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### Article

# Sports and clean environment: Key drivers of health and longevity in the European Union

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# SPORTS AND CLEAN ENVIRONMENT: KEY DRIVERS OF HEALTH AND LONGEVITY IN THE EUROPEAN UNION

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#### Abstract

This article highlights the effects of sports participation and environmental health on the lifespan and overall health of the population of the member states of the European Union. Utilizing data from 2010 to 2022, the study covers all EU countries, offering a comprehensive overview of the region's health dynamics. Through descriptive analyses of geographic distributions of indicators and panel data econometrics, clear continental disparities emerge, notably between the Northwest and Southeast regarding both the frequency of sports activity and environmental health conditions. To mitigate the potential confounding effects resulting from the strong correlations between the variables sports and environment variables and the gross domestic product per capita, the variables were standardised. This methodological consideration ensures a more accurate assessment of the direct impacts of sports participation and environmental health on lifespan and disability-adjusted life expectancy. The regression results reveal highly significant positive influences of population participation in sports and environmental health status on both lifespan and health quality, confirming the research hypotheses. Among control variables, the most statistically significant include health financing, the overall institution quality, sports funding, and lifestyle indicators.

Keywords: public health, life expectancy, panel data, sports, environmental quality

JEL Classification: I15, Q56, Z20

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#### Introduction

Increased life expectancy and improved health among the population have profound positive effects on both the economy and society. Enhanced health contributes to economic competitiveness by creating a more dynamic and productive labour force, capable of driving innovation and progress. This healthier workforce not only is is more motivated and optimistic,, but also brings a wealth of experience and knowledge to the table, enriching the overall skill set available for economic development. Furthermore, a population with higher life expectancy and better health tends to place a greater value on education, which in turn supports into the cycle of innovation and the adoption of innovative technologies. On an individual level, good health is decisive for personal well-being, enabling people to live fuller, more active lives and reducing the burden of healthcare costs. This individual wellbeing translates into stronger social welfare, since healthier individuals contribute more significantly to their communities and economies. In addition, improvements in health and life expectancy can lead to changes in demographic structure, with a higher proportion of the population being active and productive for longer periods. This demographic shift supports sustainable economic growth and societal progress, as it encourages the development and implementation of innovative technologies and solutions adapted to the evolving needs of a changing population.

The determinants of health and longevity in a population are composite and connected, reflecting the complexity of factors that influence well-being and life span. Income level and distribution play a critical role, as they affect access to nutritious food, healthcare services, and living conditions conducive to health. For instance, a balanced diet and regular physical activity, including sports, are fundamental for maintaining a healthy lifestyle, yet their adoption is heavily influenced by one's socioeconomic status. In contrast, negative health behaviours such as smoking, excessive alcohol consumption, and excessive work can significantly significantly reduce from health and longevity, often exacerbated by stress and mental health challenges. Accessibility and affordability of healthcare, along with the efficiency of healthcare systems and financing methods, critically determine the extent to which populations can obtain the the necessary medical care and preventive services. This includes vaccinations and disease prevention programmes, which are decisive in managing public health. Genetics also contributes to puzzle of health and longevity by predisposing individuals to certain health conditions, although their effects can be mitigated or exacerbated by environmental and lifestyle factors. Education emerges as a powerful determinant, empowering individuals with knowledge about healthy behaviours and the importance of seeking medical care when needed. Furthermore, public health policies that promote health education, environmental protection, and equitable access to access to healthcare are essential to improve the health of population. Social support and strong community networks offer psychological and emotional benefits that can improve mental health, reduce stress, and encourage the adoption of healthy behaviours. Finally, the ecology of the living environment, including the quality of air, water, and soil, and the presence of pollution, directly impacts health, underscoring the importance of environmental protection as a public health priority. Together, these factors illustrate the intricate web of determinants that influence health and longevity, which requires widespread strategies to promote public health and well-being.

National life expectancy and public health levels are influenced by a wide range of factors of varying nature. The literature explores various causal relationships, but there exists a gap:

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few studies accurately quantify the effects of sports participation and environmental quality due to their correlations with economic development and other macroeconomic variables. The main objective of our study is to demonstrate the impact of sports and environmental quality by isolating the effects of other determinants.

The article begins with a review of the literature that focusses on the determinants of national health and life expectancy, highlighting current debates and research gaps. In the Research methodology section, it details the database comprising OECD countries, including variables on national health, longevity, potential sports and environmental determinants, alongside other control variables, and explains the panel regression equations utilised in the study. The Results and Discussion section outlines key trends from the statistical analysis, comparing these findings with those from similar studies. Finally, the conclusions offer a summary of the research's main insights, acknowledging its limitations, and suggesting directions for future research, alongside policy implications derived from the study's findings.

#### 1. Literature review

The literature on the determinants of population health and life expectancy is extensive, yet this literature review does not aim to fully investigate the numerous factors that influence health and longevity on a national level. Instead, we focus on the impacts of environmental health and the practice of sports and physical activity, examining both the theoretical mechanisms of interaction and empirical studies concerned with this topic. Our analysis of the literature is structured into three parts: (*i*) the effects of economic, social, educational, lifestyle, genetic factors, public health policies, and social support; (*ii*) the effects of participating in sports; and (*iii*) the effects of environmental health. This structured approach allows us to explore how these factors collectively influence health and longevity.

#### 1.1. Various determinants of life expectancy and public health

Socio-economic factors, such as income level, education, and employment status, have a profound impact on public health and longevity (Sowa et al., 2016; Assari, 2018) as they determine access to healthcare, nutritious food, and healthy living conditions. These factors contribute to disparities in health outcomes and life expectancy (Singh and Siahpush, 2014), with a a higher socioeconomic status often correlated with better health indicators and longer lives due to improved access to resources that promote healthy lifestyles and prevent disease. The choices people make about their diet, smoking, alcohol consumption, and drug use (Giacosa et al, 2016) play a crucial role in determining their health and longevity (Rizzuto and Fratiglioli, 2014). A balanced diet and regular exercise can prevent chronic diseases such as obesity, diabetes, and heart disease, thus extending life expectancy (Anderson and Durstine, 2019). On the contrary, smoking, excessive alcohol consumption, and drug abuse are linked to a range of health problems, including cancers and cardiovascular diseases, which can significantly reduce life expectancy (Li et al., 2020). Accessibility, affordability, and quality of healthcare services are essential to maintain public health and extend life expectancy (Dragos et al., 2022; Fahlevi et al., 2023). Access to preventive care and timely treatment can mitigate the impact of diseases and improve survival rates. However, barriers to healthcare care, such as high costs and lack of services, can prevent individuals from receiving the the necessary care, leading to worse health outcomes and shorter lives. Genetics also play an important role in determining susceptibility to certain diseases and overall longevity. Although genetic predispositions can increase the risk of diseases such as heart

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disease, cancer, and diabetes (Yasmin et al., 2021), the expression of these genes can often be influenced by lifestyle choices and environmental factors, highlighting the complex interplay between genetics and other determinants of health. Education influences health and longevity (Savelyev et al., 2022; Kriebs, 2023) by empowering individuals with the knowledge to make informed decisions about their health. Educated individuals are more likely to engage in healthy behaviours, access healthcare services, and navigate the healthcare system effectively, leading to better health outcomes and longer life expectancy. Effective public health policies and programmes that promote vaccinations, disease prevention, and health education can have a significant positive impact on community health and longevity (Edelman and Kudzma, 2021). By addressing widespread health risks and educating the public, these initiatives can reduce the incidence of preventable diseases and increase life expectancy. Strong social and community networks provide emotional support, reduce stress, and encourage healthy behaviours, all of which contribute to better mental and physical health (Lin and Kishore, 2021). The sense of belonging and support from social networks can motivate individuals to maintain healthy lifestyles and seek help when needed, positively affecting their health and longevity. All these elements (like how we live, our healthcare, genes, education, public health efforts, and our support from friends and community) work together to affect our health and how long we live, and taking care of all these aspects is the the key to better health and longer lives for everyone.

#### 1.2. Effects of sports and physical activities

Sports and physical activities significantly contribute to national health and longevity, offering extensive benefits that extend beyond the mere physiological to include psychosocial improvements and a reduction in unhealthy habits like alcohol consumption (Malm et al., 2019). These activities play a crucial role in combating sedentarism and obesity, highlighting the need for moderate physical activity as a preventive measure against mental health issues and advocating for participation tailored to individual needs (Malm et al., 2019). Daskalopoulou et al. (2019) underscore the positive correlation between physical activity and healthy ageing, evidenced in numerous studies, and call for standardisation in health and activity metrics and an emphasis on objective assessments. Research by Hamer et al. (2014) shows that even the initiation of moderate to vigorous physical activity later in life later in life contributes significantly to healthy ageing, highlighting the value of physical activity to maintain health in older adults. Chudasama et al. (2019) found that physical activity reduces mortality risk and increases life expectancy in people with and without multimorbidity, with higher levels of levels of activity offering greater benefits, especially for those with multiple health conditions. This suggests the importance of physical activity as a key lifestyle behaviour for improved health outcomes throughout life. Ozemek et al. (2019) highlight the dangers of physical inactivity and sedentary behaviour, noting their significant contribution to the risk of chronic diseases and reduced life expectancy. Addressing the widespread problem of inactivity could lead to substantial increases in national life expectancy, underlining the urgent need for policies and programmes that encourage physical activity at all ages. Collectively, these studies underscore the critical role of sports and physical activities in enhancing health and extending life expectancy at the national level. They advocate for policies that reduce inactivity, encourage active lifestyles, and recognise the broad spectrum of benefits that physical activity brings to public health.

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#### **1.3.** Effects of environmental quality

The quality of the environmental, levels of pollution, and ecological practices within a country significantly impact the health and longevity of its population. Balakrishnan et al. (2019) highlight the severe air pollution crisis in India, where reducing pollution levels significantly could increase life expectancy, calling for comprehensive policy interventions, especially in less developed regions. Kelly and Fussell (2015) point out that despite air quality improvements, many in Europe still live in areas not meeting health-based air quality standards, with particulate matter pollution affecting a broader range of health outcomes than previously understood, necessitating a holistic approach to pollution reduction. Yin et al. (2020) note China's success in reducing air pollution through stringent emission controls, yet acknowledge that air quality still falls short of WHO guidelines, with persistent health risks indicating the ongoing need for sustainable development policies. Eckelman et al. (2020) report an increase in greenhouse gas emissions from the US health care sector, underscoring the possibility of reducing environmental impact without compromising health care quality through better resource management and policy enforcement. Eckelman & Sherman (2016) demonstrate that the US health care sector is a major contributor to national pollution, with its emissions leading to significant public health damages, emphasising the sector's need for environmental improvements. These studies collectively illustrate the critical relationship between environmental factors and national health outcomes, showing that, while significant strides have been made in the fight against pollution, much remains to be done in terms of policy, monitoring, and sustainable practices to protect public health and extend life expectancy. The need for targeted actions across various sectors, including health care, to enhance environmental performance and mitigate the adverse effects of pollution is evident, as is the potential for improving health outcomes through concerted efforts at both the national and local levels.

Summarising from the literature review, there is a focus on identifying key determinants of health and longevity both at an individual and national level, with a theoretical approach often preferred for exploring causal relationships. Although some empirical research addresses socioeconomic determinants and health system performance, the impact of sports and environmental quality on health and longevity is less statistically highlighted internationally, largely due to strong correlations with economic development and health care funding. In our article, we particularly emphasise the macroeconomic effects of sports and environmental quality on health and longevity, considering other determinants as control factors, in line with the stated objectives and research hypotheses of the study.

*H1: Widespread participation in sports has positive effects on health and longevity at the national level.* This hypothesis suggests that participating in physical activities in a broad population segment promotes better health outcomes by reducing the incidence of chronic diseases, improving mental health, and improving the overall quality of life, contributing thus to an increase in the average lifespan.

H2: The quality and protection of the environment in a country positively influence both life expectancy and public health. This hypothesis suggests that a cleaner and more protected environment reduces pollution and environmental hazards, leading to fewer health issues among the population, such as respiratory diseases and allergies, thus improving general public health and contributing to longer life expectancy.

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#### 2. Research methodology

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To achieve the objective proposed in this study, we use panel data econometrics. We first descriptively visualise and analyse the data. As our sample consists of the 27 countries of the European Union, we present the descriptive assessment based on maps. This approach allows us to directly link the spatial distribution of the two main factors, sports and environment, to other development aspects that are already known to members of the European Union. Additionally, maps allow the evaluation of spatial patterns such as clustering. In the visualisation approach, we present the quartile maps of the two main determinants, both as standalone variables (left parts of figures no. 1 and 2) and in a relative form, based on the GDP of each country. The quartile maps divide the sample into four equal groups based on the values of the variables.

After the descriptive evaluation, we proceed with the estimation process, to assess if the considered determinants significantly impact the quality of life from a health perspective in the European Union members. Before the estimation, we conducted all pre-estimation tests like stationarity and autocorrelation assessments.

Our sample consists of the 27 countries of the European Union. As such, fixed effects are expected to manifest. But among the factor variables there are also some that are constant over time, such as, for example, Hofstede's cultural dimensions. Due to this, the panel fixed effects model cannot be estimated. Variables that are fixed in time require the random effects estimations. As the descriptive analysis points out, there is significant heterogeneity in our panel. To account for this heterogeneity, we do not estimate the models in the classical random effects approach, but using the Maximum Likelihood method to fully maximise the likelihood of the resulted models. Our general model is given by equation (1):

$$DEP_{it} = \propto_i + \sum_{k=1}^m \beta_k X_{kit} + \varepsilon_{it}$$

Where:

DEP = the dependent variable

X = the vector of explanatory variables

m = the number of independent variables

k = indexes the variables

i = indexes the observations, in our case, the countries

t = indices the time, in our case, the years in the analysed period.

For robustness reasons, we employ two dependent variables, opposite in meaning, and add control variables (denoted as the *j* index in our specifications). Additionally, the main goal is to address the impact of sport and environmental protection on a healthy life. As such, equation (1) becomes:

$$LIFE\_EXP_{it} = \alpha_i + \beta_1 Sports_{it} + \beta_2 Environment_{it} + \sum_{j=3}^r \beta_j X_{jit} + \varepsilon_{it}$$
(2)

$$DALY_{it} = \alpha_i + \beta_1 Sports_{it} + \beta_2 Environment_{it} + \sum_{j=3}^r \beta_j X_{jit} + \varepsilon_{it}$$
(3)

We present in table no. 1 the coefficients, along with the significance level denoted by the stars and the standard errors. To account for model quality, we present the number of observations, the log-likelihood of the estimation process, the Likelihood Ratio LR Chi<sup>2</sup> test

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(1)



for the overall goodness of fit of the model and the Likelihood Ratio LR test for panel effects, both with the significance level. The Likelihood Ratio tests compare the models in different estimation stages. The general LR procedure is given by equation (4):

$$LR = -2\ln\frac{L(model_1)}{L(model_2)} \tag{4}$$

Where L is the likelihood of the model, with model 1 being always the more restrictive one. Analyses were performed in Tableau 2023.4 (descriptive analysis and data visualisation) and STATA 16 (descriptive analysis and model estimation).

Variable	Explanations	Mean	Std. Dev. <sup>\$</sup>	Min	Max	
Dependent variables						
LIFE_EXP	Life expectancy at birth for the national population given in years. 79.7		2.92	73.3	83.7	
DALY	Disability Adjusted Life Years. Years of potential life lost due to premature mortality + years of productive life lost due to disability.	21585	3254	17667	31350	
Main factors						
SPORT_REL	The relative values of sports performance through the standardised difference in relation to GDP per capita0.318		18.9	-50.6	36.0	
ENVIR_REL	Relative values of environmental health, by the standardised difference in relation to GDP per capita.	2.8	20.9	-73.8	59.2	
Control variables						
HEALTH_CAP	Public financing of the health system per capita, in thousands of dollars.	294.8	196.8	42.3	738.8	
SPORT_CAP	Public financing of the sport system, per capita, in thousands of dollars.	0.13	0.12	0.007	0.63	
ENVIR_CAP	Public financing devoted to environmental protection per capita, in thousands of USD.	0.26	0.21	0.04	1.26	
FRUITS	Fruit supply given in kilogrammes per capita per year.	81.0	27.9	28.4	151.0	
VEGETAB	Vegetable supply given in kilos per capita per year.	112.2	46.7	53.8	349.9	
SUGAR	Sugar supply given in kilogrammes per capita per year.	52.2	27.1	25.5	171.1	
ALCOHOL	Alcohol consumption, litres per capita, 15+.	9.93	1.76	5.4	14.7	
INDULG	Indulgence. The extent to which a society allows relatively free gratification of basic and natural human drives related to enjoying life and having fun.	42.7	18.8	13.0	78.0	

Table no. 1. Variables used and descriptive statistics

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Variable	Explanations	Mean	Std. Dev. <sup>\$</sup>	Min	Max
INSTIT	The global quality of institutions in a country, measured as the average of the six variables of Worldwide Governance Indicators.	quality of institutions in a sasured as the average of the s of Worldwide Governance 0.97 0		-0.02	1.88
EH	Environmental health evaluates the effectiveness of countries in protecting their populations from environmental hazards.	82.7	12.5	43.2	100
SPORT	Share of the adult population who regularly plays sport.	42.9	18.1	6.3	75.8
GDP_CAP	GDP per capita, in thousands of US.	34.37	23.37	6.86	126.4

*Note: Std.dev.* = *standard deviation.* 

Most of the variables in the study were taken directly from international data sources. However, for the variables SPORT\_REL and ENVIR\_REL, we employ our own mathematical constructions.

$$SPORT\_REL_{i} = 100 \int_{-\infty}^{\frac{SPORT_{i} - m_{i}}{\sigma_{i}}} \frac{1}{\sqrt{2\pi}} e^{-\frac{t^{2}}{2}} dt - 100 \int_{-\infty}^{\frac{GDPCAP_{i} - m_{i}}{\sigma_{i}}} \frac{1}{\sqrt{2\pi}} e^{-\frac{t^{2}}{2}} dt$$
(5)

$$ENVIR\_REL_i = 100 \int_{-\infty}^{\frac{EH_i - m_i}{\sigma_i}} \frac{1}{\sqrt{2\pi}} e^{-\frac{t^2}{2}} dt - 100 \int_{-\infty}^{\frac{GDPCAP_i - m_i}{\sigma_i}} \frac{1}{\sqrt{2\pi}} e^{-\frac{t^2}{2}} dt$$
(6)

In the standardisation formula (equations 5 and 6), the index *i* represents the countries within the European Union, while *m* and  $\sigma$  signify the mean and standard deviation of the respective variables for each year. This process results in standardised variables, with possible values ranging from 0 to 100. The high values of these new variables indicate a high level of participation in sports and, correspondingly, good environmental health relative to the financial possibilities provided by the economic development of country *i*.

The data spans the 27 countries of the European Union, for the period from 2010 to 2022 and is sourced entirely from international databases, including the World Bank – Indicators (2024), World Bank – WGI (2024), Environmental Protection Index - Yale University, EPI (2024), Hofstede Institute (2024), OECD (2024), and the European Commission (2024).

#### 3. Results and discussion

The review of the literature identifies numerous factors affecting the health and longevity of populations, including health funding, lifestyle, eating habits, institutional influences, and macrocultural elements. These factors have been thoroughly investigated in scholarly studies, making further elaboration unnecessary due to the vast amount of empirical evidence available. However, our research focusses on the effects of widespread sports activity and the quality of the environment on life expectancy and general health of the public. Highlighting the impacts of these particular factors poses challenges because of their strong links to economic growth, which introduces multicollinearity challenges in statistical models. To illustrate these trends, we use spatial distribution maps as an initial descriptive tool (figures no. 1 and 2).

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In the countries of the European Union, there is a significant correlation (with a Pearson's correlation coefficient of 0.83) between the frequency of sport participation, the health of the environment, and the GDP per capita. This correlation can be attributed to the idea that economic prosperity facilitates the allocation of resources toward sports infrastructure and the procurement of sports equipment, enhancing the community's engagement in athletic events. When analysing the distribution of countries by quartiles (illustrated in figure no. 1), it is evident that Northern and Western Europe enjoy higher rates of sports participation, in contrast to the lower rates observed in other areas. Notably, Denmark (75.8%), Sweden (75.3%), and Finland (70.4%) lead in the proportion of adults who regularly participate in sports. On the other end, Romania and Bulgaria exhibit the lowest participation rates, at 6.3% and 13.6% respectively. These trends are in large part in alignment with the levels of economic development, although there are intriguing exceptions to this pattern. For example, Hungary, despite being 23rd in GDP per capita, ranks 13th in terms of sports participation. Similarly, Slovenia, Estonia, and Spain outperform their economic standing with the enthusiasm of their residents for sports. In contrast, Italy stands out for its disparity, ranking high in GDP per capita (11th) but low in sports participation (22nd). Likewise, Malta, Ireland, Belgium, and the Netherlands have lower sports participation rates than what might be expected based on their economic achievements.



Figure no. 1. Spatial distribution in quartile intervals of the variables SPORT vs. SPORT\_REL

In our sample, the health of the environment is strongly linked to economic development, as shown by a Pearson correlation of 0.87 with GDP per capita. This strong correlation is explained by the fact that economic growth enables the definition and, more importantly, the implementation of environmental programmes and initiatives to promote and raise awareness about the importance of ecology and a clean environment for health. Looking at the placements of the countries within the environmental performance quartiles (EH variable,

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figure no. 1) reveals significant disparities between the northern part of Europe and the southwest part of the continent. The highest environmental protection values are found in Finland and Sweden (both with an EH score of 95.0), followed by Ireland (92.3) and Denmark (91.1). Environmental protection is least satisfactory in Latvia (71.1), Poland (70.3), Bulgaria (69.5), and Romania (60.9). The differences are notable, with the map largely overlapping the economic situation at the continental level. However, within this general situation, there are notable exceptions worth mentioning (see figure no. 2, ENVIR REL variable). Portugal ranks ninth in environmental performance, although it is only 16th in economic development. Other countries with significantly better environmental performance than their national economies include Spain, Greece, Bulgaria, and Estonia. The opposite situation is found in Belgium and the Netherlands, ranking six positions lower in environmental health than in GDP per capita. These findings on sports and environmental health can provide additional information to explain population health and longevity, thus highlighting additional factors beyond the classic ones, such as healthcare funding and lifestyle factors (alcohol and tobacco consumption, dietary balance, overwork, etc.). This study emphasises the added health and longevity benefits that widespread sports participation and a clean and healthy environment can bring.



Figure no. 2. Spatial distribution in quartile intervals of the variables EH vs. ENVIRON\_REL

Spatial distribution trends highlighted in this descriptive analysis suggest potential insights but also caution against drawing premature conclusions, given the possibility of correlations with other factors leading to incorrect inferences. To address this, our approach includes panel regression analyses. We specifically defined the explanatory variables, SPORT\_REL and ENVIR\_REL, to investigate their impact on health outcomes and longevity, carefully excluding GDP correlation to avoid Omitted Variable Bias in our regression analysis.

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Table no. 2 presents the results of our panel regression analysis, examining both longevity (through the LIFE\_EXP variable) and the overall health status of the population (via the DALY variable), where we observed signs of contrasting coefficients. This contrast is due to the DALY variable's structure, where higher values indicate worse health conditions. In our analysis, traditional health determinants such as healthcare care funding and dietary practices are merely control variables. Our focus is not to reiterate the well-discussed roles of these factors in literature but to explore the specific impacts of sports and environmental quality on health and longevity.

Statistical analysis reveals that eating fruits (variable FRUITS) has a statistically significant (p<0.05) positive impact on national health and longevity, aligning with individual-level studies (Sezaki et al., 2022) and macrolevel research (Dragos et al., 2022). Similarly, consuming vegetables (VEGETABLES) significantly improves health, showing a greater effect on wellbeing (p<0.010) than on increasing life span (p<0.1), as indicated by their different levels of statistical significance. This beneficial effect of vegetables, attributed to their nutrient density and disease prevention capabilities, mirrors findings from other research, such as the study by Miyamoto et al. (2019). Despite their less direct role in prolonging life, vegetables play a crucial role in maintaining overall health, underscoring the importance of a diet rich in fruits and vegetables for long-term health and quality of life. In contrast, sugar consumption (SUGAR) theoretically affects health and longevity (Cobiac et al., 2016), but its effects are not statistically significant in our sample. High alcohol consumption per capita (ALCOHOL) significantly and negatively impacts both life expectancy (p<0.05) and quality of life (p<0.01), especially in terms of living a healthy and disabled-free life. These findings highlight the varied impacts of diet choices on national health outcomes and longevity, underscoring the importance of balanced nutrition and moderation in alcohol consumption.

Theoretically, Hofstede's INDULGENCE index could positively affect national health and longevity by promoting a societal culture that values and encourages leisure activities, happiness, and the freedom to fulfil human desires, which can lead to lower stress levels and healthier lifestyles (in accordance with the empirical results of Mackenbach, 2014). However, in our research, this variable is not statistically significant at the classical 5% level (p>0.05, but <0.1). Hypothetically, the World Governance Indicators (WGI) of good governance, particularly corruption control, could positively influence national health and longevity by ensuring that resources for healthcare and social services are allocated efficiently and equitably (as shown for example by Socoliuc et al., 2022), reducing the risk of mismanagement and promoting public health initiatives. Our regression analyses indicate that the INSTIT variable, representing institutional quality, is statistically significant (p<0.01) and positively correlated with better health outcomes and longer life expectancy.

Public health funding and investment in sports infrastructure significantly improve healthcare access, disease prevention, and physical activity levels, collectively enhancing population health and longevity. Our panel regression analysis within EU countries shows that public health financing (HEALT\_CAP) and sports funding (SPORT\_CAP) have a significant positive impact (p<0.01) on health and longevity, echoing findings from similar empirical studies such as those by Asiskovitch (2010) and Dragos et al. (2022). These results underscore the vital role of government investment in health and sports infrastructure in promoting public health and extending life expectancy.

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Our study discovered highly significant effects (p<0.01) of sports participation (SPORT\_REL) and environmental protection (ENVIR\_REL) on health (DALY) and longevity (LIFE\_EXP), underscoring the pivotal roles that both factors play in enhancing individual and collective well-being. By isolating sports participation and environmental performance from economic development, we aimed to avoid multicollinearity and omitted variable bias, ensuring a more accurate analysis of their impacts. This approach aligns with theoretical and empirical findings in the literature that emphasise the health benefits of physical activity and a clean environment, as seen in studies by Daskalopoulou et al. (2019) Ozemek et al. (2019), and Eckelman et al. (2020), among others. The statistical significance of the SPORT\_REL and ENVIR\_REL variables, even when controlling for multiple other factors, validates our hypotheses: H1 (the positive impact of sports participation on health and longevity). This validation reflects a consensus with broader research, including Eckelman and Sherman (2016), suggesting that investments in sports and environmental health are essential to achieving better health outcomes and longer life expectancy.

	Dependent Variables				
	LIFE_EXP		DALY		
	Coef.***	Std. Err.	Coef.***	Std. Err.	
SPORT_REL	0.043***	0.016	-0.002**	0.0006	
ENVIR_REL	0.027***		-0.001***	0.0004	
FRUITS	0.009**	0.004	-0.0004**	0.0002	
VEGETABLES	0.003*	0.002	-0.0002***	0.00007	
SUGAR	-0.003	0.007	-0.0001	0.0002	
ALCOHOL	-0.187**	0.083	0.011***	0.003	
INDULG	0.040*	0.023	-0.001*	0.0008	
INSTIT	1.422**	0.553	-0.070***	0.022	
(ln)HEALTH_CAP	1.143**	0.464	-0.110***	0.019	
(ln)SPORT_CAP	0.507**	0.202	-0.026***	0.008	
(ln)ENVIR_CAP	-0.406	0.337	0.024*	0.013	
Constant	67.41***	2.677	10.85***	0.101	
Sigma_u	1.469	0.242	0.047	0.008	
Sigma_e	0.581	0.037	0.025	0.002	
Rho	0.865	0.043	0.779	0.063	
N		162		162	
Logarithmic		101.42		276 59	
likelihood		-191.42		520.58	
LR Chi <sup>2</sup> ***		84.82***	142.96***		
LR panel***		128.35***	111.97***		

Table no. 2. The effects of determinants on health and longevity: panel data estimation results

Note: \*\*\*, \*\*, \* significant at 1%, 5%, 10%

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#### Conclusions

In European Union countries, there is a robust correlation linking sports participation, environmental health, life expectancy and population health, suggesting that economic prosperity supports community sports and environmental initiatives. Northern and Western Europe exhibit higher engagement in sports, attributed to better economic conditions, although exceptions such as Hungary and Slovenia indicate that enthusiasm for sports can exceed economic standings. Similarly, environmental health correlates strongly with economic development, but countries like Portugal and Spain show that environmental performance can surpass economic indicators. The study underscores the importance of sports and a clean environment in enhancing health and longevity, beyond traditional factors such as healthcare care funding. Regression analyses highlight the significant positive impacts of public health investment and sports infrastructure on population health, challenging the need to consider broader determinants in public health strategies. Our research demonstrates that sports participation and environmental protection have significant, beneficial effects on health and longevity, validating the importance of these factors in improving well-being. By carefully separating the influence of sports and environment from economic factors, we have ensured a more precise assessment of their direct impacts on health outcomes. This study confirms the broader consensus that physical activity and preserving a clean environment are crucial strategies to improve public health and extend life.

The study faces limitations like unaccounted for confounders and its exclusive focus on EU countries, hinting at the need for a broader set of variables and global applicability in future research. Its dependence on data from a specific period can overlook long-term trends and the effects of major events, promoting continuous research. Furthermore, methodological challenges in proving causality from correlational data suggest the need for future studies using longitudinal or experimental designs. Finally, while underscoring the importance of sports and environmental quality in public health, the study recommends further exploration of their interactions with other health determinants.

The findings highlight the importance of investing in sports infrastructure and environmental initiatives throughout the EU as essential components for improving public health and life expectancy. These investments, supported by economic prosperity, should be prioritised alongside traditional healthcare funding, indicating a broader approach to health determinants. The study shows that sports enthusiasm and environmental health can surpass economic performance in certain countries, suggesting that policies should ensure universal access to these programmes regardless of economic conditions. Lastly, the strong link between environmental health and public health improvements calls for integrated policies that address economic, environmental, and health objectives simultaneously.

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