

Cheese, Microbiome and Obesity: A Love Triangle

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Short report

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Abstract

Introduction

Recent evidence has shown the importance of the microbiome in the development and maintenance of obesity. Probiotics were proposed for modulating the microbiome in order to achieve weight loss.

Methods

Data related to consumption of dairy food in European countries were obtained from the Global Dairy Consumption Report of the European Association of Dairy Trade Eucolait. Age-adjusted prevalence of obesity in European countries was extracted from the World Health Organization Global Health Repository. Linear regression was performed.

Results

Consumption of cheese in kilogram per capita was inversely correlated to the age-adjusted prevalence of obesity in 26 European countries (R^2 : 0.298, $p=0.004$).

Conclusion

Consumption of cheese appears to protect against weight gain. This finding deserves further confirmation by longitudinal studies or randomized controlled trials.

Main Text

The World Health Organization (WHO) reports that obesity affects more than 650 million adults worldwide ¹. The prevalence of obesity has tripled since 1975 ¹ and is expected to affect one out of two US citizens by the year 2030 ². Obesity leads to significant morbidity, alteration of quality of life and increased medical expenditure ³, and therefore constitutes one of the major public health challenges of the century.

Weight gain is multifactorial and includes environmental and genetic factors ⁴. The main treatment options are lifestyle interventions, pharmacotherapy and, in last instance, bariatric surgery ⁴.

Growing evidence demonstrates that obese adults have altered microbiome ⁵⁻⁹. New therapeutic targets for treating obesity include measures aimed at restoring healthy microbiome in obese individuals, such as fecal transplantation ¹⁰ or probiotics ^{11,12}. The probiotic formulation VSL#3, which contains diverse *Lactobacillus* and *Bifidobacterium* strains, was shown to protect consumers of a high-fat and high-energy diet against body mass gain and fat tissue accumulation ¹³. Of note, ecological niches of *Lactobacillus spp* and *Bifidobacterium spp* include raw and fermented dairy products. As an example, *Lactobacillus helveticus* is used as a fermentation starter, notably in Swiss cheese ¹⁴.

The European Union is the largest consumer of cheese worldwide with more than 7,000 thousands of tons consumed every year ¹⁵. However, there is high variability between countries within the European Union in terms of cheese consumption ¹⁵. Since cheese consumption could potentially modulate the gut microbiome at a large scale, we aimed to determine if cheese consumption was correlated to the prevalence of obesity at the nation-level in Europe.

Methods

We used a methods previously published to show correlation between fast-food consumption and body mass index in countries members of the Organization for Economic Co-operation and Development (OECD) ¹⁶. Data related to consumption of dairy food in European countries were obtained from the Global Dairy Consumption Report of the European Association of Dairy Trade Eucolait for the year 2017 ¹⁵. Age-adjusted prevalence of obesity in European countries was extracted from the WHO Global

Health Repository for the year 2016¹⁷. Linear regression using the prevalence of obesity as the dependent variable and cheese consumption as the independent variable was performed. Stata (version 15, StataCorp, USA) was used for analysis.

Results

Consumption of cheese in kilogram per capita was inversely correlated to the age-adjusted prevalence of obesity in 26 European countries (R^2 : 0.298, coefficient: -0.150, 95% CI: -0.248 to -0.053, $p=0.004$) (Figure 1).

Discussion

Dietary habits have been shown to modulate the micro-organisms populating the human digestive tract^{6,18,19}, but low adherence to diet change recommendations has failed to render diet-based public health interventions successful on a large scale.

One might imagine that a high cheese intake might lead to weight gain. In our study, the R^2 value indicates that 29.8% of the prevalence of obesity is explained by the annual consumption of cheese. However, the correlation is an inverse correlation, meaning that the more cheese is consumed in a country, the lower the prevalence of BMI is. Further, to reduce the prevalence of BMI by 5% in a given country, analysis of the regression slope concluded that the annual consumption of cheese per capita would need to increase by approximately 33kg, which represents the exact weight of a 12-month matured Gruyère cheese wheel.

The beneficial effect of cheese on weight loss is supported by recent evidence. For instance, a systematic review and meta-analysis of 24 cross-sectional studies found that dairy products intake and milk consumption were associated with decreased risk of obesity²⁰. Further, consumption of dairy products was demonstrated to modulate the gut microbiome^{21,22} and reduce markers of systematic inflammation²³⁻²⁶. Looking more specifically at cheese consumption, Alegria-Lertxundi et al. described that cheese consumption was inversely correlated to obesity in the Basque population in Spain²⁷.

The effect of dairy products seems to differ depending on the type of dairy and fermentation. Hansson et al. randomized 47 participants to receive four daily dairy meals corresponding to 45g of fat in the form of butter, cheese, whipped cream or sour cream. The authors found that cheese intake increased gastrointestinal hormones secretion and decreased appetite when compared to whipped cream²⁸ and induced different postprandial effects on serum triglycerides, HDL cholesterol and insulin²⁹. Further, a cross-sectional study on 114,692 Dutch citizens showed a positive association between milk, non-fermented dairy products and obesity, and an inverse association for fermented dairy such as custard and yoghurt. Results were heterogeneous for cheese, and Dutch cheese was not reported to have an effect on obesity³⁰. The effect on weight might also be modulated by the bacteria contained in dairy products. For instance, different strains of *Lactobacillus* were shown to have opposite effects on weight gain^{31,32}. Of note, taxonomic differences of the microbiome of dairy product consumers are modulated by the origin of the milk, but also by the effect of fermentation³³. Different dairy products were shown to have different effects on inflammatory markers, and consumption of fermented dairy products such as cheese, has been shown to induce a less of an inflammatory response than non-fermented dairy products^{34,35}.

The study has several limitations. First, the cheese consumption at the nation-level might not represent the cheese intake at the individual level. Also, our results do not allow to conclude if a high cheese intake during a short time period is equivalent to a low cheese intake spread over a long time period. Consumption of a Gruyère cheese wheel on a week before Summer holidays might not be recommended. Second, the existence of potential confounding factors is not excluded. People with the highest cheese intake might also be people who ski the most, as cheese is usually consumed when practicing Winter sports.

We note that Swiss citizens are the biggest consumers of cheese, which they consume raw or melted in fondue, but also have the lowest age-adjusted prevalence of BMI. Moreover, chocolate consumption was previously demonstrated to be correlated to the number of Nobel laureates per 10 million inhabitants³⁶. We therefore believe that public health intervention should aim at adopting a Swiss-inspired diet, which traditionally includes locally produced chocolate and cheese. Further, in this time of COVID-19 pandemic, we wonder whether the required limitation of travel to the Swiss Alps might lead to an increase of the average BMI in addition of a shortage of Nobel laureates in Europe.

Conclusion

Consumption of cheese appears to protect against weight gain. This finding deserves further confirmation by longitudinal studies or randomized controlled trials.

Abbreviations

None

Declarations

Ethics approval and consent to participate

Not required

Consent for publication

Not required

Availability of data and material

Data publicly available

Competing interests

Dr. Jeremy Meyer, Prof. Jacques Schrenzel and Prof. Frédéric Ris live in Geneva, Switzerland, but have no decisional power within the World Health Organization. Dr. Jeremy Meyer, Dr. Elin Roos, Prof. Jacques Schrenzel, Prof. Frédéric Ris and Mr Justin Davies regularly go to the Swiss Alps and consume Swiss cheese fondue, which usually contains 50% Gruyère and 50% Vacherin cheeses melted in a pot, which they believe have kept them in good shape. The authors have no other conflict of interest to disclose.

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Authors' contributions

JM conceived and designed the study. JM and ER acquired the data. JM and ER analyzed the data. All authors interpreted the data, performed critical revision and accepted the final version of the manuscript.

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Figures

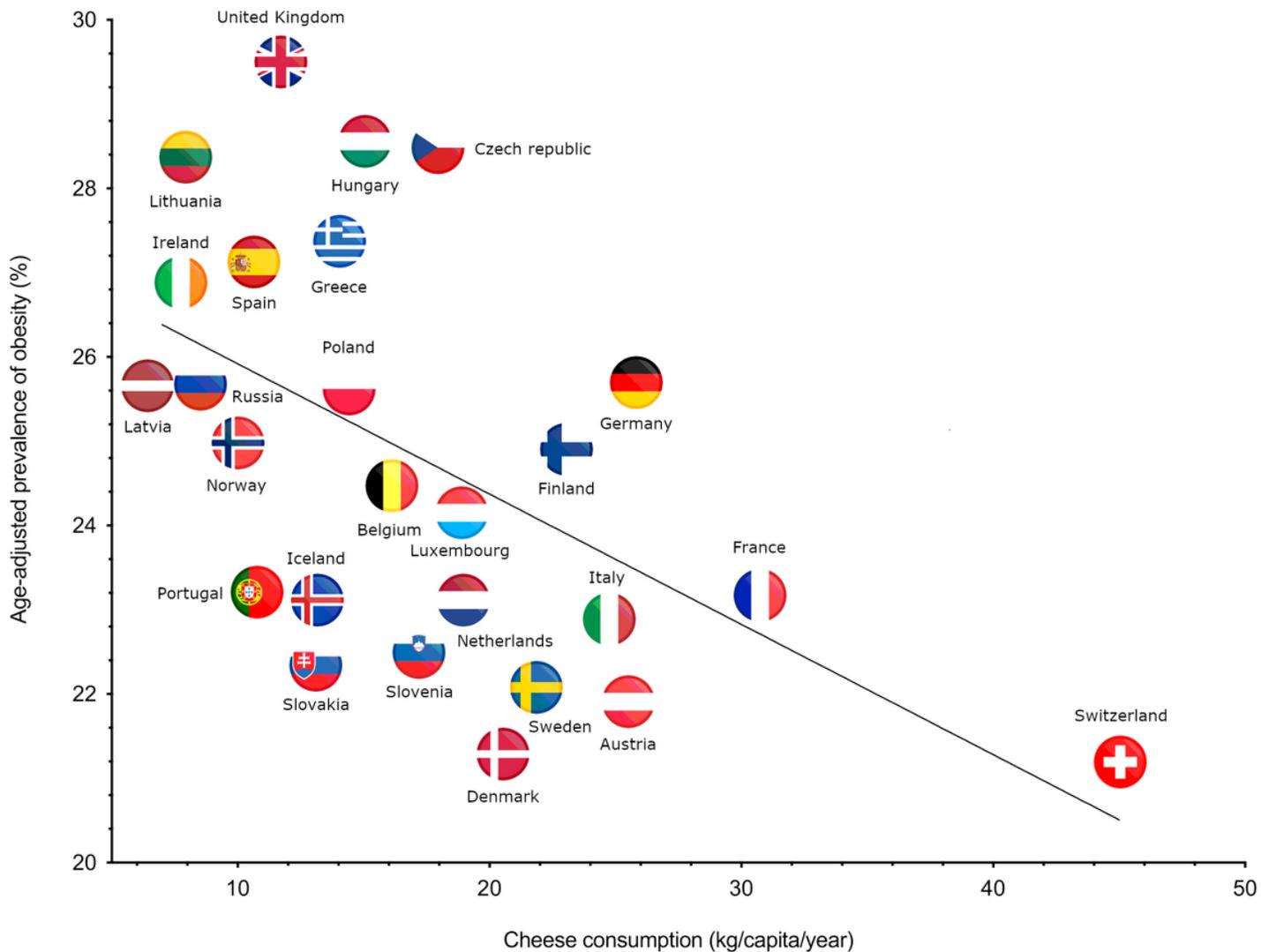


Figure 1

Correlation between cheese consumption per year per capita and the age-adjusted prevalence of obesity (%).