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SOCIAL DETERMINANTS OF HEALTH AND INEQUALITY MEASURES

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SUMMARY

Across the healthcare landscape, it is now widely understood that Social Determinants Of Health (SDOH) have a major impact on health outcomes, care quality and medical costs. Individuals' race, ethnicity, education, income level or geographical location often have more influence on their physical and mental health than clinical factors. Therefore, to improve their populations' health local health authorities will have to make a concerted effort to better address these social determinants. A key aim of this research was to identify and investigate the principal conceptual frameworks of SDOH used in the current literature, and to contribute to the ongoing debate about practicable measures which could be used for monitoring purposes and so alert Countries, Regions and Small States to where action or further research should be focused. European, Italian and Marche Region's data were used in analyses, with the relevant inequality measures applied to identify underprivileged populations in different territories.

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1. INTRODUCTION

Health inequalities are the differences in health status and experiences between groups of people occupying different positions in society. As they are socially produced, they are potentially avoidable and are widely considered unacceptable in a civilized society (Whitehead, 2007). Health inequalities exist, generally following the social gradient, e.g., the lower a person's socioeconomic position, the worse their health (Marmot and Wilkinson, 2006, Marmot, Allen, Boyce, Goldblatt and Morrison, 2020).

The main aims of this research were:

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- To identify and investigate the principal conceptual frameworks of Social Determinants Of Health (SDOH) available in current literature;
- To contribute to the ongoing debate about practicable measures which could be used to alert Countries, Regions and Small States to inequalities in the distribution of health and healthcare, particularly where public policies may have had a negative impact;
- To explore the determinants of life expectancy among a sample of European countries; and
- To apply the identified measures to European Countries, Italy, and its Marche Region.

2. SOCIAL DETERMINANTS OF HEALTH AND THEIR FRAMEWORKS

The SDOH are the non-medical factors that influence health outcomes. They are the conditions in which people are born, grow, work, live, and age, and the wider set of forces and systems shaping the conditions of daily life. These forces and systems include economic policies and systems, development agendas, social norms, social policies and political systems.

The SDOH have an important influence on health inequities the unfair and avoidable differences in health status seen within and between countries. In all countries, income, health and illness follow a social gradient: the lower a person's socioeconomic position, the worse their health.

The literature shows a wide set of related frameworks (Canadian council on social determinants of health, 2015), but arguably the most important are those proposed by Dahlgren and Whitehead (1991), Marmot (2008) and Artiga and Hinton (2018). Applying these three approaches, the authors synthetized a reference framework (see Table 1). It provides examples of the SDOH, which can influence health equity in positive and negative ways.

The literature states that healthcare system only has a limited impact on health outcomes, ranging from 10% to 20% (Remington, Catlin and Gennuso, 2015). This serves to highlight the importance of increasing the emphasis on SDOH outside the health care system.

3. METHODOLOGY AND DATA SOURCES

The study was conducted in the following steps:

1) A literature review, to understand health inequalities measures and their use;
2) Researching recent reliable data sources with health indicator and social dimensions;
3) An analysis of geographic and wealth inequalities in relation to the distribution of health using the frequently used measures.

TABLE 1. - *Framework on Social Determinants of Health*

Economic stability	**Neighbourhood and built environment**	**Education**	**Lifestyle and health behaviours**	**Community and social context**	**Health care system**
• Employment • Poverty • Food security • Housing stability	• Housing • Neighbourhood • Transportation • Access to healthy foods • Air quality • Water quality • Access to green space	• High school graduation • Enrolment in higher education • Language and literacy	• Hunger • Access to healthy options • Tobacco use • Alcohol use • Sexual activity	• Social integration • Support system • Community involvement • Discrimination	• Access to health care • Access to primary care • Health literacy

Health outcomes
Mortality, Morbidity, Life expectancy, Health status, Functional limitations

The study made use of data reported from the European Health Information Gateway (EHIG) of World Health Organization (WHO), and various Italian databases (e.g., Italian National Statistical Office ISTAT, Bank of Italy), together with Marche's information systems.

4. CLASSIFICATION OF HEALTH INEQUALITY MEASURES

From the current literature, it was possible to classify the most recent inequality measures distinguishing between their health or social dimensions or between ordered or non-ordered dimensions (Shawky, 2018). Therefore, inequality measures were classified into three groups (see Table 2).

Despite the complex and nuanced description of SDOH by WHO, the phenomena are often represented solely by socio-economic indicators, such as income and level of education. A larger set of indictors was studied but a lack of data presented a constraint; consequently, only certain indicators could be utilised. Nevertheless, these included some that were important in relation to different health outcomes.

The mathematical expression of the indices used were as follows:

Rate Ratio: $RR_i = \frac{R_i}{R_0}$ (1)

Rate difference: $RD_i = R_i - R_0$ (2)

Attributable fraction: $AF_i = \left(\frac{R_i - R_0}{R_i}\right) * 100$ (3)

Population Attributable Fraction: $PAF_i = P_i * \left(\frac{RR_i - 1}{RR_i}\right) * 100$ (4)

TABLE 2. - *Classification of Health inequality measures (in bold used indexes in analysis)*

Inequality measures relevant to ordered and nonordered social dimensions	Inequality measures relevant to ordered health dimensions	Inequality measures relevant to ordered social dimensions
• Absolute difference (AD) • Rate Difference (RD) • Rate Ratio (RR) • Broad group (BG) • Correlation and Regression (C&R) • Weighted absolute Mean Difference (wMD) • Weighted Standard Deviation (wSD) • Coefficient of Variation (CV) • Attributable Fraction (AF) • Population Attributable Rate (PAR) • Population Attributable Fraction (PAF) • Population Impact Number (PIN) • Index of dissimilarity (ID) • Theil index of inequality (Theil T)	• Gini Coefficient (GC)	• Slope index of inequality (SII) • Relative Index of Inequality (RII) • Concentration Index (CI) • Concentration Index percent Redistribution need (rCI%)

Population Attributable Rate: $PAR_i = P_t * PAF_i$ (5)

Population Impact Number: $PIN_i = N * PAR_i$ (6)

where:

R_i: Rate of outcome among the i-th population group of interest;
R_0: Rate of outcome among the reference group;
P_i: Proportion of total cases in the population associated with the i-th population group of interest;
P_t: Proportion of total outcome in the total population;
N: Number of people in the population.

5. PRINCIPAL RESULTS AND THEIR DISCUSSION

This section presents the results from some applications of the above formulae; firstly, in the European context (Tables 3, 4, 5 and 6) and secondly in Italy alone (Figure 1) and in the Marche Region (Tables 7 and 8). Table 3 shows the application of inequality measures for the populations of two distinct geographical areas (viz. Italy and France).

TABLE 3. - *Extract of an application of inequality measures between Italy and France, considering France as benchmarking (source: EHIG)*

NAT	Pop (mln) 2011	%	n. of cases (mln)	% of cases	RR	RD	AF	PAF	PAR	PIN
FRA	63.22	2.43	1.5	37.5						
ITA	59.38	4.17	2.5	62.5	1.72	1.73	42%	26.07%	0.851%	34028
TOT	122.6	3.27	4.0							

Table 4 illustrates the application of the Index of dissimilarity (ID) and the Theil T index of inequality, dividing the whole European population into 47 national subgroups.

TABLE 4. - *Index of dissimilarity and Theil T index of inequality (source: EHIG)*

ID = 35% (Live births to mothers aged under 20 years)	Theil T = 0.39 (Live births to mothers aged under 20 years)
ID = 21% (Early neonatal deaths per 1000 live births)	Theil T = 0.15 (Early neonatal deaths per 1000 live births)
ID = 35% (Maternal deaths, per 100 000 live births)	Theil T = 0.32 (Maternal deaths, per 100 000 live births)
ID = 30% (*_Hlk61514380Incidence of cancer per 100 000*_Hlk61514380)	Theil T = 0.32 (Incidence of cancer per 100 000)[1]
ID = 27% (Incidence of cervix uteri cancer per 100 000)	Theil T = 0.29 (Incidence of cervix uteri cancer per 100 000)
ID = 38% (Ischemic heart disease)	Theil T = 0.34 (Ischemic heart disease)
ID = 22% (Premature mortality)	Theil T = 0.17 (Premature mortality)

The ID represents the proportion of total health that would need to be transferred from individuals whose health is above average to those whose health is below average, to achieve a situation of total equality. It is obtained by means of the formula:

$$ID = \frac{\sum_{i=1}^{n} |p_{ip} - p_{ih}|}{2}$$

where *pip* relates to the proportion of the population representing those individuals whose health value is *i*, and *pih* is the proportion of population health for individuals whose health value is *i*. The same as with the Gini index, the ID was used with health variables in which the value assigned to each person was the risk of mortality or the frequency of disease in the socioeconomic category to which the person belonged. The larger the percentage of persons who belong to the categories

[1] Theil T is an entropic ''distance'' the population is away from the egalitarian state of everyone having the same health.

with the highest or lowest risk, the higher the ID and the larger the degree of health inequality.

In this research, ID = 30% for the incidence of cancer per 100000 inhabitants can be interpreted as the percentage of all cases that would have to be redistributed to obtain the same incidence of cancer in all individuals of the population investigated.

The formula for the Theil index of inequality (Theil T) is:

$$Theil\ T = \sum_{i=1}^{N} p_i r_i \ln (r_i)$$

where p_i is the proportion of the population in subgroup i, r_i is the ratio of the health indicator prevalence in the subgroup i to the overall health indicator prevalence in the population. Values of the Theil T index may be difficult for non-technical audiences to interpret, but they can be useful in time series or geographical analysis. In a situation with no relative inequality, the Theil index would be 0, because in this case each subgroup would have a mean value of the health indicator that is equal to the total population mean (so the ratio of these means will be 1). As a result, the products calculated for summation for the Theil T index will all include the natural log of 1 (and ln (1) = 0), leading the Theil index to be 0.

As relative inequality increases the Theil index increases. Greater values for the Theil index indicate higher levels of relative inequality with no maximum. While components of the summation for the Theil index can be negative, the Theil index itself will always be a positive value (WHO, 2013).

6. DETERMINANT FACTORS OF LIFE EXPECTANCY IN EUROPEAN COUNTRIES

Life expectancy at birth is defined as the mean number of years still to be lived by a person at birth. It is an important synthetic indicator for assessing the economic and social development of a country or a region. During the last 170 years, life expectancy has been constantly rising[2] (Münz, 2013, Bilas, Franc and Bosnjak, 2014).

Yet enormous discrepancies still exist between developed and developing countries.

This disparity in life expectancy is believed to have its roots in the differential socio-economic backgrounds of different social groups. The underlying rationale is that socio-economic and environmental factors do exert independent, as well as interactive influences on levels of life expectancy. For these reasons, this section focuses on exploring the determinants of health expectancy at birth among a sample of European countries.

In Tables 5 and 6 examples are presented of stepwise regressions that identify the key determinant factors of life expectancy at birth. Thereupon eight independent vari-

[2] Even if the current worldwide Covid-19 pandemic may well lead to falls in life expectancy in those countries which have been hit hard.

ables were chosen and their influence on the dependent variable was tested. Subsequently independent variables were included in the econometric model:

- Real gross domestic product, PPP$ per capita;
- Total health expenditure as % of GDP;
- Total health expenditure, PPP$ per capita;
- Average amount of fruits and vegetables available per person per year (kg);
- Pure alcohol consumption, litres per capita, age 15+;
- Age-standardized prevalence of obesity (defined as BMI = 30 kg-m2), age 18+, WHO estimates (%);
- Proportion of children of official primary school age not enrolled, both sexes;
- % of population with secondary education only aged 25+ years.

TABLE 5. - *Stepwise regression between life expectancy at birth, total health expenditure, PPP$ per capita and average amount of fruits and vegetables available per person per year (kg) Model Summary*

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.659a	0.434	0.396	1.747
2	0.845b	0.714	0.673	1.285

a. Predictors: (Constant), Health_expenditure_per_capita
b. Predictors: (Constant), Health_expenditure_per_capita, Fruit_and_vegetable_consumption

TABLE 6. - *Stepwise regression between life expectancy at birth, total health expenditure, PPP$ per capita and average amount of fruits and vegetables available per person per year (kg) Coefficients*

Model	Unstandardized Coefficients		Standardized Coefficients		
	B	Std. Error	Beta	t	Sig.
1 (Constant)	76.766	1.194		64.307	0.000
Health_expenditure per_capita	0.001	0.000	0.659	3.392	0.004
2 (Constant)	70.078	2.007		34.908	0.000
Health_expenditure per_capita	0.001	0.000	0.592	4.115	0.001
Fruit_and_vegetable consumption	0.033	0.009	0.533	3.705	0.002

a. Dependent Variable: Life_expectancy

The overall significance of the estimates and that of the individual coefficients were supported by the statistical tests used.

In addition to considering how long people live, it is also important to understand how long people live in good health and what makes their quality of life optimal. Good health planning is concerned with increasing the life expectancy of the population, but it is important that the years of life earned are also guaranteed good health conditions, in line with the WHO slogan ‘‘add years to life, add life to the years’’ (Vian, 2008). These considerations are very well explained in Figures 1 and 2[3].

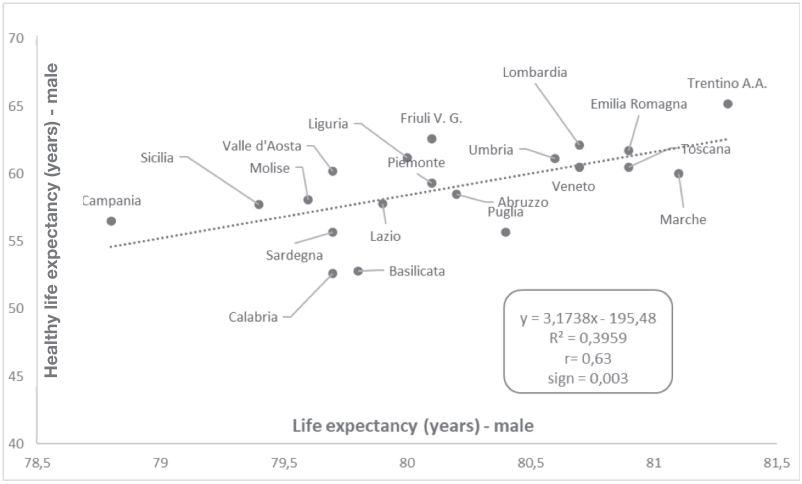

FIGURE 1. - *Correlation and regression analysis between life expectancy at birth (male) and healthy life expectancy in Italy*

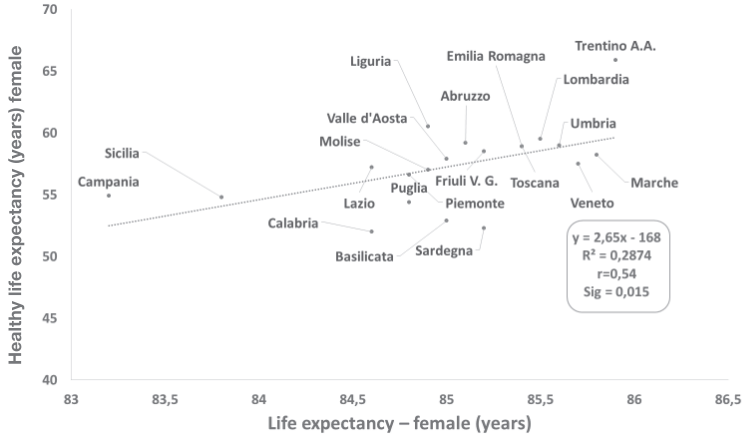

FIGURE 2. - *Correlation and regression analysis between life expectancy at birth (female) and healthy life expectancy in Italy*

[3] Healthy life expectancy at birth is an indicator of health conditions, including the impacts of mortality and morbidity.

From the comparisons between overall life expectancy and life expectancy in good health, significant differences emerge. For example, looking at Trentino-Alto Adige which has the highest values for both axes and both sexes males would spend almost 16 years on average in poor health conditions (calculated by 'overall life expectancy' minus 'life expectancy in good health'), with females living almost 20 years of their lives in difficult conditions. The same analysis carried out for the Calabria region gives males 27 years in poor health and an even more marked gap of 32.5 years for females.

Therefore, with these clear results showing differences between the Italian regions, it is difficult to speak of there being health equality. The results from these analyses appear to be consistent with the most recent literature (Marmot, 2016; Warwick-Booth, 2019; Marmot *et al*., 2020).

7. MEASUREMENT OF HEALTH INEQUALITIES IN THE MARCHE REGION

The theory of Wagstaff and Van Doorslaer (2000) suggests that only the Concentration Index (CI) is able to measure the association between socio-economic and health inequalities. The CI is defined as twice the area between the concentration curve and the line of equality (the 45-degreeline). The convention is that the CI takes a negative value when the curve lies above the line of equality, indicating a disproportionate concentration of the health variable among the poor; and a positive value when it lies below the line of equality. Formally, the CI is defined as:

$$CI = 1 - 2\int_0^1 L_h(p)dp \tag{7}$$

where $\int_0^1 L_h(p)dp$ is the area the area between the concentration curve and the line of equality. The index is bounded between -1and +1. For a discrete living standard variable, it can be written as:

$$CI = \frac{2}{n\mu}\sum_{i=1}^{n} h_i r_i - 1 - \frac{1}{N} \tag{8}$$

where h_i is the health sector variable, μ is its mean, and r_i = i/N is the fractional rank of individual, i in the living standards distribution, with $i = 1$ for the poorest and $i = N$ for the richest.

A further correction made to the CI (Erreygers, 2009) is linked to the case in which the detected health indicator corresponds to a dependent variable distributed between 0 and 1. By applying this correction the CI is redefined according to the following formula which produces the index named E (y) or Erregeyers Demographic Adjusted (EDA) index:

$$E(y) = \frac{4\mu}{(b_n - a_n)} CI(y) \tag{9}$$

where b_n and a_n represent the maximum and minimum of the health indicator or health outcome (y) (in our case 0 and 1), μ indicates the average level of health or health outcome and C (y) represents the concentration index calculated in the previous expression.

In this section the measurement of health inequalities was conducted in two steps,

initially applying the CI to a subgroup of population, ranked by a proxy of income level, and then to subgroups distinguished by level of education.

Table 7 and Figure 3 show the application of CI in the Marche region to quantify the relationship between self-perceived health and the rank of a proxy of income.

TABLE 7. - *EDA index applied in the Marche Region*

	2005	2006	2007	2008	2009	2010	2011	2012
EDA index	0.207	0.055	0.088	0.006	0.097	0.047	0.076	0.115
P value	0.000	0.079	0.006	0.861	0.001	0.153	0.004	0.000
Standard error	0.024	0.031	0.031	0.036	0.028	0.033	0.026	0.030
Significance	***	*	**		**		**	***

*Significance levels: *10%, **5%, ***1%*

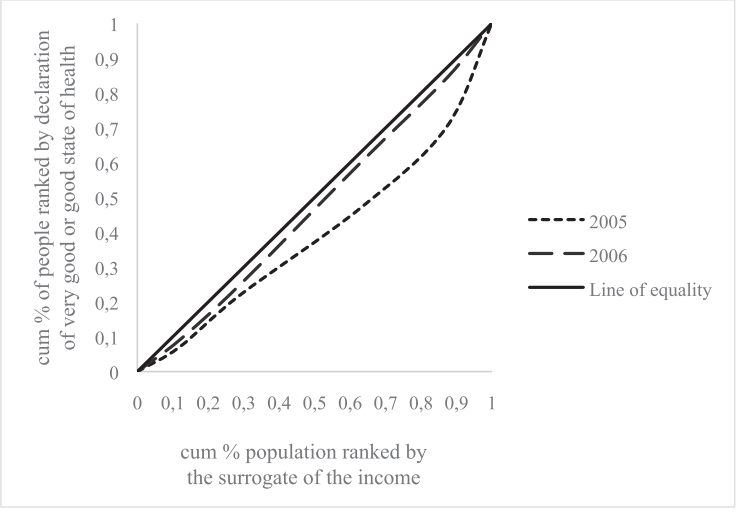

FIGURE 3. - *Concentration curve for 2005 and 2006 in the Marche Region*[4]

This latter approach was used because there is no direct income indicator in the Indagine Multiscopo of ISTAT. Therefore, the principal component analysis method was used to create a one-dimensional socio-economic index (proxy of income), consisting of a linear combination of the observed variables, such as home ownership, presence of a domestic employee, and a set of possessions (television, satellite receiver, mobile phone, computer, Internet access, hi-fi system, video camera, washing machine, dishwasher, air conditioner, car, etc.) (Vyas and Kumaranayake, 2006; O'Donnell, van Doorsrael, Wagstaff and Lindelow, 2008).

[4] For aesthetic reasons, the curves on the graph were designed to be relative to the years 2005 and 2006, which represent the range of variation of CI in the application, considering only the significant values.

From the analysis of the values shown in Table 7 it can be seen that this index ranges between the values of 0.207 for the year 2005 to 0.055 for 2008 (considering only the significant values). In the first case, the value found can be interpreted as follows: people who declare a state of good or very good health, are more likely to be in the population groups with higher income. The value of CI, which was not particularly high, suggests a weak inequality.

Furthermore, in the same Marche region, health inequalities were analysed using the level of education as the SDOH, looking at its influence in relation to four

TABLE 8. - *Summary of socio-economic inequalities for selected indicators in the Marche region*

	Regional value	**Lowest educational level group**	**Highest educational level group**	**Absolute/ Rate difference**
General health status				
Life expectancy in men (years)	81.1	80.3	83.4	3.1
Life expectancy in women (years)	87.1	86.6	89.8	3.3
% of the population that assess their health as good or very good	70.0	65.9	74.7	8.8
Accessibility of care				
Breast cancer screening (% women aged 5069)	71.8	65.9	77.8	11.9
Cervix cancer screening (% women aged 2564)	79.7	76.0	83.4	7.4
Delayed contacts with health services because of financial reasons	15.3 - 7.6*	* divided into people with limitations and without limitations		
Appropriateness				
% of adult diabetes patients (aged 25+)	3.8	5.4	2.3	3.1
Health promotion				
% of the population that reports to smoke daily	19.0	17.4	20.5	3.1
% of the adult population considered as being obese (BMI =30)	9.5	15.2	10.1	5.1
% of the adult population considered as being overweight or obese (BMI=25)	31.5	35.8	25.8	10.0
% of the population reporting to practice at least 30 min of physical activity per day	9.1	7.5	16.6	9.1

dimensions of outcomes (health status, access to care, appropriateness and health promotion) (See Table 8). It was decided to divide the population of Marche Region according to level of education because higher levels of scholarship enable people to better understand health literacy and innovations in medical and food hygiene fields. Also, better-educated people are arguably more able to deal with disadvantageous situations. In synthesis, better education can facilitate better health and, for this reason it is considered one of the most important SDOH (Feinstein, Sabates, Anderson, Sorhaindo and Hammond, 2006; Zajacova and Lawrence, 2018).

8. CONCLUSION

Health is the result of many interrelated factors. The conditions in which people live affect their health status and contribute to the creation of a gap between socio-economic groups. Socio-economic inequalities in health status are present in all countries of the world, including the most developed. In order to create a sustainable and efficient health care sector that can engender desired health outcomes (such as increased longevity), there has to be co-operation between the health sector and social care in a country, supported by an enabling social and political environment.

Recognizing and understanding individuals' SDOH, and their relative frameworks, should lead to more comprehensive holistic healthcare; but stakeholders across the care continuum will need to address several data-related challenges before this vision can become a reality.

Several summary measures have been used in the public health field to assess health inequalities. This paper sets out a toolkit to analyse and to assess the distribution of inequality between different population groups. A recommended method for evaluating inequalities involves the CI (calculated according to Wagstaff and Erreygers' methods), which was applied within the Marche region. There it was found that the level of education influences general health status, accessibility of care, appropriateness and health promotion.

Furthermore, it is important to link the most relevant SDOH and health inequalities with specific indicators and outcomes. This research placed particular emphasis on life expectancy for its examples, and the results indicated which variables were of significant influence in this regard. These were: total health expenditure per capita, and average amount of fruits and vegetables available per person per year.

The authors' aim to continue to develop headline indicators which can appropriately and effectively monitor health inequalities. This will include the development of guidelines for the collection of relevant data in order that Italian Regions, Local Health Authorities and Small States can better understand and monitor the dynamics of health inequalities.

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