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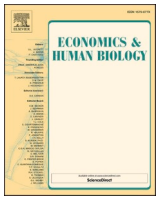

Pain trends and pain growth disparities, 2009–2021

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ABSTRACT

Physical pain is a major public health concern. Yet evidence on trends in physical pain around the world barely exists. Using nationally representative data from 146 countries (N = 1.6 million respondents), this paper finds that, all over the world, the percentage of people in pain increased from 26.3 in 2009 to 32.1 in 2021. This rising trend was present in both higher- and lower-income countries. This article also documents pain disparities: In the worldwide population, pain grew faster among women, the less educated, and the poor. Although the aggregate level of pain was greater among the elderly (> 60 years old), the growth in pain was faster among the younger (< 35 years old). These findings hold after controlling for sociodemographic factors. Disparities of pain growth in higher- and lower-income nations and potential explanatory factors are also discussed. Understanding how the level of pain varies over time and across demographic groups is crucial to evaluate and shape public health policies.

1. Introduction

Physical pain is a common health problem with vast individual, economic, and social consequences. Pain influences people's health, wellbeing, and risk of mortality (Smith et al., 2018; Zajacova et al., 2021a), the economy and the healthcare system (Frießem et al., 2009; Gaskin and Richard, 2012), and the individual's immediate social environment, such as the family and the workplace (Bendelow and Williams, 1995; de Vaan and Stuart, 2019; Dueñas et al., 2016). Understanding the growth and the distribution of pain growth in society is crucial to improving citizens' welfare and the public health system. Yet evidence on pain trends and pain growth disparities in the worldwide population barely exists. This paper uses nationally representative data from 146 countries (N = 1.6 million respondents) to examine pain trends between 2009 and 2021, potential explanations for these trends, and sociodemographic disparities in pain growth.

Later analyses show that the percentage of people in pain around the world increased from 26.3 in 2009 to 32.1 in 2021. Approximately, an extra half a billion people were in pain in 2021 as compared to 2009. Pain grew faster in countries with lower (vs higher) median age, lower (vs higher) healthcare spending, lower (vs higher) general government spending, and higher (vs lower) stress. This article also shows that pain growth is unequally distributed: The growth in physical pain was faster among women, the younger, the less educated, and the poor.

2. Background

Individuals' utility is at the centre of economic thinking. Traditionally, utility has been associated with income: the higher the income, the greater the utility. However, this notion has been widely challenged and economists started to consider self-reported wellbeing (e.g., happiness, life satisfaction) a proxy for utility (Frey and Stutzer, 2002). Physical pain has detrimental effects on individuals' wellbeing. Using panel data from Australia, McNamee and Mendolia (2014) found that chronic pain was negatively linked to life satisfaction. Ólafsdóttir et al. (2020) has shown that people would pay between 56 and 145 US dollars to avoid physical pain. In line with other aspects of wellbeing, pain has been found to influence economic and health behaviour. For example, pain is strongly associated with work productivity loss (McDonald et al., 2011), absenteeism (see Linton, 2000), job loss (Piper et al., 2021), and drug and alcohol misuse (Brennan et al., 2005; Glei et al., 2020). By examining pain trends and pain disparities around the world, the present study contributes to researchers' efforts to understand and improve individuals' utility.

Physical pain has been extensively studied in medicine and biology. More recently, economists and social scientists started to examine the socioeconomic and psychosocial factors that may influence pain. For instance, discrimination based on age, gender, race, disability, sexual orientation, and physical characteristics, has been found to increase chronic pain (Brown et al., 2018). People with lower socioeconomic status are more likely to feel disabled due to pain than those with higher

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socioeconomic status (Dorner et al., 2011). Social comparison also plays a role: People whose income ranks lower in their reference group are more likely to experience pain than those whose income ranks higher (Daly et al., 2015; Macchia, 2021). Exploring pain at the population level, prior research found that pain increased when unemployment in society was high (Dávalos et al., 2012; Macchia and Oswald, 2021). This work argues that social stressors linked to hard economic conditions may shape individual's pain. The present study also contributes to this body of research by exploring socioeconomic and psychosocial factors that may help explain the trends in physical pain.

Health disparities and their persistence over time reflect important structural inequalities that need to be addressed to improve societal welfare (see Fox and Powell, 2021; Pearlin et al., 2005). The pain disparities that the present study documents are related to the theory of fundamental causes. This theory suggests that individuals with greater resources (e.g., better socioeconomic status, higher education) tend to have better health and are more likely to avoid illnesses than people with fewer resources (Link and Phelan, 1995; Phelan et al., 2010).

2.1. Existing studies

Up to date, the literature on trends in physical pain is quite limited. Grol-Prokopczyk (2017) used a nationally representative sample of older American adults (over 51 years of age) and found that chronic pain increased from 1998 to 2010 (see also Zimmer and Zajacova, 2020). Freburger et al. (2009) used a sample of 4437 households from North Carolina and found that low back pain increased from 1992 to 2006. Shen et al. (2015) documented that moderate-to-severe pain declined from 2006 to 2009 among Medicare Beneficiaries in Nursing Homes. Nahin et al. (2019) found that the proportion of adults reporting painful health conditions in the United States increased from 1997 to 2014. Similarly, Case and Deaton (2015) showed that chronic pain among non-Hispanic Whites aged 45–64 in the US increased from 1999 to 2003. Using a sample of 5632 US residents, Glei et al. (2020) showed that physical pain rose between the mid-1990 s and the mid-2010 s, in particular, among older and low socioeconomic status individuals. Zajacova et al. (2021b) examined a sample of 441,707 US citizens and found increasing trends in pain between 2002 and 2018.

Across this body of work, the United States has received most of the attention and little is known about *trends* in physical pain in other regions of the world. Only one study used a sample of 15 rich European nations to examine pain trends among adults over 50 years old (Zimmer and Zajacova, 2020). Some articles used representative samples from countries other than the United States to study the *level* of physical pain. Blanchflower and Oswald (2019) compared the level of pain in the US with the level of pain in other 31 rich nations. Macchia and Oswald (2021) looked at the level of pain and the state of the economy using a worldwide sample (see also Macchia, 2021 for the link between personal income and physical pain). Other studies looked at the level of pain in European nations (Todd et al., 2019), and developing countries (Johnson et al., 2013).

Pain levels differ across demographic groups: Women (vs men), older adults (vs younger adults), individuals with low socioeconomic status (vs high) and with less education (vs more) tend to experience greater pain (Case et al., 2020; Janevic et al., 2017; Kennedy et al., 2014; Macchia and Oswald, 2021; Patel et al., 2013). Only two studies explored disparities in pain *trends*. Grol-Prokopczyk (2017) found no significant difference across demographic groups among older adults in the US. Zajacova et al. (2021b) showed sociodemographic disparities in pain growth among American adults.

The present study explores pain trends and pain growth disparities around the world and analyses potential explanations for these trends.

3. Methods

3.1. Data

This paper used data from the Gallup World Poll (GWP) from 146 countries from 2009 to 2021 (N = 1.6 million respondents; age range 15-99+ years old, mean = 42 years old). The GWP surveys approximately 1000 individuals in each country and year using randomly selected, nationally representative samples that represent more than 99% of the world's adult population. In regions where telephone coverage represents at least 80% of the population, the survey is administered by telephone. In developing regions, such as some Latin American countries, the former Soviet Union countries, and nearly all of Asia, the Middle East, and Africa, the survey is administered face-to-face. Regardless of the methodology, households are randomly selected.

The present study used a sample with all the countries and two subsamples of higher- and lower-income countries (see Supplemental Material (SM) for list of countries). These groups of higher- and lower-income countries were created considering the level of Gross Domestic Product per capita (GDP) at the start of the period of analysis. In 2009, the sample of 146 countries was divided into two halves. GDP data were retrieved from the World Bank database.

3.2. Dependent variable

The dependent variable for this study was individual's physical pain. Respondents were asked: "Did you experience the following … during a lot of the day yesterday? How about … Physical Pain?" People could answer yes (1) or no (0) (see Case et al., 2020). This measure was multiplied by one hundred to represent the percentage of people in pain in each survey year to ease interpretation of the coefficients. Regression models using the raw binary variable yielded the same results with coefficients divided by one hundred.

3.3. Independent variable and covariates

The main independent variable was a continuous survey year term. Respondent's sociodemographic characteristics were included as controls in the regression models to account for factors that may also affect physical pain. Sociodemographic characteristics include gender, age (linear and squared), level of education (elementary, secondary, and tertiary), country-year income quintiles, employment status (employed full time for an employer, employed full time for self, employed part time want full time, employed part time do not want full time, unemployed, out of workforce), marital status (single/never married, married, separated, divorced, widowed), and number of children under 15 in the household.

More details about these variables can be found in the SM. Descriptive statistics can be found in Table 1 (all countries), Table S.1 (higher-income countries), and table S.2 (lower-income countries).

3.4. Statistical analysis

To examine whether physical pain varied over time, Ordinary Least Squares regressions adjusted by sociodemographic characteristics were conducted. Equivalent results were obtained using Logit models. These can be found in Table S.6 in the SM. All regressions also included country fixed effects to account for country-specific factors (e.g., climate or political events) that may influence physical pain. Given that the purpose of these regressions was to explore how physical pain varied over time (one physical pain data point per year), the standard errors were clustered at the year level. Trends in physical pain were also explored across demographic groups, namely, gender, age, education, and income.

Table 1
Descriptive statistics, all countries.

Variable name	Mean	St. Dev.	Min	Max
Physical pain	30.74	46.14	0	100
Male	0.46	0.49	0	1
Age group				
Under 35	0.41	0.49	0	1
35–60	0.42	0.49	0	1
Over 60	0.17	0.37	0	1
Level of education				
Elementary	0.32	0.46	0	1
Secondary	0.51	0.49	0	1
Tertiary	0.17	0.37	0	1
Income quintile				
Bottom 20%	0.2	0.4	0	1
Second 20%	0.2	0.4	0	1
Third 20%	0.2	0.4	0	1
Fourth 20%	0.2	0.4	0	1
Top 20%	0.2	0.4	0	1
Employment Status				
Employed full-time for an employer	0.27	0.45	0	1
Employed full-time for self	0.14	0.34	0	1
Employed part-time want full-time	0.08	0.26	0	1
Employed part-time do not want full-time	0.07	0.26	0	1
Unemployed	0.06	0.24	0	1
Out of workforce	0.38	0.48	0	1
Marital Status				
Single	0.29	0.45	0	1
Domestic partner	0.05	0.22	0	1
Married	0.53	0.49	0	1
Separated	0.02	0.14	0	1
Divorced	0.04	0.19	0	1
Widowed	0.07	0.25	0	1
Children under 15 in the household	1.25	1.81	0	90

Note: Descriptive statistics for higher- and lower-income countries can be found in Tables S.1 and S.2 in the SM, respectively. N for all variables is 1,625,808.

3.5. Potential explanatory factors

Additional analyses were conducted to explore factors that may help explain the trends in physical pain.

Nation's age profile. Given that physical pain tends to increase with age (see Macchia and Oswald, 2021 for analyses with a worldwide sample), whether the trend in physical pain differed according to the age profile of the nations was examined. Country's median age data were retrieved from The World Factbook database and were available in 119 countries. This sample was divided into two subsamples based on the age profile of the country in 2009. The median of this variable was 26.8 years. One subsample contained younger-age countries (59) and another subsample contained older-age countries (60). The median age of countries in the first subsample was below 26.8 years whereas the median age of the countries in the second subsample was over 26.8 years.

Healthcare spending. Citizens in countries with poor healthcare services may experience greater pain. To test this possibility, health expenditure (% of GDP) data were used. These data were available in 142 countries and were retrieved from the World Bank Database. This sample was divided into two subsamples based on healthcare spending of each country in 2009, the start of the period of analysis. One subsample contained lower-healthcare spending countries (71) and another subsample contained higher-healthcare spending countries (71). The median of healthcare spending in 2009 was 6.1%. The median of healthcare spending in the first subsample was below 6.1% whereas the median of healthcare spending in the second subsample was over 6.1%.

General government spending. General government spending can also affect people's quality of life including physical pain. General government spending (% GDP) data were available in 134 countries and were retrieved from the World Bank Database. This sample was divided into two subsamples based on the level of general government spending (% GDP) of each country in 2009, the start of the period of analysis. One subsample contained lower-spending countries (67) and another subsample contained higher-spending countries (67). The median of government spending in 2009 was 16.03%. The median of government spending in the first subsample was below 16.03% whereas the median of government spending in the second subsample was over 16.03%. This measure could also be used as a proxy for austerity after the 2008 Global Financial Crisis and countries with lower general government spending can be classified as more austere.

Manufacturing. Jobs that are hard on the human body may play a key role in physical pain (Vandergrift et al., 2012). Thus, countries in which manufacturing increased may exhibit greater rates of pain than countries in which manufacturing decreased. To explore this possibility, manufacturing value added (% of GDP) data were used. These data were available in 136 countries and were retrieved from the World Bank Database. The trend in manufacturing between 2009 and 2021 was significantly positive in 33 countries, significantly negative in 51 countries, and insignificant in 52 countries (see Table S.28). Two subsamples were created: One subsample contained the countries in which manufacturing decreased (51), and another subsample contained the countries in which manufacturing increased (33).

Optimism. Optimism about the future has been found to be linked to physical pain: People who experienced lower optimism reported greater pain (Graham and Pinto, 2019). Following prior research, a measure of life evaluation in five years available in the Gallup World Poll was used as a proxy for optimism (Graham and Pinto, 2019). Respondents were asked "Please imagine a ladder with steps numbered from zero at the bottom to ten at the top. Suppose we say that the top of the ladder represents the best possible life for you and the bottom of the ladder represents the worst possible life for you. Just your best guess, on which step do you think you will stand on in the future, say about five years from now?" and could answer anything between 0 (worst possible life) to 10 (best possible life). This variable was available in 140 countries and the trend in optimism in each country between 2009 and 2021 was calculated. The trend in optimism was significantly positive in 53 countries, significantly negative in 20 countries, and insignificant in 67 countries (see Table S.29). The full sample was divided into two subsamples. One subsample contained the countries in which optimism decreased (20) and another subsample contained the countries in which optimism increased (53).

Stress. Prior research also found that pain was strongly liked to stress (Chou et al., 2016; Graham and Pinto, 2019). Thus, in countries in which stress increased, physical pain might have also increased. To test this idea, a measure of stress available in the Gallup World Poll was used. Respondents were asked "Did you experience the following … during a lot of the day yesterday? How about … Stress?" People could answer yes (1) or no (0). This measure was multiplied by one hundred to represent the percentage of people in stress in each survey year to ease interpretation of the coefficients. This variable was available in 140 countries and the trend in stress in each country between 2009 and 2021 was calculated. The trend in stress was significantly positive in 74 countries, significantly negative in 8 countries, and insignificant in 58 countries (see Table S.30). The full sample was divided into two subsamples. One subsample contained the countries in which stress decreased (8) and another subsample contained the countries in which stress increased (74).

4. Results

4.1. Pain trends and disparities

Fig. 1 shows the percentage of people in pain in each survey year using raw means in the data (estimates adjusted for sociodemographic factors, including age, support these patterns and are shown in Table 3). This figure shows that the percentage of people in pain has trended upward all over the world between 2009 and 2021 ($b = 0.61$; $p = .001$). An upward trend can also be observed in higher- and lower-income countries (see Fig. S.1 in the SM). It is worth noting that these trends

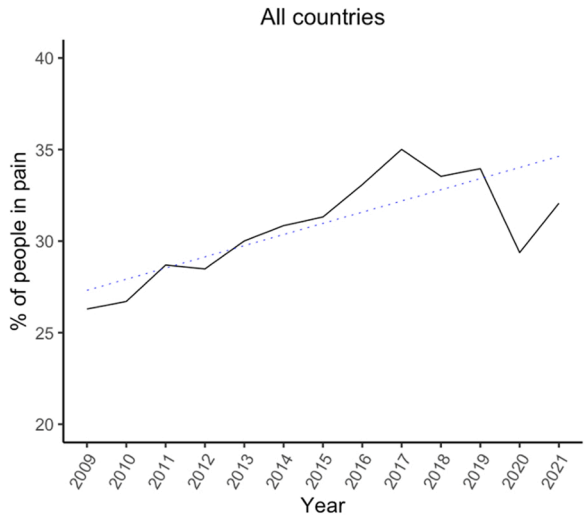

Fig. 1. Trend in physical pain, 2009–2021. $b = 0.61$; $t = 3.35$; $p = .001$. Intercept = 26.69; $t = 29.91$; $p < .001$. Number of countries: 146. Number of individual observations: 1,625,808.

show a trough in 2020 (see Discussion section for more details). The upward trend in physical pain was steeper in the 2009–2019 timespan removing the pandemic years (see Fig. S.2 in the SM).

Table 2 shows the percentage of people in pain per year in a sample with all the countries and in subsamples of higher- and lower-income countries. All over the world the proportion of people who experienced physical pain was 26.3% in 2009 and 32.1% in 2021. The proportion of people in pain in higher-income countries increased from 26.8% in 2009 to 29% in 2021 whereas in lower-income countries the proportion of people in pain increased from 25.9% in 2009 to 32.8% in 2021.

Fig. 2 provides an illustration of the raw trends in physical pain in all the countries by demographic groups. Two main findings are shown in this figure: 1) the aggregate level of physical pain was greater among women, the elderly, the less educated, and the poor in comparison to men, the younger, the more educated, and the rich, and 2) physical pain increased in all demographic groups. The raw trends in physical pain in higher- and lower-income countries can be found in Tables S.3 and S.4.

Table 3 shows the coefficients of the adjusted trends in physical pain for each demographic group in the worldwide population as well as in subsamples of higher- and lower-income countries. The key result in Table 3 is that physical pain increased over time in lower- and higher-income countries and in all groups of the population after adjusting for demographic characteristics. This table also confirms that inequality of pain has widened (i.e., pain grew faster in some groups than in others). In higher-income countries, the growth in physical pain was just as fast among men ($b = 0.22$; $p = .004$; 95% CI[0.08,0.36]) as among women ($b = 0.25$; $p = .009$; 95% CI[0.08, 0.42]). Yet in lower-income countries, physical pain grew faster among women ($b = 1.08$; $p < .001$; 95% CI[0.89, 0.26]) than among men ($b = 0.97$; $p < .001$; 95% CI [0.74, 1.19]). The models by age groups show interesting patterns. In higher-income countries, the trend in physical pain among the elderly (people over 60 years old) was statistically insignificant ($b = 0.27$; $p = .104$; 95% CI[−0.07, 0.61]) whereas the growth in physical pain was faster among the younger (people under 35 years old; $b = 0.29$; $p < .001$; 95% CI[0.20, 0.38]) than among middle-aged individuals (35–60 years old; $b = 0.17$; $p = .01$; 95% CI[0.05, 0.29]). In lower-income countries, physical pain among middle-aged individuals ($b = 1.13$; $p < .001$; 95% CI[0.89, 1.37]) grew faster than among the younger ($b = 0.92$; $p < .001$; 95% CI[0.75, 1.09]) and the elderly ($b = 0.89$; $p < .001$; 95% CI[0.62, 1.16]).

Table 2
Percentage of people in pain per year, all countries, 2009–2021.

	All countries	Higher-income countries	Lower-income countries
2009	26.29	26.79	25.91
2010	26.70	25.14	28.64
2011	28.69	26.89	30.80
2012	28.48	26.69	30.44
2013	30.01	28.62	31.29
2014	30.84	28.51	32.95
2015	31.32	27.99	34.67
2016	33.08	28.85	37.45
2017	35.01	29.26	40.68
2018	33.54	27.86	38.68
2019	33.95	30.18	37.61
2020	29.37	26.39	33.19
2021	32.07	29.03	32.83
N of countries	146	73	73
N of observations	1,625,808	815,746	810,062

Note: Mean of physical pain per year in higher- and lower-income countries can be found in Tables S.3 and S.4 in the SM, respectively.

The regression analysis shows consistent patterns in the education and income groups. In both higher- and lower-income countries, the percentage of people in pain grew faster among the less educated (*Higher-income countries:* $b = 0.58$; $p < .001$; 95% CI[0.39, 0.77]; *lower-income countries:* $b = 1.32$; $p < .001$; 95% CI[1.09, 1.53]) than among the more educated (*Higher-income countries:* b = 0.05; p = .34; 95% CI [−0.06, 0.15]; *lower-income countries:* $b = 0.49$; $p < .001$; 95% CI[0.26, 0.73]). Trends in physical pain of those in the bottom income quintile and those in the top income quintile differed significantly in both higher- and lower-income countries: The growth in physical pain was faster among people in the bottom quintile (*Higher-income countries:* $b = 0.37$; $p = .002$; 95% CI[0.17, 0.56]; *Lower-income countries:* $b = 1.19$; $p < .001$; 95% CI[0.98, 1.41]) than among those in the top quintile (*Higher-income countries:* $b = 0.21$; $p = .002$; 95% CI[0.09, 0.32]; *Lower-income countries:* $b = 0.83$; $p < .001$; 95% CI[0.61, 1.06]). These pain growth disparities are confirmed in Chi-Squared tests shown in Table S.13.

4.2. Potential explanatory factors

Nation's age profile. Regression models show that physical pain grew faster in countries with lower median age ($b = 1.14$; $p < .001$; 95% CI [0.94, 1.34]) than in countries with higher median age ($b = 0.28$; $p = .002$; 95% CI[0.12, 0.44]; Table 4 and S.14).

Healthcare spending. Physical pain grew faster in countries with lower healthcare spending ($b = 0.90$; $p < .001$; 95% CI[0.71, 1.09]) than in countries with higher healthcare spending ($b = 0.33$; $p = .001$; 95% CI [0.16, 0.50]; Table 4 and S.15).

General government spending. The growth in physical pain was faster in countries with lower government spending ($b = 0.88$; $p < .001$; 95% CI[0.73, 1.03]) than in countries with higher government spending ($b = 0.34$; $p = .003$; 95% CI[0.14, 0.54]; Table 4 and S.16).

Manufacturing. Physical pain grew in countries in which manufacturing decreased ($b = 0.66$; $p < .001$; 95% CI[0.52, 0.79]) and in countries in which manufacturing increased ($b = 0.58$; $p = .001$; 95% CI[0.38, 0.79]; Table 4 and S.17). However, the difference in pain growth was not statistically significant.

Optimism. The regression models show that physical pain grew in countries in which optimism increased ($b = 0.62$; $p < .001$; 95% CI [0.45, 0.78]) and in countries in which optimism decreased ($b = 0.48$; $p < .001$; 95% CI[0.27, 0.69]) between 2009 and 2021. However, the growth in physical pain in these two sets of countries did not differ significantly (Table 4 and S.18). Fig. S.3 and Table S.21 show upward trends in optimism in higher- and lower-income countries.

Stress. The regression models show that physical pain grew in countries in which stress increased between 2009 and 2021 ($b = 0.94$; $p < .001$; 95% CI[0.68, 1.21]) whereas the pain trend in countries in which stress decreased was statistically insignificant ($b = -0.39$;

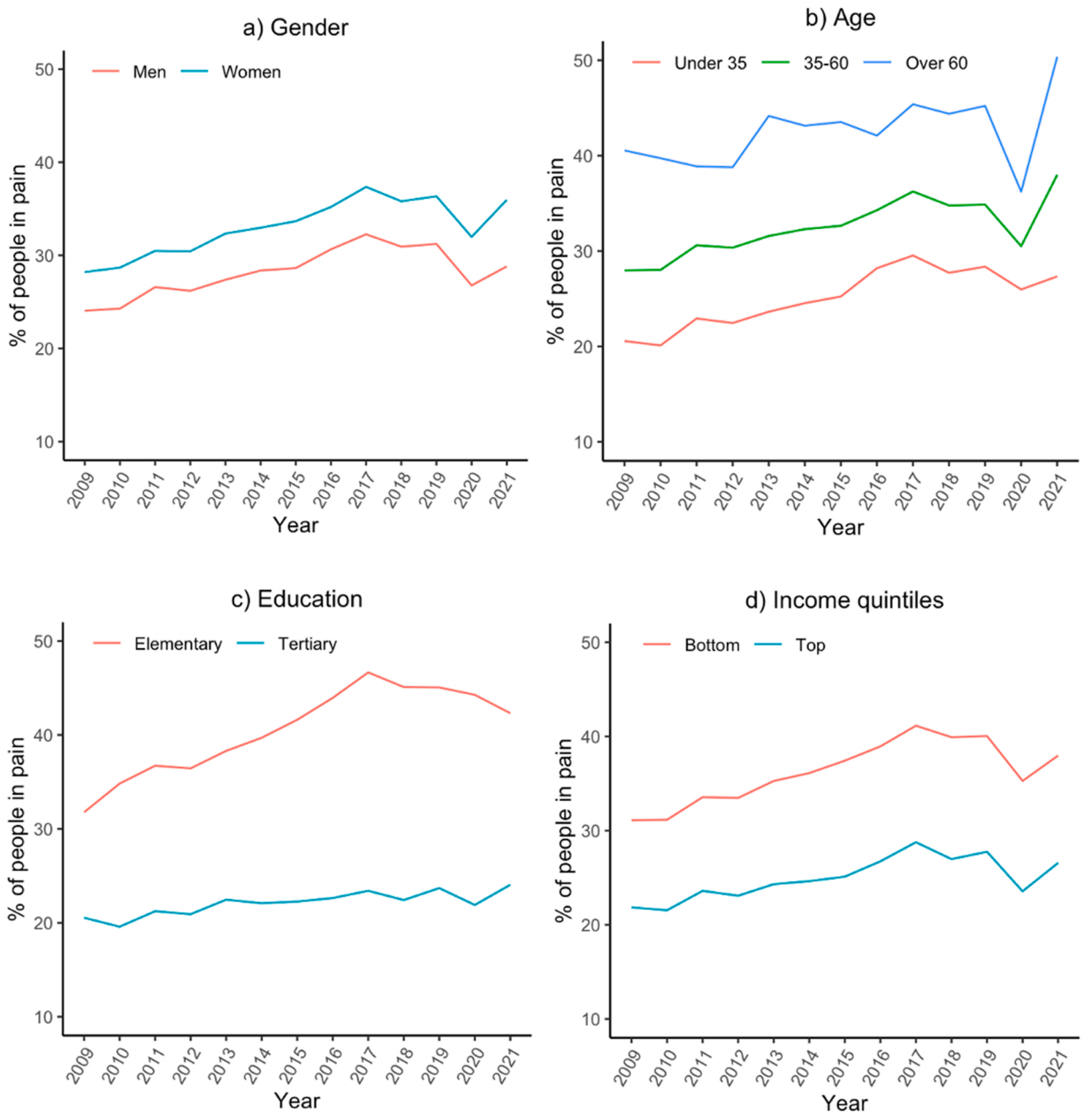

Fig. 2. Trends in physical pain in all countries by subgroups, 2009–2021. These are plots of the raw means in the data set. Upward slopes held in regressions with covariates shown in Table 3.

$p = .115$; 95% CI[−0.89, 0.11]; Table 4 and S.19). Table S.22 and Fig. S.4 show upward trends in stress in higher- and lower-income countries.

These pain growth disparities were confirmed in Chi-Squared tests shown in Table S.20.

Additional tests were conducted. The rising trends in physical pain shown in Table 3 also held after controlling for macroeconomic indicators, such as the Gross Domestic Product per capita, inflation rate, and unemployment rate (Table S.23). The trends in physical pain were also explored by continent using both the 2009–2021 period and the 2009–2019 period. The results show that physical pain increased between 2009 and 2021 in Confucian Asia, Latin America, Southern Asia, Arab countries, and Sub-Sahara Africa. When removing the pandemic years from the analyses, the regression models show that physical pain increased from 2009 and 2019 in 7 out of 10 regions: North America, Eastern Europe, Confucian Asia, Latin America, Southern Asia, Arab countries, and Sub-Saharan Africa (Table S.24 to S.27). Finally, Figs. S.5 and S.6 show the trends in physical pain across continents and by education groups.

5. Discussion

This article provides cross-country evidence on the growth in physical pain between 2009 and 2021. The data are nationally representative of the 146 countries involved in the analysis (N = 1.6 million respondents). The percentage of people in pain increased dramatically between 2009 and 2021 all over the world. This sharp increase can be seen in higher- and lower-income nations and among all the demographic groups examined here.

It is worth noting that the percentage of people in pain decreased from 2019 to 2020. Perhaps the changes in lifestyles that the COVID-19 pandemic introduced had an effect on population-level physical pain. Future research should explore this possibility.

This paper also documents physical pain inequalities. The aggregate

Table 3
Trends in physical pain in full sample and by demographic subgroups, 2009–2021. Ordinary Least Squares with covariates.

	Dependent variable: % of people in pain		
	All countries	Higher-income countries	Lower-income countries
Full sample	0.63*** (0.08)	0.24** (0.07)	1.03*** (0.09)
By gender			
Women	0.65*** (0.08)	0.25** (0.08)	1.08*** (0.08)
Men	0.59*** (0.08)	0.22** (0.06)	0.97*** (0.10)
By age group			
Under 35	0.68*** (0.05)	0.29*** (0.04)	0.92*** (0.08)
35–60	0.61*** (0.08)	0.17** (0.06)	1.13*** (0.11)
Over 60	0.45** (0.13)	0.27 (0.15)	0.89*** (0.12)
By education			
Elementary	1.11*** (0.08)	0.58*** (0.09)	1.32*** (0.10)
Tertiary	0.175** (0.04)	0.05 (0.05)	0.49*** (0.11)
By income quintile			
Bottom	0.78*** (0.09)	0.37** (0.01)	1.19*** (0.09)
Top	0.51*** (0.07)	0.21** (0.05)	0.83*** (0.10)

* p < .05, ** p < .01, *** p < .001.
Each cell shows the Ordinary Least Squares coefficient of the effect of time on physical pain with standard errors in parentheses.
Regressions were conducted by the subgroups mentioned in column 1 using physical pain as a function of a continuous linear time trend, personal characteristics (gender, age, level of education, marital status, income quintiles, employment status, and number of children in the household), and country fixed effects. Standard errors were clustered at the year level. For instance, 0.25 ** in the Women-Higher-income countries cell represents the effect of time on physical pain for women in higher-income countries.
Individual N for full sample models: All countries = 1,625,808; Higher-income countries = 815,746; Lower-income countries = 810,062.
The same table with additional subgroups can be found in Table S.5 in the SM. Full models can be found in Tables S.6 to S.12 in the SM.

Table 4
Trends in physical pain by potential explanatory factors, 2009–2021. Ordinary Least Squares with covariates.

	Dependent variable: % of people in pain	
	Low	High
National median age	1.14***	0.28**
	(0.09)	(0.07)
Healthcare spending	0.90***	0.33**
	(0.09)	(0.08)
General government spending	0.88***	0.34**
	(0.07)	(0.09)
Manufacturing	0.66***	0.58***
	(0.07)	(0.11)
Optimism	0.62***	0.48***
	(0.08)	(0.11)
Stress	-0.39	0.94***
	(0.23)	(0.12)

* p < .05, ** p < .01, *** p < .001.
Each cell shows the Ordinary Least Squares coefficient of the effect of time on physical pain with standard errors in parentheses.
Regressions were conducted by the factors mentioned in column 1 using physical pain as a function of a continuous linear time trend, personal characteristics (gender, age, level of education, marital status, income quintiles, employment status, and number of children in the household), and country fixed effects. Standard errors were clustered at the year level. For instance, 1.14*** in the National median age-Low cell represents the effect of time on physical pain in countries with lower median age.
For manufacturing, optimism, and stress, 'low' represents a decline from 2009 to 2021 and 'high' represents an increase from 2009 to 2021. For instance, the 0.66*** in the Manufacturing-Low cell represents the effect of time on physical in countries in which manufacturing decreased.
Individual N for full sample models: National median age: Low = 622,760; High = 702,450. Healthcare spending: Low = 807,788; High = 762,035. General government spending: Low = 783,845; High = 734,535. Manufacturing: Low = 653,123; High = 349,838. Optimism: Low = 199,546; High = 583,786. Stress: Low = 64,779; High = 831,291.
Full models can be found in Tables S.14 to S.19 in the SM.

level of physical pain was greater among women, the elderly, the less educated, and the poor in comparison to men, the younger, the more educated, and the rich. This is in line with prior research that showed that women (vs men), older adults (vs younger adults), individuals with low socioeconomic status (vs high) and with less education (vs more) tend to experience greater pain (Case et al., 2020; Janevic et al., 2017; Kennedy et al., 2014; Macchia and Oswald, 2021; Patel et al., 2013).

This inequality of pain has widened. The trends in physical pain across gender and age groups showed some differences in higher- and lower-income countries. Whereas in higher-income countries physical pain grew just as fast among women as among men, in lower-income countries pain grew faster among women than among men. Age results are mixed: Although in both higher- and lower-income nations the level of pain was greater among the elderly, the *growth* in pain was faster among the younger (vs middle-aged individuals) in higher-income nations and among middle-aged individuals (vs the younger and the elderly) in lower-income populations. Future research should explore whether specific social and cultural factors influence pain growth across gender and age groups in higher- and lower-income nations.

The trends in physical pain in the education and income groups were fairly consistent all over the world. In both higher- and lower-income populations, physical pain grew faster among the less educated (vs the more educated) and among those in the bottom income quintile (vs the top). These findings are in line with the theory of fundamental causes (Link and Phelan, 1995; Phelan et al., 2010) and with previous research that suggests that socioeconomic disadvantages are strongly linked to health-related stressors and chronic pain (Goosby, 2013; Pearlin et al., 2005).

Although physical pain grew faster among some groups of the population than among others, the increase in physical pain can be clearly observed in lower- and higher-income countries and in all groups of the population.

These rising trends in physical pain may be explained by a potential change in the social norms of reporting pain. Research suggests that the strong marketing of opioid analgesics may have encouraged Americans to report more pain to get access to these medications (Humphreys, 2017; Lembke, 2016; Quinones, 2016). Future research should explore whether a change in the social norms of reporting pain occurred in other countries.

The present study explored factors that may explain the rising trends in physical pain. One would expect that the percentage of people in pain rises with population age: The greater the number of older people, the greater the number of citizens in pain. However, the results of this study show that physical pain grew faster in countries with lower median age than in countries with higher median age. This suggests that the rising trends in physical pain may not be driven exclusively by the pain of the elderly and that factors that affect people's quality of life may play a role. Indeed, prior research has found that government spending was beneficial for people's wellbeing (Bjørnskov et al., 2008). In line with these findings, the present study found that physical pain grew faster in countries with lower healthcare and general government spending than in countries with higher spending.

This study also examined whether the trend in physical pain differed according to the level of manufacturing activity in each country. The increase in physical pain may be accompanied by an increase in manufacturing as manufacturing workers are likely to be at risk of different types of pain (Vandergrift et al., 2012). The analyses showed that the trend in physical pain grew in countries in which manufacturing decreased and in countries in which manufacturing increased. This finding suggests that jobs that hurt the body may be responsible for the rising trend in pain and that the psychological effect of losing a job (e.g., financial insecurity) may also play a role (see Blanchflower and Oswald,

2020).

Indeed, prior research showed that psychological factors, such as optimism about the future and stress, are linked to physical pain (Chou et al., 2016; Graham and Pinto, 2019). The present study found that although physical pain grew in countries in which optimism increased and in countries in which optimism decreased, the growth in physical pain in these two sets of countries did not differ significantly. Physical pain grew in countries in which stress increased but did not grow in countries in which stress decreased.

Previous work suggests that stress and pain are highly interrelated. Chou et al. (2016) has shown that financial insecurity leads to stress and anxiety which are linked to physical pain. Wiech and Tracey (2009) uncovered the neural mechanisms that support the effect of negative emotions on physical pain (see also Wager and Atlas, 2013). Zajacova et al. (2021b) found that the percentage of people who experienced different types of physical pain increased in the United States between 2002 and 2018 and that mental distress and health behaviours were the strongest correlates of the trends in physical pain. Recent research supports these possibilities by proposing the use of cortisol, the hormone involved in the physiological responses to external social stressors, as a key factor to understanding human health (Roberts and McWade, 2021). This body of research supports one potential underlying cause of the rising levels of physical pain: Stress might physically hurt.

Improving citizens' wellbeing has been a key goal in many governments around the world (Stiglitz et al., 2009; see also Blanchflower and Bryson, 2022 for a recent debate). Policymakers should consider measuring physical pain when assessing citizens' wellbeing (see Macchia, 2022). The link between physical pain and social stressors suggests that physical pain can be a valuable complement to the commonly used measures of life satisfaction, and mental health. People may find it easier to report whether they feel pain than whether they experience stress.

One natural concern is that the measure of pain does not allow to infer the severity and the type of pain. In addition, given that physical pain, optimism, and stress were self-reported, the link between physical pain and these factors should be interpreted with caution. Yet these findings are relevant to researchers across the social sciences as well as to policymakers around the world.

6. Conclusions

The percentage of people in pain increased dramatically between 2009 and 2021 all over the world and among several groups of the population. Pain inequality has also increased: the growth in pain was faster among women, the younger, the less educated, and the poor in comparison to men, the elderly, the more educated, and the rich.

The rise in physical pain is a phenomenon that social scientists and policymakers need to address. By providing the first worldwide evidence on pain trends and pain growth disparities, this paper opens a new line of research and demands further work to continue decoding the pain that citizens around the world are experiencing.

Data availability

The Gallup World Poll data belong to Gallup, Inc. For more information, see: https://www.gallup.com/analytics/318875/global-research.aspx. Scripts for analyses are available through the Open ScienceFramework(OSF). https://osf.io/4hcd8/?view_only=f86fd4d92f5a405189bf3f9bb552cd2a.

Author statement

Lucía Macchia designed the study, analysed the data, and wrote and revised the paper.

Conflict of interests

The author declares no conflict of interests.

Data availability

The Gallup World Poll data belong to Gallup, Inc. For more information, see: https://www.gallup.com/analytics/318875/global-research.aspx. Scripts for analyses are available through the Open Science Framework (OSF) https://osf.io/4hcd8/?view_only=f86fd4d92f5a405189bf3f9bb552cd2a.

Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.ehb.2022.101200.

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