Knowledge, attitudes and eating habits red and processed meat among gym users: a cross-sectional survey

Title*: Knowledge, attitudes and eating habits on red and processed meat among gym users: a cross-sectional survey.*

Authors:

Bert Fabrizio[1], Scaioli Giacomo[1], Tolomeo Martina[2], Lo Moro Giuseppina[1], Gualano Maria Rosaria[1], Siliquini Roberta[1]

Affiliations:

[1] Department of Public Health Sciences, University of Turin, Italy

[2] Degree Course in Dietistics, University of Turin, Italy

Corresponding Author*:*

Dr. Giuseppina Lo Moro, MD

Department of Public Health Sciences, University of Turin

Via Santena 5 bis, 10126 Turin, Italy

Tel. +390116705837

Fax +390116795889

Email: giuseppina.lomoro@unito.it

Keywords: Red Meat; Processed Meat; Feeding Behaviour; Sports

Abstract

Aims

In 2015, the International Agency for Research on Cancer classified red meat (RM) and processed meat (PM) intakes as "probably carcinogenic" and "carcinogenic" to humans, respectively. The aim of the study was to evaluate eating behaviours and knowledge on the potential risks of RM-PM consumption among gym users.

Methods

In 2018, a cross-sectional survey was conducted in 20 gyms in Turin using a 48-items questionnaire assessing socio-demographic, sports, dietary information and knowledge about RM-PM (sample size=298). Multivariable logistic and linear regressions were performed. The significance level was $p \leq 0.05$.

Results

Around 75% of the sample consumed RM and PM at least once a week, with an average of 240.55g±435.99 and 106.50g±157.88 weekly, respectively. Only 7.69% exceeded 700g of raw RM weekly.

Females, those with higher education, those who practise sport outside gyms and those who declared to practise sport to stay healthy declared to consume less RM. Those who practise sport at a competitive level, those who are on a diet for athletic needs, those with higher BMI, and those who consume more eggs and alcohol had a higher RM

intake. The association with PM consumption was negative for females and positive for those living without a partner.

The likelihood of answering incorrectly to one of the knowledge outcomes was lower for those who had healthcare-related background and declared to practise sport to stay healthy, while it was higher for participants who stated to have sport-related background, to be on a diet to lose weight, to read rarely/never the RM-PM nutrition labels and to consume <400g of fruit and vegetables daily.

Conclusions

Given the relatively low knowledge of the potential risks of RM-PM consumption, it would be advisable to implement campaigns, specifically focused on male athletes and people with lower socio-economic status, in order to raise awareness about this topic.

Introduction

Diet is one of the most important environmental causes of cancer. (1). Specifically, colorectal cancer (CRC) is one of the tumours whose incidence is more correlated to diet and lifestyle in general (2). It has been estimated that it could be possible to prevent about 50% of CRC cases through diet, weight loss and exercise (3).

In 2015, the International Agency for Research on Cancer (IARC) classified red meat (RM) as "probably carcinogenic to humans" (Group 2A) and processed meat (PM) as "carcinogenic to humans" (Group 1) (4). RM refers to all mammalian muscle meat, including, beef, veal, pork, lamb, mutton, horse, and goat; while PM refers to meat that has been transformed through salting, curing, fermentation, smoking, or other processes to enhance flavour or improve preservation (4). The association between RM, PM and cancer, was observed mainly for CRC, but was also seen for pancreatic cancer and prostate cancer (4,6). According to these evidences, the European Code Against Cancer exhorts to avoid PM and to limit RM consumption (5).

Moreover, in 2018, the World Cancer Research Fund/American Institute for Cancer Research (WCRF/AICR) gave new recommendations (1). About RM, it was recommended to consume no more than about three portions per week, roughly equivalent to 700g of raw meat per week, while the recommendation about PM was to consume very little, if any of it (1).

The pathogenesis of PM and RM-related cancers seems to involve nitrites and N-nitroso compounds (NOCs), heme iron (HI), heterocyclic amines (HCAs) and polyciclic aromatic hydrocarbons (PAHs) (1). Exogenous NOCs are usually added to PM in the preservation process. Besides, endogenous NOCs are promoted by HI in the intestine and by the reaction with products of amino acids in the stomach (7,8). HI stimulates the production of carcinogens, gut inflammation and damages DNA (9). Some authors estimated the HI amount in meat being 40% of total iron (10). Others differentiated concentration percentage of HI between different types of meat (11). HCAs and PAHs are produced by cooking meats at high temperatures, or with the food in direct contact with a flame or a hot surface, as in barbecuing or broiling. These chemicals have been linked to carcinogenesis in experimental studies (1,12,13).

Despite the above-mentioned risk, RM is one of the most important protein sources, with high biological value that can satisfy metabolic muscular necessities of sport practitioners (14), with a consequent higher risk of excessive RM consumption.

Several studies tried to evaluate the need to increase protein intake in sport practitioners (15,16). Athlete's needs are influenced by the type and the intensity of activity. A protein intake of 1,6 g/kg/day is estimated to be sufficient to cover the needs even of athletes who practise sports that require great muscle mass and strength (17). However, surveys on athletes practising sports of strength (e.g. weightlifting) and bodybuilders indicate that it is common to consume about 2-3,5g/kg/day of proteins (18). The only

Italian study assessing eating habits of gym users, focused on supplement use and performed in 2011 (19) - before IARC classification (6) - highlighted that people who used protein supplements also consumed more protein-rich food, especially meat (19). Therefore, since the above-mentioned studies (18, 19) seem to suggest a greater meat consumption among gym users, this specific population subgroup appears to be at high risk of exceeding the recommended portions.

Beyond sports, other factors could potentially influence RM and PM consumption, such as socio-demographic variables, dietary habits and awareness about the potential risk of RM and PM consumption (20–25).

Existing literature highlighted that social inequalities are important determinants of health (20). The prevalence of certain biological variables and lifestyles have been associated with socio-economic status (SES). Among these factors, diet is one of the determinants less studied in relation to SES, particularly in Italy (21,22). Different proxies, such as education, can measure SES. For instance, in Italy, the EPIC study showed that people with a higher educational level were more likely to consume healthier food (e.g. fruit or vegetables), while people with a lower level of education are more prone to consume less healthy food (e.g. PM). Moreover, the consumption of this last type of food was higher in males (21). Other researches obtained similar results: males and low SES have been associated to a higher consumption of RM and PM (23,24).

Given these findings, it seems important to determine sport attendants' RM and PM consumption, and the socio-demographic factors that could potentially influence it. In addition, it would be interesting to find out if they are aware about dangerousness of these meats, and if the knowledge about RM and PM can be associated with RM and PM intake. Currently, there are no studies about awareness on the potential risk of RM and PM consumption conducted after the new IARC classification (6). A study conducted in 2014 in Italy, Belgium, Holland and Germany, investigating PM knowledge, demonstrated that about half of participants had never heard about NOCs added to PM (25).

In this scenario, the present study aimed to examine eating habits and awareness about RM and PM among gym users, to analyse if sports, socio-demographic and dietary factors could influence RM and PM intake, and to evaluate if a lower knowledge about the potential risk of consuming RM and PM is associated with an increased consumption of these type of meat.

Methods

The sample

Between December 2017 and March 2018, a cross-sectional survey was carried out amongst a convenience sample of sport practitioners attending 20 gyms in Turin (Italy).

Participation was voluntary, anonymous and without compensation. The researchers ensured the participants' anonymity and the observance of ethical principles: prior to the survey administration, the aims of the study were explained and the participants were asked to sign an informed consent form. This study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving human subjects/patients were approved by the Internal Review Board of the Department of Public Health Sciences of the University of Turin, Italy.

The questionnaire

A 48-point self-administered questionnaire was developed after a literature review of comparable studies (25–33) and tested in a pilot study on a sample of ten gym users.

The first part of the questionnaire investigated socio-demographic characteristics of the participants, such as age, gender, place and year of birth, level of education, employment, marital status and CRC family history (eleven items). The second part was addressed to evaluate type, duration and motivation of practised sport (five items). In the third part, information about diet and supplement intake was assessed (eight items), while in the fourth section data about eating habits (e.g. weekly food frequency and portions size), with a detailed part on RM and PM consumption, was collected (twelve items).The last part focused on knowledge and awareness about the potential dangers of RM and PM (twelve items).

Statistical analysis

The results were analysed using the STATAMP11 statistical software (Stata Corp., College Station, TX, 2011).

Descriptive analyses were conducted, and results were expressed in frequencies and percentages for categorical variables and mean with standard deviation (SD) for continuous variables.

Outcomes construction

Three outcomes about RM and PM consumption were considered:

- Grams consumed per week of fresh RM. (Consumption Outcome 1, CO1)
- Grams consumed per week of PM. (Consumption Outcome 2, CO2)
- Consumption of raw RM ≥700g per week, considering recommendations by WCRF/AICR (1). (Consumption Outcome 3, CO3)

To create these outcomes, it was asked how many times per week participants ate fresh RM or PM. In addition, in order to calculate the grams, images from an atlas (34) were utilized: for each kind of meat there was an item containing three pictures of dishes corresponding to three different weights. It was asked to indicate which dish image corresponded to the usual portion consumed.

Three outcomes on knowledge were evaluated:

- Do you think that an excessive consumption of sodium and potassium nitrite/nitrate can be correlated to cancer development? (Knowledge Outcome 1, KO1)

- Do you think that barbecuing/broiling/griddling meat can be dangerous for your health? (Knowledge Outcome 2, KO2)
- Do you think that overcooked meat can be dangerous for your health? (Knowledge Outcome 3, KO3)

The KO1 was considered right if participants answered “I know” to the question “Do you know what sodium and potassium nitrite/nitrate are?”, then “Yes” to the question “Do you think that sodium and potassium nitrite/nitrate can be dangerous for health?” and, finally, “Cancer” to “Which of these diseases do you think can be correlated to an excessive consumption of sodium and potassium nitrite/nitrate?”. As 11.4% of the sample did not answer to at least one of these three questions, KO1 was missing for 34 participants.

The KO2 was considered right if participants answered “Yes” to the question “Do you think that some cooking methods can cause the production of compounds potentially dangerous for health?” and then “Barbecuing/broiling/griddling” to the question “Which of these cooking methods can expose more to this potential danger?”. KO2 was missing for 7.05% (n=21) respondents.

The KO3 was considered right if participants answered “Yes” to the question “Do you think that the level of cooking meat can influence the exposure by potentially dangerous compounds?” and then “Overcooked meat” to the question “Which of these level of

cooking meat can expose more to these compounds?". It was not possible to calculate KO3 for 26 participants (8.72%) that did not answer to one of these two questions.

Independent variables construction

Certain independent variables were created by combining more items of the questionnaire, e.g. the variable "background" was defined by putting together information about education and work.

Moreover, a "score on knowledge about RM and PM consumption" (SKRPC) from 0 to 5 points was created, based on a true/false test according to WCRF/AICR recommendations (1). One point was assigned for each right answer, that were: "true" for "RM consumption should not exceed 300-500g per week"; "false" for "consumption should be limited only for RM"; "false" for "consumption should be limited only for PM"; "false" for "consumption of RM and PM should be limited only for specific diseases"; "false" for "there is no recommendation about RM and PM consumption".

Univariate and multivariable models

For each outcome, univariate and multivariable logistic or linear regression models were performed to assess the potential role of socio-demographic, dietary, sports and knowledge variables on the outcomes considered. The covariates to be included into the multivariable models were selected using a stepwise forward selection process, with a univariate p-value < 0.25 as the main criterion (35), and with age, gender and BMI as

potential confounders. Certain variables were deleted from the model to avoid collinearity, such as "attending a university course" (collinear with "education higher than high school diploma"), "hours per week of weightlifting" (collinear with "hours per week at the gym"), "practicing sport to participate in competitions" (collinear with "practicing sport at competitive level"). Variables with a number of missing observations higher than 10% of participants were excluded.

Results were expressed as Odds Ratios (OR) or coefficients (Coef.) with 95% Confidence Interval (CI). A two-tailed p-value < 0.05 was considered significant for all the analyses.

Results

Descriptive analysis

A total of 671 gym users were asked to participate, and the response rate was 44.7%. Among 300 collected questionnaires, 298 were filled appropriately and used for the analyses. The overwhelming majority of the participants (99.3%) were Italian. Females were 54.05%. The mean age was 37.7 ±14.5 and the mean BMI was 22.9 ±3.3. The study population spent an average of 5.5 ±3 hours per week at the gym. About half of the sample declared to be on a diet (56.5%), with the main aim to stay healthy (41.4% of those who declared to be on a diet). (Table 1)

The majority consumed RM at least once a week (74.8%) with an average consumption of raw RM per week of 240.6g ±436. Similarly, 76.0% consumed PM at least once a week, with an average consumption per week of 106.5g ±157.9. Only 7.7% exceeded 700g of weekly raw RM. (Table 2)

The majority of the participants declared to consume more frequently veal as fresh RM (73.5%) and almost half of them declared to consume more frequently air-cured beef as PM (49.6%) (it was possible to indicate more options).

The majority gave a wrong answer to KO1 (66.3%). Almost half (48.9%) affirmed to know what sodium and potassium nitrite/nitrate are, and 55.7% thought that these compounds could negatively influence health. The diseases most chosen as correlated to sodium and potassium nitrite/nitrate were cancer (60.3%) and hypertension (25.8%) (it was possible to indicate more options).

Around 60% answered correctly to KO2. The majority thought that some cooking methods could cause the production of potentially dangerous compounds (84.1%). The cooking methods more involved in this potential danger were barbecuing/broiling/griddling for the 70.9% of the participants and frying for the 34.2%. (it was possible to indicate more options).

Less than half of the sample (34.9%) answered correctly to KO3. About 70% thought that the degree of cooking meat could influence the exposure to potentially dangerous compounds. The degrees most frequently chosen as more involved in the creation of

potentially dangerous compounds were overcooked meat (50%) and rare meat (35.8%). (Table 3)

Multivariable analyses

Being female, having an education higher than high school diploma, practising sports outside gyms and practising sport with the aim to stay healthy, were negatively associated with RM consumption.

Instead, practising sport with the aim of making competitions and being on a diet for athletic needs were positively associated with RM intake. The higher were BMI, eggs proteins (g/day) and alcohol (g/day) the more were the grams of fresh RM consumed weekly. There was a negative association between PM consumption and females, and a positive association between PM consumption and living without a partner. Concerning the cut-off of 700g per week, the likelihood of exceeding was significantly lower for females and for those with education higher than high school diploma. The higher were eggs proteins and alcohol intakes (g/day), the more were participants prone to consume above 700g. (Table 4)

The participants with a healthcare-related background had a lower probability of answering incorrectly to KO1, if compared to those whose background was neither in sport nor in healthcare field. Similarly, people who practise sport to stay healthy were less likely to getting wrong with KO1. The likelihood of answering incorrectly to KO2

was higher for those with a sport-related background and those on diet to lose weight. Additionally, the participants who affirmed to read rarely/never the nutrition facts label before buying RM and PM were more likely to answer incorrectly to KO2, if compared to those who read always it. WCRF/AICR recommendations suggest eating at least 400g of fruits and vegetables daily (1). People who consume <400g were more likely to be incorrect regarding KO3. Instead, the higher was BMI, the less participants were prone to answer incorrectly to KO3. (Table 5)

Discussion

This study aimed to assess eating habits and knowledge about RM and PM in gym users, considering current recommendations, to evaluate whether a lower awareness about RM and PM corresponded to an increased consumption, and to analyse if sports, socio-demographic and dietary factors could influence RM and PM intake.

The main findings showed that some factors were negatively associated with RM consumption, such as being female, having an education higher than high school diploma and practising sports outside gyms. Instead, other factors, e.g. practising sport with the aim of making competitions and being on a diet for athletic needs, were positively associated. There was a negative association between PM consumption and females, and a positive association between PM consumption and living without a partner. However, no association between a low knowledge about the potential risks of

RM and PM consumption and the consumption of these types of meat was found. The likelihood of answering incorrectly to one of knowledge outcomes was lower for those who had a healthcare-related background and those who practise sport to stay healthy, while it was higher, for instance, for participants who stated to read rarely/never the RM and PM nutrition labels and to consume <400g of fruit and vegetables daily.

About RM consumption, less than 8% exceeded the cut-off recommended by the World Cancer Research Found International (1). This could be due to the fact that RM is not excessively consumed in the Mediterranean diet (27,36), more than to the fact that gym user are aware of WCRF/AICR's recommendations. Indeed, only about 23% of our sample gave all the right answers to the SKRPC outcome, while almost 13% scored 0 points.

About PM consumption (1), the majority of the participants consumed an average of more than 100g weekly, which represents more than the two portions recommended by reference levels (17). Besides, almost half of the gym users interviewed consumed more frequently air-cured beef, which, beyond NOCs contents, has an additional risk because of its high HI contents (1,9,11). These findings showed that changing eating habits might be difficult even if there is evidence of the dangers, probably because of insufficient knowledge, as shown by SKRPC results.

A protein intake of 1,6g/kg/day is sufficient even for sports that require great muscle mass (17). Our sample consumed an average of 1.06g/kg/day, probably because gym

users practise different activities. It would be useful to analyse in more detail the relationship between protein consumption and the specific activity practised.

Regarding knowledge outcomes, less than half of participants knew what NOCs are. These results are very similar to those of an European study (25) performed before IARC statement, meaning that there is still a lot to work in order to spread the message that RM and PM represent a potential danger.

While 60% answered correctly to KO2, more than 50% reported that they barbecue/broil/griddle meat most of the times/always. This is alarming given that HCAs and PAHs are produced through these cooking methods (1,12,13).

The presence of HCAs and PAHs is influenced also by the degree of cooking (13); however, less than half answered correctly to KO3. Anyway, less than 4% of the sample reported consumption of overcooked meat. Interestingly, almost 36% thought that rare meat was the most dangerous degree of cooking.

The results of our study showed also that certain socio-demographic, dietary and sport-related variables were significantly associated with RM and PM consumption.

As expected, (21,23,24) females had a negative correlation with all the consumption outcomes. This is in line with other studies conducted on the same topic (21,23,24). We also found an inverse correlation between meat intake and education, usually used as SES proxy. Indeed, many investigations found an association between lower education and higher RM and PM intake, together with other less healthy food (21,23,24,37). Our

findings confirmed this relationship only between low education and RM consumption (21).

Interestingly, living without a partner was positively associated with PM consumption, showing that marital status could influence diet, as already demonstrated in other studies (38,39). It could be reasonable to suppose that PM is chosen because it is easy to prepare, but it would be interesting to investigate in more detail.

Overall, these results confirmed the already known tight relationship between diet and socio-demographic factors (20–24).

Since RM is one of the most important protein sources that can satisfy metabolic muscular necessities (14), positive associations found between RM consumption and those who practise sport at a competitive level or are on a diet for athletic needs were predictable.

The negative association between RM intake and the practise of sports outside the gym could be explained by the fact that gym users tend to practise sports of strength (e.g. weightlifting), which differ from sports outside this context.

Surprisingly, the number of hours at the gym was negatively associated with RM grams consumed. However, we have no data about the type of sport practised by gym users at the gym. We believe that this could influence the consumption of RM, it would be interesting to evaluate which activities were practised to better understand this association.

Concerning awareness, participants with healthcare-related background had a lower probability of answering incorrectly to KO1, but not to KO2 and KO3; this underlines a potential lack in the education about food and nutrition in healthcare related university courses. People who practise sport to stay healthy were more likely to answer correctly to KO1, probably because they were more prone to be updated about risky lifestyles.

As expected, a lower awareness about food and nutrition could be linked to less knowledge about the potential risks of RM and PM consumption, as shown by the fact that participants who rarely/never read the nutrition facts label were more likely to answer incorrectly to KO2, and that those who consume <400g of fruits and vegetables were more likely to get wrong to with KO3.

This study had some strengths and limitations that should be acknowledged. One of the main strengths is that it is one of the first Italian studies about consumption and awareness on the potential risks of RM and PM consumption, conducted after IARC statements (6) and one of the first Italian studies conducted among gym users. Moreover, the gyms involved had different localization, prices and available disciplines, so it was possible to reach people with potential different backgrounds.

The main limitation is the cross-sectional structure, which prevents identification of causal associations. Additionally, the opportunistic and voluntary nature of the sample may influence the generalisability of findings, as well as the response rate just below 50%. It was not possible to monitor the differences between people who decided to

participate and people who refused, causing a potential loss of important information from persons who did not participate. Also, a lack of information could be due to missing values, although the variables used in our models did not exceed 10% of missing observations. Furthermore, the results of this study cannot be representative of the general Italian population, however such findings could help to explore the characteristics of gym users subgroup. Another limitation is that items on eating habits could influence participants when they answer to the knowledge items. Lastly, self-administered surveys could lead to a recall bias, caused by differences in the accuracy or completeness of the recollections.

Conclusions

In conclusion, our results make it clear that there is the need to implement educational campaigns on RM and PM. Specific attention should be focused on male athletes that use nutrition as a way to improve performances, and on people with lower education. It would be advisable to start informational programs in gyms, and try to reach general population through other means, such as education in schools. Future efforts should be addressed to create interventions for raising awareness about these risky habits, also using gyms as a setting to spread healthy lifestyles.

Acknowledgements:

The Authors would like to thank all the gym owners and all the gym users enrolled for the participation at this study.

Funding:

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Declaration of Conflicting Interests:

None declared.

Data Availability Statement:

All relevant data are within the paper.

Ethical approval:

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent:

Informed consent was obtained from all individual participants included in the study.

References

1. World Cancer Research Fund International/American Institute for Cancer Research. Diet, Nutrition, Physical Activity and Cancer: a Global Perspective. Continuous Update Project Expert Report 2018. [Accessed 2018 Aug 21]. Available from: http://dietandcancerreport.org/
2. Watson AJM, Collins PD. Colon Cancer: A Civilization Disorder. Dig Dis. 2011;29(2):222–8.
3. World Cancer Research Fund/American Institute for Cancer Research. Diet, Nutrition, Physical Activity and colorectal cancer. Continuous Update Project Expert Report 2018 [Accessed 2018 Aug 21]. Available from: http://dietandcancerreport.org/
4. International Agency for Research on Cancer. Consumption of red meat and processed meat. Vol. 114, IARC Monogr Eval Carcinog Risks Hum. 2016
5. Schüz J, Espina C, Villain P, Herrero R, Leon ME, Minozzi S, et al. European code against cancer 4th edition: 12 ways to reduce your cancer risk. Cancer Epidemiol. 2015. Volume 39, Supplement 1, Pages S1-S10, doi.org/10.1016/j.canep.2015.05.009
6. Bouvard V, Loomis D, Guyton KZ, Grosse Y, Ghissassi F El, Benbrahim-Tallaa L, et al. Carcinogenicity of consumption of red and processed meat. Lancet Oncol. 2015 Dec; 16(16):1599–600.

7. Tricker AR. N-nitroso compounds and man: sources of exposure, endogenous formation and occurrence in body fluids. Eur J Cancer Prev. 1997 Jun ;6(3):226–68.

8. Oostindjer M, Alexander J, Amdam G V, Andersen G, Bryan NS, Chen D, et al. The role of red and processed meat in colorectal cancer development: a perspective. Meat Sci . 2014 Aug ;97(4):583–96.

9. Cascella M, Bimonte S, Barbieri A, Del Vecchio V, Caliendo D, Schiavone V, et al. Dissecting the mechanisms and molecules underlying the potential carcinogenicity of red and processed meat in colorectal cancer (CRC): an overview on the current state of knowledge. Infect Agent Cancer . 2018 Dec 15;13(1):3.

10. Lee D-H, Anderson KE, Harnack LJ, Folsom AR, Jacobs DR. Heme iron, zinc, alcohol consumption, and colon cancer: Iowa Women's Health Study. J Natl Cancer Inst . 2004 Mar 3;96(5):403–7.

11. Balder HF, Vogel J, Jansen MCJF, Weijenberg MP, van den Brandt PA, Westenbrink S, et al. Heme and chlorophyll intake and risk of colorectal cancer in the Netherlands cohort study. Cancer Epidemiol Biomarkers Prev . 2006 Apr 1;15(4):717–25. doi/10.1158/1055-9965.EPI-05-0772

12. Cross AJ, Sinha R. Meat-related mutagens/carcinogens in the etiology of colorectal cancer. Environ Mol Mutagen. 2004; 44(1):44–55.

http://doi.wiley.com/10.1002/em.20030

13. National Cancer Institute. Chemicals in Meat Cooked at High Temperatures and Cancer Risk . National Cancer Institute. 2010 [Accessed 2018 Aug 21]. p. 1–5. Available from: https://www.cancer.gov/about-cancer/causes-prevention/risk/diet/cooked-meats-fact-sheet#q2
14. Phillips SM. Dietary protein requirements and adaptive advantages in athletes. Br J Nutr . 2012 Aug 30;108 Suppl 2(S2):S158-67.
15. Campbell B, Kreider RB, Ziegenfuss T, La Bounty P, Roberts M, Burke D, et al. International Society of Sports Nutrition position stand: protein and exercise. J Int Soc Sports Nutr . 2007 Sep 26; 4(1):8.
16. American Dietetic Association, Dietitians of Canada, American College of Sports Medicine, Rodriguez NR, Di Marco NM, Langley S. American College of Sports Medicine position stand. Nutrition and athletic performance. Med Sci Sports Exerc . 2009 Mar;41(3):709–31.
17. SINU - Società di Nutrizione Umana. LARN. Livelli di Assunzione di Riferimento di Nutrienti ed energia per la popolazione italiana. 2014th ed. SICS editor., editor. 150-169 p. p.
18. Phillips SM. Protein requirements and supplementation in strength sports . Vol. 20, Nutrition. 2004. p. 689–95.
19. Bianco A, Mammina C, Paoli A, Bellafiore M, Battaglia G, Caramazza G, et al.

Protein supplementation in strength and conditioning adepts: knowledge, dietary behavior and practice in Palermo, Italy. J Int Soc Sports Nutr . 2011 Dec 29;8(1):25.

20. Bauer UE, Briss PA, Goodman RA, Bowman BA. Prevention of chronic disease in the 21st century: Elimination of the leading preventable causes of premature death and disability in the USA. Lancet . 2014 Jul 5; 384(9937):45–52.

21. Ricceri F, Giraudo MT, Sieri S, Pala V, Masala G, Ermini I, et al. [Dietary habits and social differences: the experience of EPIC-Italy.] . Vol. 39, Epidemiol Prev. 2015.

22. Costa G, Bassi M, Gensini GF, Marra M NAZ. L'equità in salute in Italia. Secondo rapporto sulle disuguaglianze sociali in sanità. Franco Angeli Editore M, editor. 2015.

23. Mertens E, Kuijsten A, Dofková M, Mistura L, D'Addezio L, Turrini A, et al. Geographic and socioeconomic diversity of food and nutrient intakes: a comparison of four European countries. European Journal of Nutrition . 2018 Mar 28; 1–19.

24. Clonan A, Roberts KE, Holdsworth M. Socioeconomic and demographic drivers of red and processed meat consumption: implications for health and environmental sustainability. Proc Nutr Soc . 2016 Aug 29; 75(3):367–73.

25. Hung Y, de Kok TM, Verbeke W. Consumer attitude and purchase intention

towards processed meat products with natural compounds and a reduced level of nitrite. Meat Sci . 2016 Nov; 121:119–26.

26. Agnoli C, Krogh V, Grioni S, Sieri S, Palli D, Masala G, et al. A Priori–Defined Dietary Patterns Are Associated with Reduced Risk of Stroke in a Large Italian Cohort. J Nutr . 2011 Aug 1; 141(8):1552–8.

27. Agnoli C, Grioni S, Sieri S, Palli D, Masala G, Sacerdote C, et al. Italian Mediterranean Index and risk of colorectal cancer in the Italian section of the EPIC cohort. Int J cancer . 2013 Mar 15; 132(6):1404–11.

28. CPO Piemonte. Studio Andromeda-Questionario sugli stili di vita. 2016 [Accessed 2018 Aug 21]. Available from: https://www.cpo.it/it/articles/show/studio-andromeda-la-tua-storia-per-uno-screening-migliore/

29. CREA. L'indagine nazionale sui consumi alimentari in Italia: INRAN-SCAI 2005-06. 2010 [Accessed 2018 Aug 21]. Available from: http://nut.entecra.it/files/download/INRAN-SCAI/5_monografia_scai_parte_a3_metodi_questionari_02_02_10.pdf

30. Giammarioli S, Boniglia C, Carratù B, Ciarrocchi M, Chiarotti F, Mosca M, et al. Use of food supplements and determinants of usage in a sample Italian adult population. Public Health Nutr . 2013; 16(10):1768–81.

31. Keating GA, Bogen KT, Chan JM. Development of a Meat Frequency

Questionnaire for Use in Diet and Cancer Studies. J Am Diet Assoc . 2007 Aug; 107(8):1356–62.

32. Parmenter K, Wardle J. Development of a general nutrition knowledge questionnaire for adults. Eur J Clin Nutr . 1999 Apr ; 53(4):298–308.

33. Sinha R, Cross A, Curtin J, Zimmerman T, McNutt S, Risch A, et al. Development of a food frequency questionnaire module and databases for compounds in cooked and processed meats. In: Molecular Nutrition and Food Research. 2005 p. 648–55.

34. Chiuchiù MP, Bedogni G, Fantuzzi AL. Atlante fotografico Scotti-Bassani delle porzioni degli alimenti. Milano. Istituto Scotti Bassani.; 2005.

35. Hosmer D, Lemeshow S. Applied Logistic Regression. New York: John Wiley & Sons, Inc.; 1989.

36. Davis C, Bryan J, Hodgson J, Murphy K. Definition of the Mediterranean Diet; A Literature Review. Nutrients . 2015 Nov 5; 7(11):9139–53.

37. Darmon N, Drewnowski A. Does social class predict diet quality? Am J Clin Nutr . 2008 May 1; 87(5):1107–17.

38. Yannakoulia M, Panagiotakos D, Pitsavos C, Skoumas Y, Stafanadis C. Eating patterns may mediate the association between marital status, body mass index, and blood cholesterol levels in apparently healthy men and women from the ATTICA study. Soc Sci Med . 2008 Jun; 66(11):2230–9.

39. Zazpe I, Estruch R, Toledo E, Sánchez-Taínta A, Corella D, Bulló M, et al. Predictors of adherence to a Mediterranean-type diet in the PREDIMED trial. Eur J Nutr . 2010 Mar 4; 49(2):91–9.

Tab. 1 *Descriptive analysis: socio-demographic, sports and dietary information*		*N (%)*	*Mean (SD)*
Female		160 (54.05)	
Age (n=297)			37.74 (14.54)
BMI (n=297)			22.90 (3.28)
Italian nationality		296 (99.33)	
Education higher than high school diploma		281 (94.61)	
Having an income		221 (75.42)	
Living with a partner		118 (40.97)	
CRC family history		16 (5.61)	
Background	**Sports field**	58 (19.46)	
	Healthcare field	22 (7.38)	
	Neither in sport field nor in healthcare field	218 (73.15)	
Weightlifting		188 (64.16)	
Practising sports outside the gym		119 (41.61)	
Hours per week of sports at the gym (n=251)			5.46 (2.99)
Sport duration (months) (n=293)			92.78 (112.28)
Being on a diet		165 (56.51)	
Being on vegan or vegetarian diet		22 (7.56)	
Thinking that supplementary proteins are needed in the diet		88 (30.03)	
Not taking supplements		156 (60.70)	
Consumption of fruit and vegetables<400g daily		139 (48.43)	
Proteins consumed g/kg/die (n=160)			1.06 (0.43)
Alcohol consumed g/die (n=295)			4.81 (6.46)

Tab. 2 *Descriptive analysis: red and processed meat consumption*		*N (%)*	*Mean (SD)*
Consumption of fresh red meat at least once a week		219 (74.75)	
Consumption of fresh red meat, times per week (n=274)			2.19 (3.10)
Consumption of fresh red meat, grams per week (n=273)			240.55 (435.99)
Consumption of raw red meat ≥700g per week		21 (7.69)	
Frequency of barbecuing/broiling/griddling meat	**Always**	53 (23.98)	
	Most of the times	63 (28.51)	
	Half of the times	51 (23.08)	
	Rarely/never	54 (24.43)	
Degree of cooking most used	**Rare**	24 (14.46)	
	Undercooked	25 (15.06)	
	Medium	59 (35.54)	
	Well cooked	52 (31.33)	
	Overcooked	6 (3.61)	
Consumption of processed meat at least once a week		203 (76.03)	
Consumption of processed meat, times per week (n=267)			2.86 (3.39)
Consumption of processed meat, grams per week (n=264)			106.50 (157.88)
Consumption of red and processed meat, grams per week (n=253)			331.26 (464.32)

Tab. 3 *Descriptive analysis: awareness on red and processed meat risks*		*N (%)*
Reading the nutrition label before buying red and processed meat	**Always**	82 (30.60)
	Often	46 (17.16)
	Sometimes	69 (25.75)
	Rarely/ never	71 (26.49)
Wrong answer to "Do you think that an excessive consumption of sodium and potassium nitrite/nitrate can be correlated to cancer development?"		175 (66.29)
Wrong answer to "Do you think that barbecuing/broiling/griddling meat can be dangerous for your health?"		111 (40.07)
Wrong answer to "Do you think that overcooked meat can be dangerous for your health?"		177 (65.07)
Score on knowledge about red and processed meat consumption (SKRPC)	**0 points**	38 (12.75)
	1 points	30 (10.07)
	2 points	49 (16.44)
	3 points	50 (16.78)
	4 points	62 (20.81)
	5 points	69 (23.15)

Tab. 4 Predictors of red and processed meat consumption, multivariable analyses		Fresh red meat consumption (grams per week, CO1)			Processed meat consumption (grams per week, CO2)			Fresh red meat consumption ≥ 700g per week (CO3)		
		Multivariable linear regression			Multivariable linear regression			Multivariable logistic regression		
		Coef.	95% CI	p	Coef.	95% CI	p	OR	95% CI	p
Female		-150.64	-282.92; -18.37	0.026	-75.80	-131.18; -20.43	0.008	0.14	0.02; 0.92	0.041
Age		-1.01	-5.24; 3.21	0.637	-0.38	-2.39; 1.64	0.712	0.96	0.90; 1.01	0.119
BMI		17.86	0.18; 35.55	0.048	4.03	-3.75; 11.80	0.308	1.15	0.96; 1.37	0.120
Education higher than high school diploma		-127.01	-239.34; -14.67	0.027				0.22	0.05; 0.92	0.038
Living without a partner					65.90	9.78; 122.02	0.022			
CRC family history					-9.27	-109.07; 90.54	0.855			
Background	**Neither in sport field nor in healthcare field**				Rif	-	-			
	Healthcare field				-67.60	-148.57; 13.37	0.101			
	Sport field				-14.17	-73.22; 44.88	0.636			
Weightlifting		-1.94	-135.18; 131.31	0.977	-22.85	-75.98; 30.28	0.397	0.92	0.15; 5.75	0.929
Practising sports outside the gym		-147.81	-262.86; -32.77	0.012	-27.80	-76.24; 20.65	0.259	0.27	0.07; 1.11	0.069
Hours per week at the gym		-21.64	-39.10; -4.19	0.015	-0.21	-7.47; 7.05	0.955	0.84	0.69; 1.02	0.077
Sport duration (months)										
Practicing sport at competitive level		279.61	101.24; 457.98	0.002	-8.51	-80.24; 63.21	0.815	2.86	0.55; 14.78	0.211
Practicing sport to stay healthy		-230.23	-392.38; -68.07	0.006				0.72	0.14; 3.84	0.702
Being on a diet for athletic needs		203.13	12.20; 394.06	0.037				1.23	0.23; 6.47	0.807
Thinking that supplementary proteins are needed in the diet		31.44	-125.90; 188.79	0.694	19.22	-45.93; 84.36	0.561	0.46	0.08; 2.54	0.373
Not taking supplements		-47.23	-197.41; 102.95	0.536	-15.73	-78.76; 47.30	0.623	0.24	0.04; 1.46	0.121
Eggs proteins g/die		15.27	2.64; 27.91	0.018	1.02	-4.99; 7.03	0.739	1.16	1.04; 1.30	0.010
Consumption of fruit and vegetables<400g daily					16.44	-28.33; 61.20	0.470			
Alcohol consumption g/die		12.43	3.15; 21.72	0.009	1.73	-2.15; 5.60	0.381	1.13	1.03; 1.25	0.011

Tab. 5 *Predictors of knowledge about the potential risks of the consumption of red and processed meat, multivariable analyses*		Do you think that an excessive consumption of sodium and potassium nitrite/nitrate can be correlated to cancer development? (KO1)			Do you think that barbecuing/broiling/griddling meat can be dangerous for your health? (KO2)			Do you think that overcooked meat can be dangerous for your health? (KO3)		
		Multivariable logistic regression			Multivariable logistic regression			Multivariable logistic regression		
		OR	95% CI	p	OR	95% CI	p	OR	95% CI	p
Female		1.20	0.54; 2.68	0.662	1.16	0.54; 2.49	0.707	0.67	0.36; 1.28	0.229
Age		0.99	0.96; 1.02	0.586	0.99	0.96; 1.02	0.599	0.99	0.97; 1.01	0.431
BMI		1.05	0.93; 1.18	0.471	0.92	0.82; 1.03	0.148	0.88	0.80; 0.98	0.019
Education higher than high school diploma								0.59	0.32; 1.07	0.081
Having an income		1.58	0.64; 3.87	0.320						
Living without a partner		1.28	0.56; 2.90	0.556	1.08	0.49; 2.36	0.855			
Background	**Neither in sport field nor in healthcare field**	Rif	-	-	Rif	-	-	Rif	-	-
	Healthcare field	0.18	0.05; 0.63	0.008	0.51	0.14; 1.85	0.305	0.36	0.12; 1.08	0.067
	Sport field	1.03	0.43; 2.50	0.941	2.13	1.01; 4.49	0.048	1.08	0.52; 2.27	0.831
Weightlifting					1.45	0.68; 3.10	0.340			
Practising sport to stay healthy		0.30	0.09; 0.97	0.043						
Being on a diet to lose weight					3.11	1.06; 9.11	0.039	2.45	0.90; 6.67	0.080
Being on a diet to stay healthy		0.55	0.27; 1.15	0.112	1.19	0.60; 2.38	0.619	0.69	0.38; 1.26	0.228
Being on vegan or vegetarian diet		0.43	0.06; 3.10	0.404						
Not taking supplements		1.47	0.67; 3.20	0.335	0.70	0.34; 1.44	0.336			
Fruit and vegetables g/die		0.99	0.99; 1.00	0.737						
Consumption of fruit and vegetables<400g daily					1.74	0.93; 3.24	0.081	1.95	1.11; 3.45	0.021
Alcohol g/die					0.97	0.92; 1.02	0.256			
Reading the nutrition label before buying red and processed meat	**Always**	Rif	-	-	Rif	-	-	Rif	-	-
	Often	2.39	0.81; 7.06	0.113	2.29	0.89; 5.87	0.085	1.95	0.83; 4.57	0.125
	Sometimes	0.60	0.25; 1.45	0.259	1.73	0.72; 4.13	0.220	1.71	0.80; 3.68	0.167
	Rarely/ never	1.16	0.45; 3.04	0.755	2.43	1.00; 5.91	0.049	1.06	0.49; 2.27	0.890