes: Rarely or never, occasionally, or daily. Additionally, data on physical activity was collected using the Moroccan Arabic version of the IPAQ questionnaire.[19] Questions regarding tobacco and alcohol consumption were inspired by the WHO STEPWISE questionnaire.[20]
- Clinical data: This section involved clinical measurements of blood pressure taken using an automatic blood pressure monitor. Biochemical assessments encompassing fasting blood glucose and cholesterol data are drawn from patient's medical records.
- Anthropometric Data: Body measurements were taken following WHO standardized protocols. This included recording weight (in kilograms), waist circumference (in centimeters), and calculating the Body Mass Index (BMI) to assess and categorize the nutritional status of the respondents.

The variables under study were categorized into four groups: Cardiovascular Risk Factors (CVRF), which included obesity, hypertension, hyperglycemia, and hypercholesterolemia; lifestyle factors such as diet, physical activity, smoking, and alcohol consumption; and control variables, namely age, gender, and origin. Each of these components played a crucial role in painting a holistic picture of the participants' health, allowing for a nuanced analysis of cardiovascular risks associated with lifestyle and dietary patterns.

## Statistical Analysis

Data entry and statistical processing were conducted using SPSS® version 20 software (IBM® SPSS® Statistics). Results for quantitative variables are presented as mean ± standard deviation, while qualitative variables are expressed as percentages. Hypothesis tests were applied at a 5% significance level based on the nature and distribution of the variables. The statistical tests utilized included the Chi-square test, Student's *t*-test, Kruskal–Wallis test, and multinomial logistic regression.

# Results

## General Characteristics of the Population

A total of 981 patients participated in the study, with 55.8% of the population originating from urban areas. The age of participants ranged from 21 to 88 years, with an average age of 51.2 ± 14.46 for men and 50.20 ± 13.84 for women (Table 1). Females predominated strongly, accounting for 82.5% of the participants compared to 17.5% of males, resulting in a female-to-male sex ratio of 4.7. Within the entire population, 17% were classified as illiterate, while 26.9% held a university degree. The majority of participants were married, constituting 69.7% of the cohort. A comprehensive socio-demographic profile is provided in Table 2.

## Health Status of Participants

The prevalence of various cardiovascular risk factors (CVRFs) and their associations with age, gender, and origin are depicted in Figure 1 and Table 3 respectively. The prevalence of hypertension stood at 17.6%, showing an age-related increase from 11% in the 30–39 age group to 24.1% in individuals over 60, with no significant disparity between men and women. Mean systolic and diastolic blood pressure values are outlined in Table 2.

Hyperglycemia prevalence was found in 15% of the cohort, with a pronounced rise noted with advancing age. This condition was more prevalent in the 30–39 age group at 6.9%, escalating to 24.5% in participants over 60. A gender disparity was evident, with 16.6% of women affected as opposed to 7.6% of men.

Hypercholesterolemia affected 26.5% of individuals in the study, with its prevalence correlating with age. The incidence in the younger 20–29 age group was just 1.4%, which significantly increased to 47.4% in the over 60 age group. The manifestation of these risk factors did not show significant variation when comparing rural and urban residents (Figure 1).

**Table 1** Main anthropometric ata of participants

| Variables | Men(Mean± SE) | Women (Mean± SE) |
|---|---|---|
| **Age** | 51.12 ±14.46 | 50.20±13.84 |
| **Size(cm)** | 166.20±8.31 | 164.06±7.76 |
| **Weight(Kg)** | 79 0.87±12.83 | 79.26±12 |
| **Waist circumference** | 101.29±14.52 | 102.85±14.63 |
| **Hip circumference** | 105.46±15 | 107.11±12.6 |
| **WC/HC** | 0.96±0.12 | 0.96±0.15 |
| **BMI** | 29.02±4.94 | 29.62±5.18 |
| **Systolic BP (mmHg)** | 129.35±1.36 | 129.86±15.47 |
| **Diastolic BP (mmHg)** | 83.07±13.09 | 83.50± 11.14 |

**Notes**: Values are shown as mean ± SE.

**Table 2** General characteristics of participants (n=981)

| Variables | | n | % |
|---|---|---|---|
| **Origin** | Urban | 574 | 55.8 |
| | Rural | 434 | 44.2 |
| **Age class** | 20–29 | 69 | 7 |
| | 30–39 | 173 | 17.6 |
| | 40–49 | 194 | 19.8 |
| | 50–59 | 292 | 29.8 |
| | Over 60 | 253 | 25.8 |
| **Gender** | Men | 172 | 17.5 |
| | Women | 809 | 82.5 |
| **Marital status** | Single | 101 | 10.3 |
| | Married | 684 | 69.7 |
| | Divorced | 113 | 11.5 |
| | Widows (widowers) | 83 | 8.5 |
| **Education level** | Unschooled | 112 | 17 |
| | Primary | 194 | 14.4 |
| | Secondary | 411 | 16.5 |
| | Academic | 246 | 26.9 |

## Toxic Habits, Lifestyle, and Anthropometric Assessment of Participants

Tobacco use was reported by 12.6% of the study participants, with a stark gender contrast; only 0.7% of women smoked, compared to 68.6% of men. Age and origin did not significantly alter the prevalence of smoking within the group. Alcohol consumption was notably low, with 96.2% of participants having never consumed alcohol, and this trend exceeded 90% across all age demographics. Due to the minuscule proportion of female drinkers (0.4%), gender-based

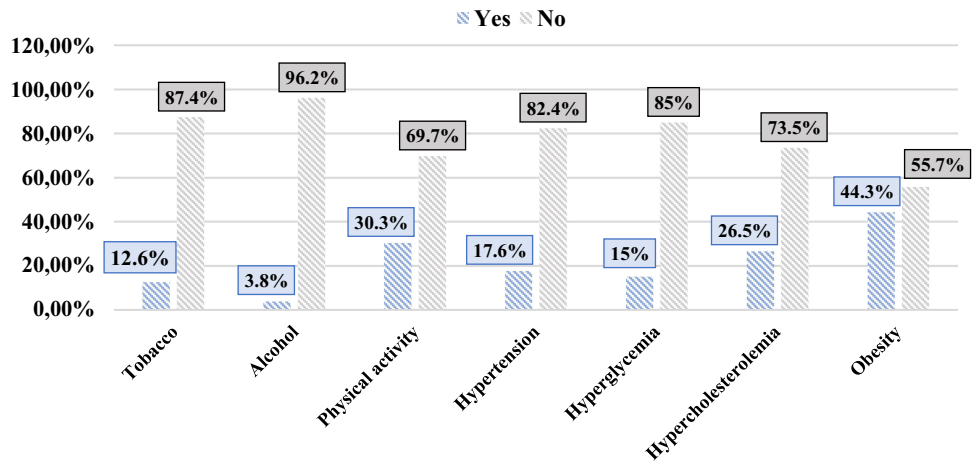


**Figure 1** Prevalence of risk factors among participants.

**Table 3** Prevalence of Cardiovascular Risk Factors by Origin, Gender, and Age Class

| Variable | Modality | Tobacco % | P | Alcohol % | P | PA % | P | HTN % | P | Hypergly % | P | Hyperchol % | P | Obesity % | P |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Origin** | Urban | 13.5 | ns | 3.7 | ns | 81.2 | ns | 17.9 | ns | 14.1 | ns | 25.8 | ns | 41.1 | ns |
| | Rural | 11.5 | | 3.9 | | 84.6 | | 17.3 | | 16.1 | | 27.4 | | 48.4 | |
| **Gender** | Male | 68.6 | <0.001 | 19.8 | na | 80.2 | ns | 22.1 | ns | 7.6 | 0.001 | 32 | ns | 41.9 | ns |
| | Female | 0.7 | | 0.4 | | 83.2 | | 16.7 | | 16.6 | | 25.3 | | 44.9 | |
| **Age class** | 20–29 | 10.1 | ns | 4.3 | ns | 71 | 0.005 | 13 | 0.001 | 0 | 0.0001 | 1.4 | 0.001 | 43.5 | ns |
| | 30–39 | 11.6 | | 3.5 | | 86.1 | | 11 | | 6.9 | | 12.1 | | 41.6 | |
| | 40–49 | 13.4 | | 3.6 | | 80.4 | | 14.9 | | 10.3 | | 17.5 | | 44.3 | |
| | 50–59 | 11 | | 2.4 | | 80.1 | | 18.8 | | 18.2 | | 28.8 | | 49.3 | |
| | Over 60 | 15.4 | | 5 | | 88.1 | | 24.1 | | 24.5 | | 47.4 | | 40.7 | |

**Notes**: Values were shown as a percentage. p<0.0001; p<0.001.
**Abbreviations**: P.A, Physical activity; HTN, Hypertension; Hypergly, Hyperglycemia; Hyperchol: Hypercholesterolemia; ns,No significant; na,Not applicable.

**Table 4** Variation in anthropometric measurements by age and gender

| Variables | Modality | BMI | | | Abdominal Perimeter | | |
|---|---|---|---|---|---|---|---|
| | | Mean±SE | IC 95% | Test t or F | Mean±SE | IC 95% | Test or F |
| **Age class** | 20–29 | 29.47± 4.60 | (28.36–30.58) | F= 0.85 | 0.94± 0.9 | (0.92–0.97) | F= 0.46 |
| | 30–39 | 29.25± 5.70 | (28.41–30.09) | | 0.96±0.16 | (0.94–0.99) | |
| | 40–49 | 29.71±4.91 | (29.02–30.40) | | 0.97±0.14 | (0.95–0.99) | |
| | 50–59 | 29.91±5.03 | (29.33–30.48) | | 0.97±0.17 | (0.95–0.99) | |
| | 60 et plus | 29.31±5.20 | (28.68–29.93) | | 0.96±0.10 | (0.94–0.97) | |
| **Gender** | Male | 29.14±4.94 | (28.42–29.86) | t= −1.36 | 0.96±0.12 | (0.94–0.98) | t= 0.15 |
| | Female | 29.66±5.18 | (29.30–30.01) | | 0.96±0.15 | (0.95–0.97) | |

**Notes**: Values are shown as mean ± SE.
**Abbreviations**: BMI, Body mass index; CI, Confidence Interval; F, Fisher; t, Student.

comparisons of alcohol consumption were not substantial. The patterns of alcohol use were similarly low across both rural and urban dwellers.

Physical inactivity was observed in a considerable 69.7% of the cohort, with sedentariness increasing with age—from 71% among those aged 20–39 to 88.1% in those aged 60 and above. Sedentary habits were uniformly distributed regardless of gender or geographical origin. Overweight prevalence stood at 44.3% across the population, with the incidence appearing uniform across different age brackets and between genders. The study found that average abdominal circumference measurements did not significantly vary between different sexes and age groups, as detailed in Table 4.

## Eating Habits

Daily consumption of vegetables, fruits, and fishes was reported by 97.1%, 47.3%, and 30.2% of participants, respectively. Fast food, soda, energy drinks, meat, and butter were consumed daily by 20.3%, 18%, 5.3%, 44.2%, and 65.7% of the participants. Figure 2 depicts the frequency of food consumption among our study population.

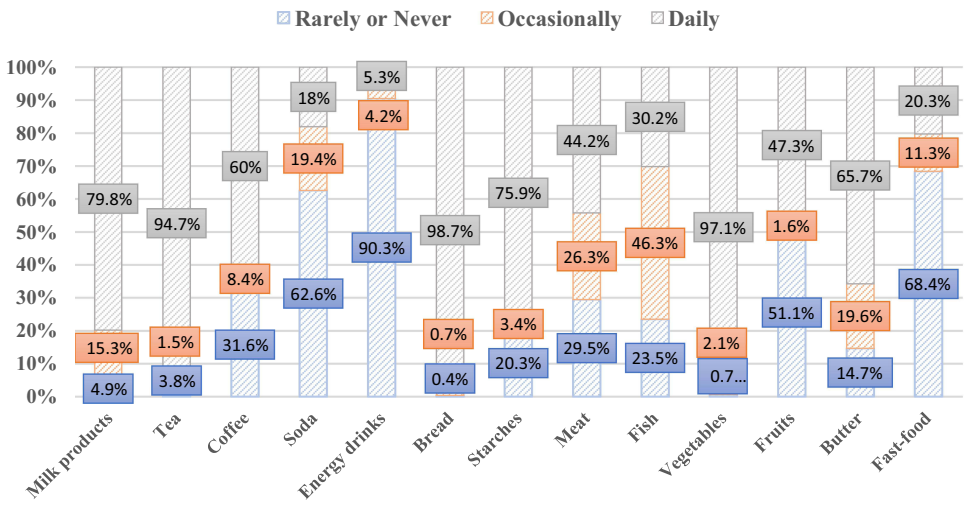


**Figure 2** Food frequency consumption.

## Cardiovascular Risk Assessment

According to the "NHANES" Cardiovascular Risk Score, three profiles were established (Figure 3), encompassing those with a low CVR (−5%), moderate CVR (between 5%-10%), and high CVR (+20%). Among the 981 individuals, 224 subjects had a high cardiovascular risk, representing 22.9% of the population.

Cardiovascular risk was associated with physical inactivity, alcohol consumption, and dietary habits. Individuals not engaging in physical activity showed a higher CVR (24.3%) compared to those who did (15.3%) (Figure 4).

The intensity of physical activity appeared to influence the level of CVR; as shown in Figure 5, the graph illustrates that high CVR is five times lower with intense activity than with light activity.

Furthermore, the distribution of different CVR levels was similar between individuals with a normal build and those who were overweight (Table 4). Moreover, soda, milk, dairy products, vegetables, fruit, fish, and fast food emerged as determining factors influencing the level of CVR (Table 5).

# Discussion

The current study serves as the initial evidence indicating the significant onset of nutritional transition within the population of Settat. This primarily rural city is progressively experiencing the impact of urbanization and industrialization, consequently adopting more "westernized" habits and lifestyles. In this survey, the socio-demographic profile uncovered that more than half (55.8%) of the population hails from urban areas. This urbanization trend aligns with the 2017 report from the Casablanca-Settat regional directorate, forecasting an increasing urbanization rate by 2030 within various provinces of the region, owing to the notable indigenous growth observed in recent years.[15,21]

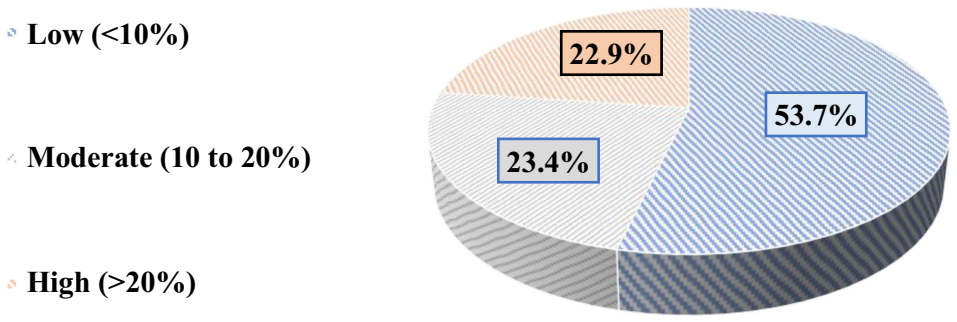


**Figure 3** Distribution of cardiovascular risk.

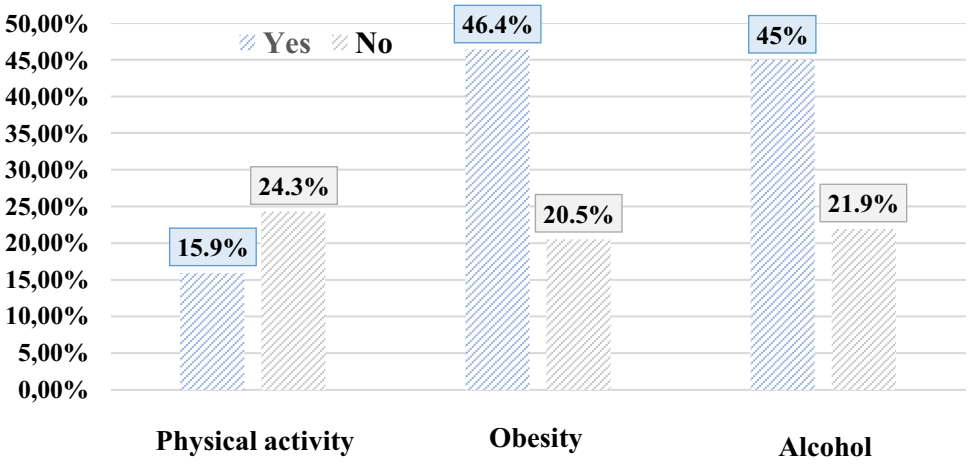


**Figure 4** Association between high cardiovascular risk (+20%) and the risk factors.

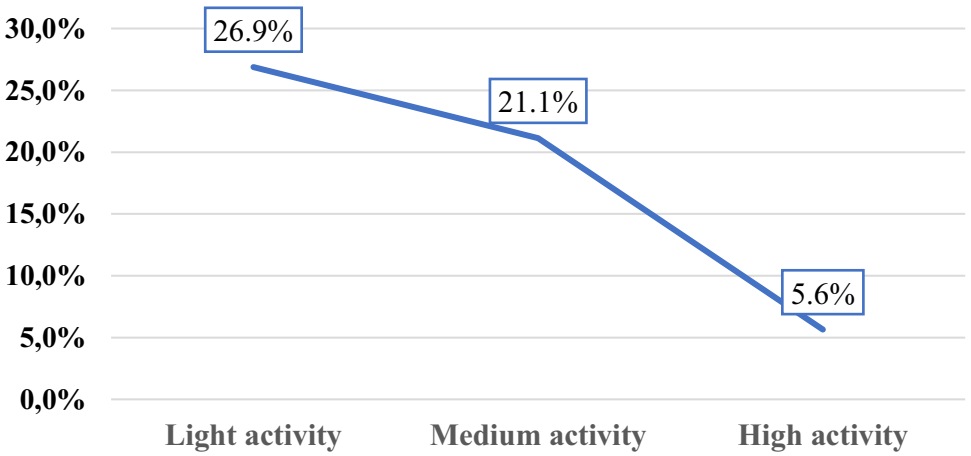


**Figure 5** Distribution of cardiovascular risk by intensity of physical activity.

The health status assessment of participants identified notable incidences of obesity, hypertension, hyperglycemia, and hypercholesterolemia, affecting 44.3%, 17.6%, 15%, and 26.5% of the subjects, respectively. Comparatively, the prevalence of hypertension in our sample remains lower than the national average estimated at 36%,[22] as well as the figures recorded in the Moroccan region of Rabat (25%), Tunisia (28%), and Egypt (26.3%).[23,24]

Presently, diabetes poses a significant public health concern globally, including in Morocco, where the estimated number of diabetics among individuals aged 20 and over ranges between 1.5 and 2 million, constituting 11.6% of this demographic.[25] In our study, the prevalence of hyperglycemia surpassed the values reported in the Laayoun and Oujda cohorts (6.2% and 11.9%, respectively),[26,27] but resembled figures found in the Tunisian capital (15%).[28] Additionally, a quarter of the population (26.5%) exhibited hypercholesterolemia. Similar results were observed in a study conducted on the population in Pau, where 24% demonstrated lipid anomalies, and in certain African countries such as Togo (58.1%) and Algeria (67.8%).[29–31]

In the context of hypercholesterolemia, 25.5% of the male population was affected compared to 5.77% of the female population. This aligns with the national prevalence, which is higher in women than in men (32% vs 25.9%).[22] Similar gender-based prevalence trends were observed in Algeria (16.6% vs 12.6%), while no notable differences between sexes were observed in Tunisia.[28,31]

A total of 12.6% of the participants were smokers, a prevalence close to the findings presented by the NSPFH in 2018.[32] Research has indicated that the risk of cardiovascular system damage escalates concerning the quantity, type, and duration of

**Table 5** Multinomial Regression Between Cardiovascular Risk and Frequency of Food Consumption

| Food | Moderate CVR | | | | High CVR | | | |
|---|---|---|---|---|---|---|---|---|
| | B | Wald | P | OR (CI à 95%) | B | Wald | P | OR (CI à 95%) |
| **Milk products** | | | | | | | | |
| Occasionally | 0.34 | 0.76 | 0.04 | 1.4 (0.65–3.03) | 0.29 | 0.53 | < 0.005 | 1.33 (0.61–2.92) |
| Daily | −0.48 | 3.28 | | 0.61 (0.36–1.04) | −0.94 | 9.6 | | 0.38 (0.21–0.7) |
| **Coffee** | | | | | | | | |
| Occasionally | 0.26 | 1.77 | Ns | 1.30 (0.88–1.93) | −0.18 | 0.69 | Ns | 0.83 (0.54–1.28) |
| Daily | 0.27 | 0.67 | | 1.31 (0.68–2.54) | 0.24 | 0.54 | | 1.27 (0.66–2.45) |
| **Tea** | | | | | | | | |
| Occasionally | −0.73 | 1.98 | Ns | 0.48 (0.17–1.33) | −0.15 | 0.12 | Ns | 0.85 (0.36–2.03) |
| Daily | 1.51 | 2.67 | | 0.54 (0.74–7.95) | 0.83 | 0.86 | | 2.3 (0.39–13.41) |
| **Soda** | | | | | | | | |
| Occasionally | 0.13 | 0.39 | 0.05 | 1.13 (0.75–1.71) | 0.25 | 0.93 | 0.001 | 1.29 (0.76–2.19) |
| Daily | −0.12 | 0.23 | | 0.88 (0.53–1.45) | 0.82 | 0.06 | | 1.08 (0.58–2.05) |
| **Energetic drinks** | | | | | | | | |
| Occasionally | 0.99 | 4.51 | <0.05 | 2.7 (1.08–6.75) | −0.27 | 0.50 | <0.005 | 1.32 (0.61–2.83) |
| Daily | −0.97 | 7.3 | | 5.13 (1.56–16.83) | −0.42 | 0.53 | | 1.53 (0.48–4.81) |
| **Starches** | | | | | | | | |
| Occasionally | −0.48 | 0.02 | Ns | 1.04 (0.53–2.04) | 0.10 | 0.07 | Ns | 1.1 (0.53–2.31) |
| Daily | 0.34 | 0.28 | | 0.7 (0.19–2.52) | 0.66 | 1.39 | | 1.03 (0.64–5.81) |
| **Bread** | | | | | | | | |
| Occasionally | 0.21 | 0.02 | Ns | 1.2 (0.9–1.7) | −0.006 | 0 | Ns | 0.9 (0.19–0.48) |
| Daily | 0.55 | 1.13 | | 0.57 (0.06–5.33) | 0.55 | 0.23 | | 0.57 (0.05–5.61) |
| **Vegetables** | | | | | | | | |
| Occasionally | −0.71 | 8.76 | <0.05 | 0.05 (0.01–0.31) | −19.57 | 0 | < 0.05 | – |
| Daily | −1.77 | 5.08 | | 0.16 (0.03–0.7) | −2.63 | 5.78 | | 0.07 (0.08–0 0.61) |
| **Fruits** | | | | | | | | |
| Occasionally | 0.11 | 0.34 | <0.05 | 1.12 (0.75–1.66) | −0.76 | 0.22 | <0.05 | 1.1 (0.7 −1.6) |
| Daily | −0.23 | 0.10 | | 0.79 (0.19–3.23) | −0.55 | 0.37 | | 0.57 (0.05–5.6) |
| **Meat** | | | | | | | | |
| Occasionally | −0.31 | 2.20 | 0.005 | 0.73 (0.48–1.10) | −0.11 | 0.26 | < 0.05 | 0.89 (0.57–1.38) |
| Daily | −0.26 | 1.18 | | 0.76 (0.47–1.23) | −0 0.3 | 0.02 | | 0.96 (0.58–1.58) |

(*Continued*)

**Table 5** (Continued).

| Food | Moderate CVR | | | | High CVR | | | |
|---|---|---|---|---|---|---|---|---|
| | B | Wald | P | OR (CI à 95%) | B | Wald | P | OR (CI à 95%) |
| **Fish** | | | | | | | | |
| Occasionally | −0.98 | 0.01 | Ns | 1.02 (0.62–1.68) | −0.28 | 1.04 | < 0.05 | 0.75 (0.43–1.29) |
| Daily | −0.32 | 2.08 | | 0.72 (0.46–1.12) | −0.61 | 6.68 | | 0.54 (0.34–0.86) |
| **Butter** | | | | | | | | |
| Occasionally | 0.16 | 0.34 | Ns | 1.17 (0.68–2.02) | 0.75 | 8.4 | | 2.1 (1.27–3.51) |
| Daily | 0.12 | 0.30 | | 1.13 (0.71–1.79) | 0.01 | 0.003 | < 0.005 | 0.5 (1.01–0.6) |
| **Fast-food** | | | | | | | | |
| Occasionally | 1.35 | 29.71 | <0.0001 | 3.87 (2.38–6.30) | −0.71 | 38.85 | | 6.7 (3.69–12.25) |
| Daily | −3.09 | 1.91 | | 1.5 (0.82–3.02) | −4.50 | 1.45 | <0.0001 | 0.49 (0.15–1.56) |

**Notes**: Low cardiovascular risk is used as a reference modality. p<0.0001 or p<0.001.
**Abbreviations**: β, Bêta constant; Wald; OR, Odds Ratio; CI, Confidence Interval; ns, No significant.

tobacco use.[33] Even individuals with low smoking frequency, such as those who smoke only one cigarette a day, face considerably heightened risks. Notably, the lowest prevalence of smoking was observed among women, at 0.7%. In developed countries, the prevalence of smoking stands at 42% among men and 24% among women, while in developing countries, it reaches 48% among men and 7% among women. For instance, the United Kingdom has a smoking rate of 23% among women and 25% among men. In contrast, the Philippines shows a lower prevalence for women at 9% but a higher rate for men at 48%.[34,35] While limited studies in Morocco have examined smoking in the general population, all have consistently found it to be a predominantly male behavior.[36–38] In Arab- Muslim societies, the predominance of male smokers might be explained by socio-cultural factors where female smokers face disapproval.[39]

The "NHANES" Cardiovascular Risk score indicated that over 45% of the surveyed population in Settat city were at a moderate to high CVR level, with scores ranging from 10 to 30%. This finding represents a considerable increase from a previous study conducted five years earlier, which documented that 35.28% of patients in primary healthcare settings had a CVR over 10%. It also surpasses the CVR percentages reported in the research by Tachfouti et al and Boutahiri et al, as well as a more recent study from the Souss-Massa region, which indicated CVR percentages of 26% and 28% in moderate to high range.[40–42]

The prevalence of non-drinkers exceeded 90% across all age groups. This aligns with national surveys on non-communicable diseases (NCDs), which reported a similar prevalence where 92.9% had never consumed alcohol in their lives.[22] It was not feasible to compare this data by gender due to the low percentage of women consuming alcohol (0.4%, n=3).

The low alcohol consumption rate may be influenced by the dominant Muslim religion, which traditionally prohibits alcohol.[43] Further analysis examining the link between alcohol consumption and CVR revealed a higher CVR among those who consume alcohol (Figure 4).

Abdominal obesity is known to be associated with cardiovascular risk.[44] In our sample, patients with abdominal obesity exhibited a higher cardiovascular risk than those of normal build (20.5% vs 46.4%), although obesity itself was not directly associated with CVR (Table 4). This finding might be explained by the prevalence of obesity within the population, indicating that cardiovascular risk is the consequence of multiple interacting factors that might vary among individuals. Obesity was notably prevalent in the population, affecting 44.3%. This figure significantly surpasses the prevalence in Morocco, recorded at 13.2%,[21] and even exceeds figures from other North African countries such as Algeria and Tunisia, where it stands at more than 19%.[23,24] Literature identifies obesity as the most prevalent risk factor in women compared to men, observed in Tunisia (46% vs 8%), South Africa (44% vs 8%), Mauritius (5% vs 5%), Tanzania (3.6% vs 0.6%), USA (24.9% vs 19.9%), and Brazil (13% vs 6%).[45,46] On a national scale, the Stepways survey reported an estimated prevalence of obesity in women at 19.1%,

compared with 7.2% in men.[21] A study in the Moroccan region of Safi reported a high prevalence of abdominal obesity among women (46.15%) compared with men (15.7%).[47] However, our findings differ, showing similar results between the sexes. A Canadian study also found similar rates (15% in women vs 15% in men).[48]

A high BMI is a known consequence of consuming calorie-intensive foods, such as sugary products and fast food.[49] As a preventive measure against obesity and sedentary behavior, the World Health Organization (WHO) recommends at least 150 minutes of moderate physical activity per week.[2] In our study, only 17.3% met this recommendation, while 82.7% did not. This prevalence indicates an alarming situation, potentially linked to economic conditions, poverty, and a lack of sports facilities within the city. Sedentary lifestyles are prevalent in numerous countries;[50,51] in Switzerland, it stands at around 37%, in Tunisia at 57%, in France at 53%, and in Canada at 52.6%.[44,52,53] To the best of our knowledge, there are no individual studies on sedentary behavior in Morocco, but the national survey on non-communicable diseases reported a prevalence of 21.1%.[21] Women in our sample exhibited higher sedentary behaviors compared to men (67.3% vs 12.5%). This aligns with literature reporting higher sedentary lifestyles among women than men in various countries: Algeria (49.5% vs 33.8%), France (50.1% vs 41.5%), Switzerland (66.5% vs 50.6%), Canada (62% vs 38%), and the USA (62% vs 56%).[44,53,54] There was a slight association between a sedentary lifestyle and cardiovascular risk (p=0.04) (Figure 4). Among sedentary individuals, 24.1% had a high CVR compared to 16.8% among non-sedentary individuals. The intensity of physical activity appeared to correlate with the level of CVR; as depicted in Figure 4, the graph demonstrates that a high CVR is five times lower with intense activity compared to light activity. This aligns with other studies reporting a decrease in cardiovascular risk as the level of activity increases and the significant association of physical activity with reduced cardiovascular mortality.[55]

Furthermore, an unhealthy diet is recognized as one of the risk factors contributing to various chronic diseases, including cardiovascular disease.[48] Analyzing the dietary habits of our population revealed two distinct dietary models. The first, a "traditional" diet, predominantly includes cereals, fruits, and legumes, while the second, a "transitional" diet, is influenced by the introduction of chemical and industrial products. Among our participants, bread (98.7%) and tea (94.7%) were the most frequently consumed items throughout the week. These commonly found items on the Moroccan table may contain substantial amounts of sugar, contributing to Moroccans being heavy consumers of sugar, with an annual average of 34.5 kg per inhabitant, surpassing the world average of 20 kg per inhabitant per year.[56] Vegetables and fruit were consumed at rates of 97.1% and 47.3%, respectively, possibly due to the region's agricultural focus on vegetable and cereal cultivation.[21]

Our study's findings reveal significant correlations between the consumption of certain food items and the level of cardiovascular risk (CVR), as demonstrated through multinomial regression analysis detailed in Table 5. This confirms our preliminary hypothesis that diet plays a crucial role in cardiovascular health. Notably, high CVR is strongly associated with the intake of energy drinks, sodas, and fast foods. These products, which are not traditional components of the Moroccan diet, have gained popularity alongside the country's economic development and urbanization.

Fast-food chains, catering to a wide consumer base, often provide a variety of options at prices more accessible than those of traditional eateries. This trend towards a "Westernized" diet is further bolstered by the region's strong agricultural capabilities, which attract investment into the agro-industrial sector. This sector is instrumental in linking food production to processing and distribution networks, thereby facilitating the integration of these highly industrialized food products into the Moroccan food system.[7] The shift in dietary patterns underscores the need to consider the implications of such "Westernization" on public health, particularly in terms of increasing CVR.

Despite Morocco's status as a leading fish producer with a vast maritime domain that ranks first in the Arab and African regions and 17th globally, the consumption of fish among Moroccans is notably low. Our study found that 23.5% of participants seldom or never consume fish, with the national per capita fish consumption averaging only 10 to 12 kilograms annually—significantly below the global average of 20 kilograms.[57,58] This aligns with studies affirming the protective role of these foods against cardiovascular diseases and underscores investigations on Moroccan's adherence to the Mediterranean diet, notably in northern Morocco. Such diet that is renowned for its emphasis on fish and vegetables, is recommended for preventing CVD by enhancing lipid profiles, reducing inflammation, oxidation, coagulation, and primarily lowering blood pressure.[49]

## Conclusion

In light of this extensive study, our observations reveal Settat as profoundly influenced by multiple facets of a nutritional transition, reflecting a concerning reality where approximately a quarter of the population (22.9%) faces a potential risk of encountering fatal or non-fatal cardiovascular events within the next five years. The prevalence of various cardiovascular risk factors (CVRFs) — including obesity, hyperglycemia, arterial hypertension, and hypercholesterolemia — in our population is undeniably troubling. Our findings underscore the pivotal roles played by an unhealthy diet and physical inactivity in determining the trajectory of cardiovascular diseases (CVDs).

This research has served as a critical examination and validation of our hypothesis regarding the potential impact of nutritional transition on the incidence of CVD. Consequently, it emphasizes the urgency of directing public attention towards the immense benefits of embracing a healthy lifestyle. Encouraging a shift towards a healthier diet, regular engagement in physical activity, and promoting the practice of sports must be regarded as foundational pillars in the prevention of CVDs. Actionable steps towards these lifestyle adjustments are imperative to curb the looming threat of cardiovascular diseases within the population of Settat.

## Abbreviations

RF, Risk factor; CVRF, Cardiovascular risk factor; CVD, Cardiovascular diseases; NCD, Non-communicable disease; NSPFH, National Survey on Population and Family Health; HC, Hip circumference; WC, Waist circumference; BMI, Body Mass Index; BP, Blood Pression; SE, Standard Ecartype. P.A; Physical activity; HTN, Hypertension; Hypergly, Hyperglycemia; Hyperchol, Hypercholesterolemia.

## Data Sharing Statement

The data used to support the findings of this study are included within the article.

## Ethics Approval and Consent to Participate

The study was approved by the Ethics Committee of the Hassan First University and done in accordance with the Declaration of Helsinki.

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## Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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## References

1. Roth GA, Abate D, Abate KH, et al. Global, regional, and national age-sex-specific mortality for 282 causes of death in 195 countries and territories, 1980–2017: a systematic analysis for the Global Burden of Disease Study 2017. *Lancet*. 2018;392:1736–1788.
2. WHO. *Cardiovascular Diseases Geneva*. World Health Organization; 2017. Available from: https://www.who.int/news-room/fact-sheets/detail/cardiovascular-diseases-(cvds). Accessed February 5, 2023.
3. Barouaca H, Emelumadu OF, Adinma ED, et al. Nutrition transition in developing countries. *Biosanté*. 2012;10:10–15.

4. Hercberg S, Castetbon K, Czernichow S, et al. The Nutrinet-Sante Study: a web-based prospective study on the relationship between nutrition and health and determinants of dietary patterns and nutritional status. *BMC Public Health*. 2010;10(1):242. doi:10.1186/1471-2458-10-242
5. Tazi M, Abir-Khalil S, Chaouki N, et al. Prevalence of the main cardiovascular risk factors in Morocco: results of a National Survey, 2000. *J Hypertension*. 2003;21(5):897–903. doi:10.1097/00004872-200305000-00013
6. Aboussaleh Y, Sbaibi R. Nutritional Status of Population in North-West Morocco. *Antropo*. 2015;33:13–20.
7. Haut-Commissariat Au Plan. *Morocco's Social Indicators*; 2020.
8. Benjelloun S. Nutrition transition in Morocco. *Public Health Nutr*. 2002;5(Suppl. 1A):135–140. doi:10.1079/PHN2001285
9. Ministry of Health Report. *National Nutrition Strategy. 2011-2019*; 2011.
10. Fadoua ALLALI. Nutrition Transition In Morocco. UM6SS EDITIONS. *Int J Med Surgery*. 2017;4:145. doi:10.15342/ijms.v4is.145
11. Breewood H. *What is the Nutrition Transition? (Foodsource: Building Blocks)*. Food Climate Research Network, University of Oxford; 2018.
12. Bard J. Glucidolipid diet and cardiovascular diseases. *Actualités pharmaceutiques*. 2021;28:610. doi:10.1016/j.actpha.2021.08.007
13. Costil V, Beilin LJ, Clifton PM, et al. Dietary Advice To prevent Cardiovascular Risk and Lipid Disorders. *Hegel*. 2014;30:S14 à S16.
14. Mokhtar N, Elati J, Chabir R, et al. Diet culture and obesity in Northern Africa. *J Nutt*. 2001;131(3):887S–892S. doi:10.1093/jn/131.3.887S
15. High-Commissionner for planning. Provincial Direction of Settat. *Monographe of the Province of SettatDE*; 2018.
16. El Rhazi K, Nejjari C, Romaguera D, et al. Adherence to a Mediterranean diet in Morocco and its correlates: cross-sectional analysis of a sample of the adult *Moroccan* population. *BMC Public Health*. 2012;12:345. doi:10.1186/1471-2458-12-345
17. Aboussad A, Cherkaoui M, Vimard P . *Health and Vulnerability in Morocco*. Université Cadi Ayyad; LPED; 2010:254.
18. El Kinany K, Garcia-Larsen V, Khalis M. Adaptation and validation of a food frequency questionnaire (FFQ) to assess dietary intake in Moroccan adults. *Nutr J*. 2018;17(1):61. doi:10.1186/s12937-018-0368-4
19. Benmaamar S, Epstein J, Benaicha N, et al. Cross-Cultural Adaptation and Validation of the Moroccan Version of the « International Physical Activity Questionnaire » (IPAQ). *J Epidemiol Public Health*. 2022:S63–S85−. doi:10.1016/j.respe.2022.03.092.
20. WHO. *STEPwise pour la Surveillance des Maladies non transmissibles (STEPS)*. WHO/NMH/CCS; 2001.
21. Ministry of agriculture, Maritime Fisheries, Rural Development, Water and Forests. *Régional Direction of Agriculture Casablanca-Settat Region. Agriculture Monographe Agricole of Région Casablanca-Settat Region*; 2018.
22. Ministry of Health. *National Survey of Common Risk Factors of Non-Communicable Diseases STEPS*; 2017.
23. Otmane A. Physical Activity and Nutritional Status among women in childbearing age in Morocco (Casa-Rabat) and relationship with Sociodemographic characteristics. relation avec Thesis defended on Mai the 19th 2012; Ibn Tofaïl university, Faculty of Sciences of Kénitra (Morocco).
24. Nejjari C, Arharbi M, Chentir MT, et al. Epidemiological trial of hypertension in North Africa (ETHNA): an international multicenter study in Algeria, Morocco, and Tunisia. *J Hypertens*. 2013;31(1):49–62. doi:10.1097/HJH.0b013e32835a6611
25. Bourkhime H, Es-safi I, Bari A, et al. Profile of Diabetes in Rural Area in the Province of Ifrane, Morocco. *J Epidemiol Public Health*. 2023;71S2:101784.
26. Rguibi M, Belahsen R. Metabolic syndrome among Moroccan Sahraoui adult women. *Am J Hum Biol*. 2004;16(5):598–601. doi:10.1002/ajhb.20065
27. Sellam EB, Bour A. Prevalence of risk factors for cardiovascular disease in women in Oujda (Morocco). *Med Metabolic Dis*. 2016;10:56.
28. Elasmi M, Ennouri S, Rachdi H, et al. Prevalence of conventional Cardiovascular Risk Factors in population in Great Tunis. *J Epidemiol Public Health*. 2020;57:87–92.
29. Visseren FL. 2021 ESC Guidelines on cardiovascular disease prevention in clinical practice. *Eur Heart J*. 2021;1111. doi:10.1093/eurheartj/ehab484
30. Bernard M, LioretS, Gartner A, et al. Nutrition Transition and Non Communicable Diseases related to Diet in developing countries. *Health Guide*. 2002;12:45–55.
31. Yahia-Berrouiguet A, Sidi-Yakhlef A, Hamdaoui H, et al. Survey for the prevalence of the cardiovascular Risk Factors in Tlemcen (Algérie). *Med Metabolic Dis*. 2009;3:313–319.
32. Ministry of Health. *National Survey on Family Health (NSFH)*; 2018.
33. Thomas D. Smoking: cardiovascular risk factor number 1. *Cardiologue letter*. 2008;416.
34. Huchon G. Female Smoking. *Médecine Hygiene*. 2003;26:2430.
35. World Health Organization. *The Tobacco Atlas / Judith Mackay and Michael Eriksen*. World Health Organization; 2002. Available from: https://apps.who.int/iris/handle/10665/42580. Accessed February 5, 2024.
36. Tachfouti N. Smoking-attributable mortality in Morocco: results of prevalence-based study in Casablanca. *Arch Public Health*. 2014.
37. Mezzani. T. Smoking: knowledge, attitudes and Behavior of general Practitioners in Khénifra. *Thesis Med*. 2008.
38. Herouach S, El Bahraoui H. Modernity and Morocco: gender Smoking as a Modernity Sub-youth Culture Aspect, Fez as a Case Study. *Open Political Science*. 2020;3(1):128–156. doi:10.1515/openps-2020-0011
39. Nejjari C, Benjelloun MC, Berraho M, et al. and demographic factors of smoking in Morocco. *Int J Public Health*. 2009;54(6):447–451. doi:10.1007/s00038-009-0082-2
40. Tachfouti N, Essayagh M, El Rhaffouli A, et al. Cardiovascular Risk Assessement at the Hospital Staff in Meknes. A Meknes. *Moroccan Revueof Public Health*. 2017;1(1):548. doi:10.34874/Imist.Prsm/Rmsp/2232
41. Boutahiri N. *Cardiovascular Risk Assessement at the Hospital Staff in Meknes (512 Cases)*. Morocco. Thesis on medecine. Sidi Mohamed Ben Abdellah University. FMPF; 2011.
42. Korrida A, Ayachi M, Mziwira M, et al. Cardiovasculaire Risk Assessment on asymptomatic residents in South of Morocco. *Med Mal Metab*. 2021;15:709–715.
43. Laian Z, Young CM, Leasure L, et al. Religious perceptions of alcohol consumption and drinking behaviours among religious and non-religious groups. *Mental Health Religion Culture*. 2016;19(9):1028–1041. doi:10.1080/13674676.2017.1312321
44. Oppert J, Balarac N, et al. Physical Activity and Management of obese patients. *Ann Endocrinol*. 2001;62:S37–S42.
45. World Health Organisation. *Media Centre Obesity and Overweight: Fact Sheet N°311 IOTF Report*. Geneva: World Health Organisation; 2015.
46. World Obesity Federation, 2022. WorldObesityAtlas2022. Available from: https://data.worldobesity.org/publications/WorldObesity-Atlas-2022-updated.pdf. Accessed February 5, 2024.
47. Elghouizi H. Prevalence of Cardiovascular Risk Factors on the Elderly in Safi. *Thesis Med*. 2011.

48. Public Health Agency of Canada. Tracking Heart Diseases and Stroke in Canada; 2009. Available from: http://www.phacaspc.gc.ca/publicat/2009/cvd-avc/pdf/cvd-avs-2009-fra.pdf. Accessed April 5, 2023.
49. Benyaich A, Anzid K, Hilali A, et al. Mediterraneen Dient and the prevalence of Cardiovascular Risk Factors in Nador (Morocco). *Med Mal Metab*. 2020;14:85–92.
50. WHO guidelines on physical activity and sedentary behaviour. 2021. ISBN 978-92-4-003211-8.
51. Ford ES, Caspersen CJ; Ford ES et Caspersen CJ. Sedentary behaviour and cardiovascular disease: a review of prospective studies. *Int J Epidemiol*. 2012;41(5):1338–1353. doi:10.1093/ije/dys078
52. Erlichman J, Kerbey AL, James WPT. Physical activity and its impact on health out comes: prevention of unhealthy weight gain and obesity by physical activity: an analysis of the evidence. *Obes Rev*. 2002;3(4):273–287. doi:10.1046/j.1467-789X.2002.00078.x
53. Brad R, McLeod L, Ruseski JE, et al. Physical Activity And Health Outcomes: evidence From Canada. *Health Econ*. 2014;23(1):33–54. doi:10.1002/hec.2900
54. Kwak L, Berrigan D, Van Domelen D, Sjöström M, Hagströmer M. Examining differences in physical activity levels by employment status and/or job activity level: gender-specific comparisons between the United States and Sweden. *J Sci Med Sport*. 2016;19(2016):482–487. doi:10.1016/j.jsams.2015.05.008
55. Elagizi A, Kachur S, Carbone S, et al. A Review of Obesity, Physical Activity, and Cardiovascular Disease. *Curr Obes Rep*. 2020;9(9):571–581. doi:10.1007/s13679-020-00403-z
56. COSUMAR. Annual Report 2013; 2013.
57. Ministry of finance and privatisation. *Departement of Studies and Financial Forecasts. Analyse of Fisheries and Aquaculture Sector in the New Context*; 2008.
58. Ministry of Economy, Finances and Administration Reform. *Moroccan Sector of Fisheries and Aquaculture: Structural Trends, Challenges and Developpement Levers*; 2020.