

# Diverging Mortality Inequality Trends among Young and Old in the Netherlands\*

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## Abstract

We analyse the trends in inequality in mortality across poverty groups at different ages over the period 1996–2016 in the Netherlands. In addition, we examine whether these trends are related to unequal changes in avoidable mortality, separated by preventable and treatable causes of death. We find that while inequalities in mortality have decreased at ages up to 65, inequalities increased for the oldest age groups. The decline in inequality at the younger ages can, to a large extent, be explained by a strong decrease of mortality from preventable and cardiovascular causes among the poor. The link between

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inequality and avoidable mortality at the oldest ages is less straightforward. The increasing inequality at old age might be the result of the inequalities shifting from the young to the older age groups, or of the rich benefiting more from the recent health (care) improvements than the poor.

## I. Introduction

Life expectancy at birth in the Netherlands increased from 77.6 years in 1996 to 81.9 years in 2019.<sup>1</sup> Although this development indicates substantial gains in the average chances of survival, it is unlikely that these were distributed equally. Survival improvements may have been different not only for groups that are socio-economically more and less advantaged, but also for younger and older age groups. Because (period) life expectancy is a cross-sectional summary measure composed of mortality probabilities at different ages, it does not reveal this heterogeneity in the mortality experience of different age and socio-economic groups.

The reduction of the persistent disparities in survival across socio-economic groups remains an important goal of health policy worldwide.<sup>2</sup> In the Netherlands, the overall progress in medical care and survival seems not to have led to a decrease in the inequality across socio-economic groups. In spite of the extensive welfare system and high access to care, with universal and comprehensive coverage,<sup>3</sup> socio-economic differences in survival remain a major cause for concern.<sup>4</sup> In fact, the Netherlands is one of the OECD countries with the lowest out-of-pocket expenditures as a share of total expenditures on health.<sup>5</sup> Yet, closing – or at least reducing – the gap in life expectancy between socio-economic groups continues to be an important policy aspiration.<sup>6</sup> Along with addressing the socio-economic differences in underlying health behaviours, these are considered a crucial part of the prevention strategy agreed upon by the Dutch government, industry and other societal parties in the national ‘prevention coalition’.<sup>7</sup>

Addressing inequalities in survival starts with properly measuring them. Earlier studies for the Netherlands generally focus on the gap in life expectancy between low- and high-educated groups. Most studies find large gaps in life expectancy at age 30 and older between the low and

<sup>1</sup>OECD, 2020.

<sup>2</sup>Commission on Social Determinants of Health, 2008.

<sup>3</sup>Van Doorslaer and Jones, 2004; Van Doorslaer, Masseria and Koolman, 2006; OECD/European Observatory on Health Systems and Policies, 2019.

<sup>4</sup>Wetenschappelijke Raad voor Regeringsbeleid, 2018; Raad voor Volksgezondheid and Samenleving, 2020.

<sup>5</sup>OECD, 2021.

<sup>6</sup>Health Holland, 2019.

<sup>7</sup>Rijksoverheid, 2018.

high educated.<sup>8</sup> Moreover, several researchers find this absolute gap to be relatively stable over time,<sup>9</sup> although van Baal et al. (2016) forecast widening inequalities for the population aged 65 and over. A number of studies have focused on inequalities among income groups, using administrative data on individual (household) income. Kalwij, Alessie and Knoef (2013) estimate a survival model for the Dutch elderly that depends, among other things, on income. They find a gap of 2.5 years in life expectancy at age 65 between low- and high-income individuals. Muns, Knoef and van Soest (2018) analyse the trend of inequality in life expectancy at age 40 between income groups, following a similar approach as Chetty et al. (2016) for the United States. They find that the gap in life expectancy between the lowest and highest income quintiles increases by 1.8 years for men and 2 years for women between 2005 and 2015.

In this study, we examine the development of mortality by socio-economic group, gender and age from 1996 to 2016. We follow the approach developed by Currie and Schwandt (2016), focusing on the overall time trends across gender and age groups, and the differences *within* these groups across poverty deciles. We rank individuals based on the poverty share of the municipality they are living in. We extend the approach of Currie and Schwandt (2016) by investigating whether the trends in absolute inequality in mortality can be related to causes of death that are either treatable or preventable.

We contribute to the existing literature in several respects. First, we focus on the trends in inequality in mortality at different ages instead of the trend in overall life expectancy. Because life expectancy is a summary measure, the overall trend can mask possibly diverging trends across ages. The fact that earlier Dutch studies arrive at different conclusions on the inequality in life expectancy, depending on the starting age of their analysis, already indicates that age-specific trends might be diverging. Studying the trends in age-specific inequality also allows policymakers to better focus attention and efforts to reduce inequalities where most needed. Diverging trends in age-specific mortality might also be indicative of differences in health across birth cohorts. This would imply that the socio-economic disparities in current-period life expectancy are not representative for younger cohorts, as they are largely driven by the differences in current old-age mortality among older cohorts.<sup>10</sup>

Second, we analyse socio-economic differences by income rather than by education, as in previous Dutch studies. Because we can precisely measure poverty shares in geographic areas (such as municipalities), this allows

<sup>8</sup>Kulhánová et al., 2014; Mackenbach, Rubio-Valverde and Nusselder, 2019; OECD/European Observatory on Health Systems and Policies, 2019.

<sup>9</sup>Statistics Netherlands, 2012; De Beer and Van der Graag, 2018; Mackenbach et al., 2019.

<sup>10</sup>Currie and Schwandt, 2016.

for a ranking of socio-economic groups based on a continuous measure. Education, however, is categorical, which results in less variation across the population and, hence, makes it more difficult to divide the population into (between- and within-country comparable) deciles. Furthermore, within-country comparability is hampered by changes in the relative sizes of educational groups over time (due to increases over time in the education level, particularly for women), while rankings based on poverty shares lead to similarly sized socio-economic groups in every year.

Third, we base our socio-economic ranking of individuals not on individual income, but on the poverty share within their municipalities. This has two practical advantages. First, it allows us to compare our results directly with those for other countries, where administrative data on individual income are not available. Second, it allows us to expand our analysis to younger age groups. Previous Dutch studies have excluded these age groups, either because they do not have an individual income or because their current income is not representative of their lifetime income. Moreover, an extensive series of studies has found that where people grow up and live is important for their economic and health outcomes,<sup>11</sup> implying that the direct measurement of the relation between mortality and poverty at the municipality level has direct relevance on its own.

Finally, we examine whether trends in inequalities are driven by socio-economic differences in the development of particular causes of death. Kulhánová et al. (2014) find that educational inequalities in mortality in the Netherlands are mainly driven by cardiovascular diseases and particular types of cancer (including lung cancer), while for other types of cancer (colorectal, prostate and breast cancer) and external causes (for women) do not show such differences between education groups. Studies for other countries find that trends in inequality in mortality are driven by specific causes. For instance, Kallestrup-Lamb, Kjærgaard and Rosenskjold (2020) find that the stagnation in mortality of Danish elderly women between 1985 and 1995 was largely caused by an increasing mortality from cancers and lung- and bronchus-related causes. Similarly, in a study among the Norwegian population for more recent years, namely 2005–2015, Kinge et al. (2019) find that the evolution of mortality from lung cancer, chronic obstructive pulmonary diseases and dementia varied most across income groups.

In this study, we examine trends in two groups of causes of death that can be classified as avoidable,<sup>12</sup> either by treatment or by prevention. Disaggregating the analysis of inequality trends by these two groups of causes of death can help to guide health-care policymakers to focus their inequality reduction

<sup>11</sup> See, for example, Chetty et al. (2016), Chetty and Hendren (2018) and De Jong, Muilwijk-Vriend and Ter Weel (2020).

<sup>12</sup> Nolte and McKee, 2004.

efforts on lifestyle interventions (for prevention) and/or on more (equal) access to health care (for treatment).

We find that mortality decreased between 1996 and 2016 in all age groups and for all poverty groups. Mortality gradients by poverty in the age groups under 65 either decreased or remained stable. We observe the largest decrease in this gradient for men in the age group 20–49 and we demonstrate that this is mainly attributable to a large drop in mortality from potentially preventable causes among the poorest. By contrast, inequalities at older ages (>65) seem to have increased over the last decades, especially for women. Inequality among these older groups increased for all causes of death, either avoidable or not.

## II. Data and methods

### 1. Data sources

We use three main sources of data to estimate mortality inequalities. To estimate the municipal age-specific mortality rates, we obtain the number of deaths and population size by municipality, age and gender using individual-level data from Statistics Netherlands from 1996 onwards. Information on the individuals' gender, date of birth (in months) and place of residence are obtained from the municipal records database (Gemeentelijke Basis Administratie or GBA in Dutch). Additionally, we obtain the date and primary cause of death from individual-level death registries. To construct municipal poverty shares, we use household-level income data from tax registries available from 2004 onwards. In the preceding years, we use information from the Regionale Inkomensverdeling<sup>13</sup> as individual-level income data are not available. For years without municipality-level poverty data (1996–1999), we use information from the nearest year (2000).

### 2. Poverty deciles

We divide the population into socio-economic groups using municipal poverty shares, that is, the share of households in a municipality with disposable household income below the poverty threshold. Grouping households in the same municipality using place of residence, we obtained the total number of households and the number of households with an income below the poverty threshold within a municipality. When calculating poverty shares, households that did not have a full year or had missing income are excluded, along with individuals living in student residences, institutions or nursing homes.

<sup>13</sup>Statistics Netherlands, 2004.

The poverty threshold, defined by Statistics Netherlands (2020b), is an absolute threshold adjusted for inflation for comparability over time. This threshold is widely used in the Netherlands to monitor the evolution of poverty.<sup>14</sup> It is set as the fixed yearly income a single-person household received from social benefits in the year 1979.<sup>15</sup> To make the absolute threshold applicable to any type of household, we multiply household income by an equivalence factor depending on the household's size and composition.<sup>16</sup>

We calculated poverty shares for all 504 municipalities in the Netherlands. Municipalities are a sufficiently high level of aggregation to calculate a reliable poverty share. Additionally, many income- and health-related policies, such as the provision of home care and poverty policy, are decentralised at the municipality level. To ascertain that municipal changes in poverty deciles over time are not caused by municipality mergers, we keep the municipal borders from the year 2001 fixed over time.<sup>17</sup>

We divide the municipalities over ten deciles based on their poverty share and population size for 1996, 2005 and 2016 separately.<sup>18,19</sup> This allows municipalities to change deciles over time due to, for example, evolution of poverty or migration. As a result, for each year, we compare the 10 per cent of the population living in the least poor municipalities (decile 1) to the 10 per cent living in the poorest municipalities (decile 10). To achieve ten equally sized groups, each decile does not contain an equal number of municipalities, as the municipalities vary in population size. In addition, we split the largest three municipalities (Amsterdam, Rotterdam and The Hague) into three or four equally sized subgroups with equal mortality and poverty shares. In this way, we allow these municipalities to fall into two adjacent deciles (e.g. deciles 9 and 10) to better balance the bin sizes.

Table 1 provides descriptive statistics of each poverty decile in 2005. First, it shows that the poorest deciles contain fewer municipalities than the wealthier deciles. This results from large variations in population size across municipalities and from smaller municipalities generally having lower poverty shares. The latter can also be observed from Figure 1, which displays how municipal poverty shares are geographically distributed across municipalities in 2005. The map shows that poverty is mainly clustered in the northern

<sup>14</sup>Sociaal Cultureel Planbureau/Statistics Netherlands, 2014.

<sup>15</sup>In 1979, the purchasing power of social benefits was at its highest.

<sup>16</sup>Statistics Netherlands, 2020c.

<sup>17</sup>There have been a notable number of mergers between municipalities between 1995 and 2016. In 1995, the Netherlands counted 633 municipalities. This number was reduced gradually to 390 in 2016 with the greatest reduction between 1996 and 1997 (Statistics Netherlands, 2020a).

<sup>18</sup>Note that municipal poverty shares from the year 2000 are used to divide the 1996 population into deciles.

<sup>19</sup>As robustness checks, instead of re-assigning the municipalities to a poverty decile each year separately, we ran the analyses keeping the poverty deciles fixed. Keeping the poverty deciles fixed at the poverty decile of either 1996, 2005 or 2016 does not affect our main results.

TABLE 1  
*Descriptive statistics (in year 2005) by poverty decile*

	Poverty decile									
	1	2	3	4	5	6	7	8	9	10
Number of municipalities										
Total	104	84	79	66	50	42	29	27	22 <sup>a</sup>	8 <sup>b</sup>
Number of inhabitants per municipality (×1,000)										
Total	1,632	1,635	1,639	1,655	1,578	1,651	1,626	1,721	1,631	1,510
Mean	15.7	19.5	20.7	25.1	31.6	39.3	56.1	63.8	74.2	188.8
Std dev.	9.8	15.8	12.2	18.9	27.6	32.6	50.1	69.5	56.2	0.7
Min	1.5	4.2	4.6	0.4	3.5	8.1	6.5	7.0	1.0	178.8
Max	48.0	132.8	78.6	106.5	155.7	139.8	176.5	276.3	158.2	196.8
Municipal poverty share (per cent)										
Mean	5.4	6.3	7.0	7.7	8.5	9.5	10.7	11.8	14.2	18.1
Std dev.	0.5	0.2	0.2	0.2	0.3	0.4	0.3	0.4	1.2	0.6
Min	4.1	6.0	6.7	7.3	8.1	8.9	10.1	11.3	12.6	16.8
Max	6.0	6.7	7.3	8.0	8.9	10.1	11.1	12.4	16.1	18.5
Age of population in decile in years										
Mean	38.4	38.9	39.0	39.0	39.3	38.9	38.5	38.3	38.9	37.5
Std dev.	22.6	22.6	22.6	22.7	22.6	22.8	22.4	22.2	22.3	21.6
Disposable household income (×1,000 euros) <sup>c</sup>										
Mean	23.1	22.7	22.1	21.5	21.7	20.7	20.3	20.3	19.7	20.2
Std dev.	16.2	16.5	15.8	15.6	16.2	13.3	13.3	14.1	14.1	17.2
Median	20.4	20.0	19.5	19.1	19.1	18.5	18.2	18.0	17.2	17.2

Note:

<sup>a</sup>Decile 9 actually contains 20 municipalities as one is split into three.

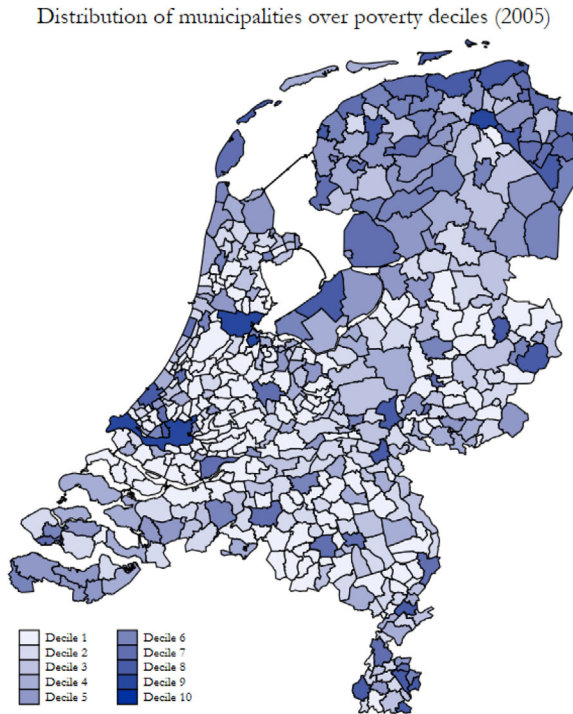
<sup>b</sup>Decile 10 actually contains three municipalities as one is split into three and one into four.

<sup>c</sup>Disposable income is standardised with respect to household size.

provinces and in the larger municipalities (in terms of population size) such as Amsterdam and Rotterdam.

In addition, from Table 1 it follows that there is substantial variation in poverty shares across municipalities. For example, in 2005, poverty shares range from 4.1 to 18.5 per cent. Even though income inequality of households

FIGURE 1  
*Municipalities in poverty deciles in the Netherlands (2005)*



has remained relatively stable in the years before and after 2005,<sup>20,21</sup> the gap in average poverty shares between municipalities in decile 1 and decile 10 decreased from 15 per cent (7 to 22 per cent) in 2000 to 13 per cent (5 to 18 per cent) in 2005 to 11 per cent (4 to 15 per cent) in 2016.

### 3. Mortality rates

We estimate age/gender-specific mortality rates using demographic administrative data by combining deaths and population within a municipality. We are also interested in trends for potentially avoidable causes. To investigate whether these trends can be attributed to treatable or preventable causes, we adopt a classification for avoidable mortality from OECD/Eurostat (2019). This list of causes of death, expressed in ICD-10 codes, combines classifications used in earlier analyses.<sup>22</sup>

<sup>20</sup>Statistics Netherlands, 2016.

<sup>21</sup>Measured by a Gini coefficient of approximately 0.29.

<sup>22</sup>Nolte and McKee 2004, 2011; Eurostat, 2014; CIHI/Statistics Canada, 2018.



Using this classification, we assign deaths into four mutually exclusive groups: (1) treatable causes, (2) preventable causes, (3) causes that could be both preventable and treatable, and (4) other causes that are not assigned to one of the first three groups. More extensive definitions can be found in the introduction of this issue. Moreover, Table A.1 in the online Appendix lists the causes of death with the largest increases or decreases in absolute deaths between 1996 and 2016 in the Netherlands.

Two remarks about this classification are worth making. First, it is focused on identifying causes of death that can likely be avoided (groups 1–3) and not on identifying a group of diseases that can certainly not be avoided (group 4). If the latter was intended, then we would expect no declining trend in mortality for this group at all, as these deaths should be unavoidable. However, as we shall see below, this is not the case. Second, the classification of deaths from avoidable causes is based on premature deaths before age 75.<sup>23</sup> This means that the estimates of the cause-specific trends for the oldest age group (80 and older) should be interpreted with caution.

#### 4. Methods

We compare the poverty gradients of mortality by age and gender in the years 1996, 2005 and 2016. Following the approach of Currie and Schwandt (2016), we estimate age/gender-specific mortality rates by municipal poverty decile from 1996 onwards and we smooth them using three-year averages (1996–1998, 2005–2007 and 2016–2018). We use the following age groups: 0–4, 5–19, 20–49, 50–64, 65–79 and 80+. The mortality rates are standardised by age within each age/gender group.<sup>24</sup>

Our measure of absolute inequality within a particular age and gender group for a particular year is the slope coefficient of a regression of mortality on poverty decile (included as a continuous variable running from 1 to 10). This slope measures the average change in mortality when going from one poverty decile to the next (poorer) decile. Age/gender-specific inequality trends can be assessed by comparing slopes across years. We formally test for a difference in slope coefficients between 1996 and 2016. If this difference is positive, we interpret this as increasing absolute pro-rich mortality inequalities over time. In other words, if the poverty gradient becomes more positive over time, it means that, on average, the decline in mortality for the least-poor deciles (e.g. decile 1) is larger than for the poorest deciles (e.g. decile 10). We conduct these analyses for both total mortality and for each of the four cause-of-death groups.

<sup>23</sup>OECD/Eurostat, 2019.

<sup>24</sup>The mortality rates of one-year age groups are weighted so that the age distribution within each age, gender and poverty group in each year matches the age distribution within the corresponding age and gender group (across all incomes) in 1995.

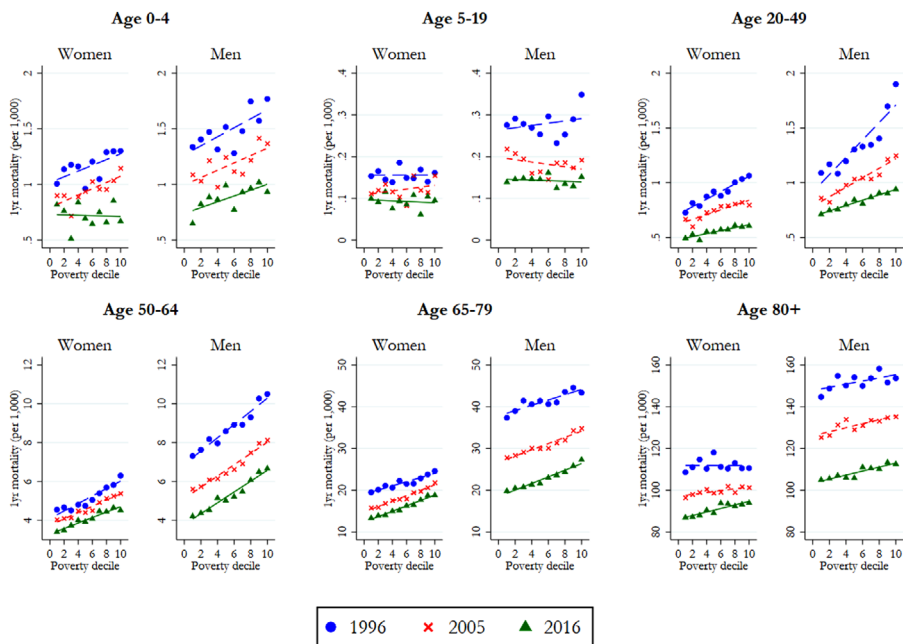
### III. Results: mortality inequality by gender and age

#### Part A

The main results of our analyses are presented in Figure 2 and in Table 2. The slopes of the fitted regression lines, or the poverty gradients, in Figure 2 indicate the level of inequality. The estimated slope coefficients per year, which are quite precisely estimated from age group 20–49 onwards, and the corresponding intercepts can be retrieved from Table 2. Column 9 in Table 2 shows whether the slope has increased, decreased or remained stable between 1996 and 2016. From Figure 2, we see that for almost all age groups, mortality was higher among men, and in poorer groups. Moreover, in the last 20 years, mortality has substantially declined across all age/gender groups and for each

FIGURE 2

*Poverty gradients in mortality by gender, age group and year*



*Note:* Figure 2 plots one-year mortality rates (smoothed over three years) across poverty deciles by gender, age group and year. Poverty decile 1 contains 10 per cent of the population living in the wealthiest municipalities and decile 10 contains those living in the poorest municipalities. Mortality rates are age-adjusted using one-year age bins, keeping the age composition within each age group and gender similar to the one in 1995. The estimated intercepts and slope coefficients of the fitted regression lines can be found in Table 2.

TABLE 2  
Slope coefficients of fitted regression lines in Figure 2, including constants

	Intercept of regression line (Figure 2)		Poverty gradient/slope of regression lines (Figure 2)		Difference in poverty gradient/slopes			
	1996 (1)	2005 (2)	1996 (4)	2005 (5)	2016 (6)	$\Delta_{2005}^{1996}$ (7)	$\Delta_{2016}^{2005}$ (8)	$\Delta_{2016}^{1996}$ (9)
<i>Women</i>								
Age 0–4	1.017 (0.068)***	0.793 (0.054)***	0.026 (0.011)**	0.028 (0.009)***	-0.002 (0.012)	0.002 (0.014)	-0.030 (0.015)**	-0.028 (0.016)*
Age 5–19	0.156 (0.011)***	0.109 (0.015)***	0.000 (0.002)	0.002 (0.002)	-0.001 (0.002)	0.002 (0.003)	-0.003 (0.003)	-0.001 (0.003)
Age 20–49	0.712 (0.021)***	0.622 (0.023)***	0.035 (0.003)	0.022 (0.004)***	0.014 (0.002)	-0.013 (0.005)	-0.008 (0.004)*	-0.021 (0.004)***
Age 50–64	4.094 (0.143)***	3.750 (0.083)***	0.193 (0.023)**	0.162 (0.013)***	0.141 (0.013)***	-0.031 (0.027)	-0.021 (0.019)	-0.052 (0.027)*
Age 65–79	19.033 (0.388)***	14.774 (0.264)***	0.501 (0.063)***	0.651 (0.043)***	0.647 (0.037)***	0.150 (0.076)**	-0.003 (0.056)	0.147 (0.073)**
Age 80+	111.862 (1.989)***	97.083 (0.807)***	-0.007 (0.321)	0.449 (0.130)***	0.848 (0.141)	0.455 (0.346)	0.399 (0.192)	0.855 (0.350)**

(Continued)

TABLE 2  
(Continued)

	Intercept of regression line (Figure 2)		Poverty gradient/slope of regression lines (Figure 2)		Difference in poverty gradient/slopes				
	1996 (1)	2005 (2)	2016 (3)	1996 (4)	2005 (5)	2016 (6)	$\Delta_{2005}^{1996}$ (7)	$\Delta_{2016}^{2005}$ (8)	$\Delta_{2016}^{1996}$ (9)
<i>Men</i>									
Age 0–4	1.267 (0.084)***	0.996 (0.073)***	0.740 (0.057)***	0.041 (0.014)***	0.033 (0.012)***	0.026 (0.009)***	-0.007 (0.018)	-0.007 (0.015)	-0.014 (0.016)
Age 5–19	0.264 (0.022)***	0.199 (0.015)***	0.147 (0.008)***	0.003 (0.004)	-0.003 (0.002)	-0.001 (0.001)	-0.006 (0.004)	0.002 (0.003)	-0.003 (0.004)
Age 20–49	0.916 (0.079)***	0.785 (0.028)***	0.693 (0.012)***	0.079 (0.013)***	0.043 (0.005)***	0.025 (0.002)***	-0.036 (0.013)***	-0.019 (0.005)***	-0.055 (0.013)***
Age 50–64	6.892 (0.175)***	5.124 (0.127)***	3.789 (0.131)***	0.340 (0.028)***	0.290 (0.020)***	0.278 (0.021)***	-0.050 (0.035)	-0.011 (0.029)	-0.061 (0.035)*
Age 65–79	37.808 (0.726)***	26.692 (0.469)***	18.444 (0.389)***	0.633 (0.117)***	0.747 (0.076)***	0.792 (0.063)***	0.114 (0.139)	0.046 (0.098)	0.160 (0.133)
Age 80+	147.790 (2.177)***	126.081 (1.390)***	103.441 (0.915)***	0.758 (0.351)**	0.965 (0.224)***	0.952 (0.147)***	0.207 (0.416)	-0.013 (0.268)	0.194 (0.381)

Note: Columns 1–3 and 4–6 report the estimated intercepts and slope coefficients, respectively, from a regression of mortality on poverty deciles, as plotted in Figure 2, by gender, age group and year. Columns 7–9 report differences in the estimated slope coefficients between each period. Standard errors are given in parentheses. \*\*\*, \*\* and \* denote statistically significant from zero at 1, 5 and 10 per cent, respectively.

poverty decile. Men experienced larger reductions in mortality, leading to a narrowing of the gender gap in mortality.

The poverty gradients do not show the same trends over time across age groups. In particular, we mostly find decreasing gradients below the age of 65 (that is, pro-poor improvements) and increasing pro-rich inequalities at older ages. In Figure 2 and Table 2, we observe greater mortality declines for the poorest decile than for the wealthiest in the youngest female age group (age group 0–4), for both men and women at prime age (20–49), and for both men and women aged 50–64, although only statistically significant at 10 per cent. At prime age, men experience a stronger decline in inequalities than women. Our results suggest that, over the last two decades, absolute inequalities in mortality have been decreasing for the youngest age groups.

By contrast, we observe the opposite pattern for the oldest age groups. Even though all poverty groups experienced large reductions in mortality, the reductions are larger for the wealthier deciles. For instance, mortality for women aged 80+ in the poorest group dropped from 111 per 1,000 in 1996 to 94 per 1,000 in 2016, in comparison to a decline from 109 to 87 per 1,000 in the wealthiest group. As a result, the gap in age- and gender-specific mortality rates between these groups increased, which is reflected in the rising poverty gradient (column 9 in Table 2). This rise is statistically significant only for women.

## IV. Results: trends by cause-of-death groups

### Part B

Figure 3 and Table 3 present the results by the cause-of-death categories: preventable, treatable, both or other (i.e. not preventable/treatable). We first discuss overall trends in mortality by age and gender following from Figure 3. This figure shows the absolute changes (decreases if below zero) in cause-specific mortality between 1996 and 2016 for each poverty decile. In addition, the fitted regression lines in Figure 3 illustrate whether the absolute changes in mortality per cause-of-death category between 1996 and 2016 were larger for the poor, larger for the wealthy, or equally distributed across poverty deciles. From this, we infer whether the changes in mortality inequality observed in Section III can be attributed to unequal changes in mortality from either preventable, treatable, both or other causes. These attributions can also be derived from Table 3. Similar to Table 2, Table 3 presents the poverty gradients for the years 1996 and 2016, and the difference between them for each cause-of-death category separately (columns 3, 6, 9 and 12). Note that these estimated differences are equal to the slope coefficients of the fitted regression lines in Figure 3. We excluded the youngest two age groups from the cause-of-

TABLE 3  
Poverty gradients in mortality by cause category, gender, age group and year

	Preventable		Treatable		Both (preventable and treatable)		Other		
	1996 (1)	2016 (2)	1996 (4)	2016 (5)	1996 (7)	2016 (8)	1996 (10)	2016 (11)	
	$\Delta_{2016}^{1996}$ (3)		$\Delta_{2016}^{1996}$ (6)		$\Delta_{2016}^{1996}$ (9)		$\Delta_{2016}^{1996}$ (12)		
<i>Women</i>									
Age 20–49	0.015 (0.001)***	0.008 (0.001)***	0.001 (0.001)	0.001 (0.001)	0.006 (0.001)***	0.001 (0.001)	0.011 (0.003)***	0.003 (0.001)**	–0.008 (0.003)***
Age 50–64	0.070 (0.009)***	0.065 (0.008)***	0.013 (0.007)*	0.009 (0.004)**	0.059 (0.008)***	0.019 (0.003)**	0.046 (0.012)***	0.049 (0.005)***	0.003 (0.013)
Age 65–79	0.148 (0.022)***	0.230 (0.026)***	0.047 (0.017)***	0.069 (0.009)***	0.145 (0.040)***	0.117 (0.010)**	0.158 (0.031)***	0.230 (0.013)***	0.071 (0.033)**
Age 80+	0.113 (0.050)**	0.367 (0.039)***	0.082 (0.075)	0.089 (0.038)**	–0.157 (0.154)	0.170 (0.026)**	–0.020 (0.155)	0.221 (0.112)**	0.242 (0.191)

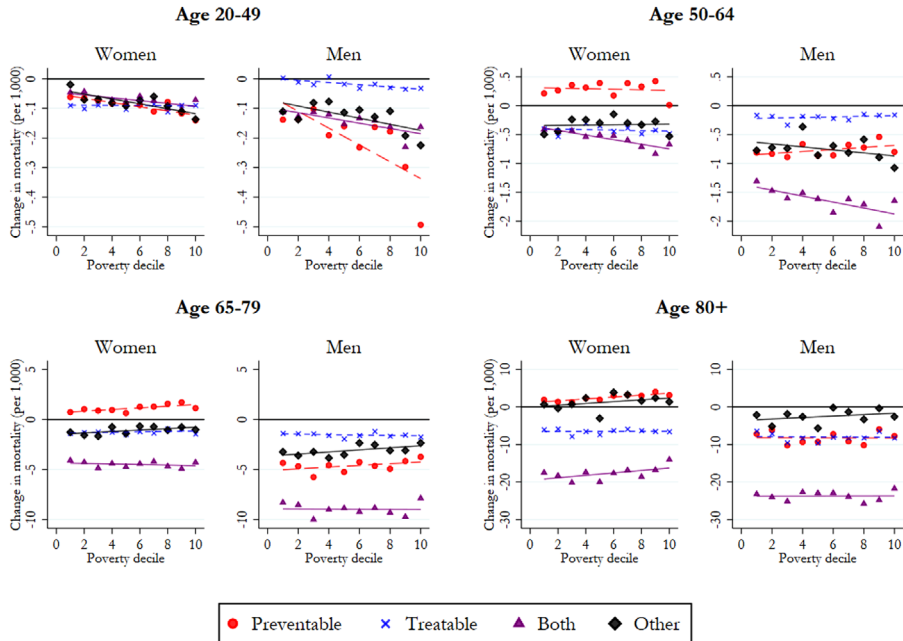
(Continued)

TABLE 3  
(Continued)

	Preventable		Treatable		Both (preventable and treatable)		Other	
	1996 (1)	2016 (2)	1996 (4)	2016 (5)	1996 (7)	2016 (8)	1996 (10)	2016 (11)
		$\Delta_{2016}^{1996}$ (3)		$\Delta_{2016}^{1996}$ (6)		$\Delta_{2016}^{1996}$ (9)		$\Delta_{2016}^{1996}$ (12)
<i>Men</i>								
Age 20–49	0.041 (0.007)***	0.013 (0.002)***	0.004 (0.001)***	-0.000 (0.001)**	0.013 (0.003)***	0.004 (0.001)***	0.018 (0.004)***	0.008 (0.001)***
Age 50–64	0.111 (0.011)***	0.129 (0.009)***	0.008 (0.005)*	0.013 (0.004)***	0.111 (0.016)***	0.059 (0.003)***	0.103 (0.019)***	0.077 (0.011)***
Age 65–79	0.182 (0.050)***	0.266 (0.029)***	0.073 (0.016)***	0.051 (0.008)***	0.167 (0.063)***	0.161 (0.019)***	0.207 (0.040)***	0.312 (0.027)***
Age 80+	0.253 (0.145)*	0.245 (0.067)***	0.066 (0.095)	0.044 (0.037)	0.251 (0.176)	0.258 (0.052)***	0.211 (0.141)	0.403 (0.088)***

Note: The table gives the poverty gradients (slope coefficient fitted regression lines in Figures A.1–A.4) and differences in poverty gradients (equal to slope coefficient fitted regression lines in Figure 3) by avoidable mortality category. Columns 1–2, 4–5, 7–8 and 10–11 report the estimated slope coefficients from a regression of mortality on poverty deciles, as plotted in Figures A.1–A.4 in the online Appendix, by cause-of-death category, gender, age group and year. Columns 3, 6, 9 and 12 report the differences in these slope coefficients between 1996 and 2016. These differences are equal to the slope coefficients of the fitted regression lines plotted in Figure 3. Standard errors are given in parentheses. \*\*\*, \*\* and \* denote statistically significant from zero at 1, 5 and 10 per cent, respectively.

FIGURE 3  
*Change in mortality (1996–2016) across poverty deciles by gender, age group and cause of death*



*Note:* This figure plots the difference in one-year mortality (smoothed over three years) between 1996 and 2016 across poverty deciles by cause-of-death category, gender and age group. Poverty decile 1 contains 10 per cent of the population living in the wealthiest municipalities and decile 10 contains those living in the poorest municipalities. Mortality rates are age-adjusted using one-year age bins, keeping the age composition within each age group and gender similar to the one in 1995. The slope coefficients of the fitted regression lines can be found in columns 3, 6, 9 and 12 in Table 3.

death analyses as the numbers of deaths per cause category are too small for a reliable analysis.

Figure 3 shows reductions in mortality between 1996 and 2016 for almost all cause-of-death categories and age groups. The largest drops occurred in deaths from both preventable and treatable causes, which mainly cover deaths from cardiovascular diseases. Additionally, we find that the decreases in mortality were larger for men than women in every age group and for each category, except for treatable mortality in the age groups 20–49 and 50–64. Another difference between men and women is the evolution of preventable mortality, which seems to be decreasing for men in all age groups and increasing for women in the oldest three age groups.

The results by poverty decile for the age group 20–49 indicate that, for both men and women, (almost) all cause-of-death categories that are statistically



significantly, at 5 per cent, contributed to decreasing inequalities over time. For men in this age group, the decrease in preventable mortality between 1996 and 2016 was, in particular, much higher in poorer groups than in wealthier groups. This is reflected in a decrease in the poverty gradient of 0.028 (column 3 in Table 3), which can be interpreted as follows. The preventable mortality gap between the poorest and the least-poor decile fell by 0.28 deaths per 1,000 individuals between 1996 and 2016. Because this fall is larger than the decreases from the other cause-of-death categories (columns 6, 9 and 12), we argue that preventable mortality was the main contributor to the decrease in the gap in total mortality for men in the age group 20–49.

For the age group 50–64, however, the flattening of the poverty gradient of total mortality between 1996 and 2016 was mainly due to a decrease in mortality inequality from causes labelled both preventable and treatable (such as diabetes and cardiovascular diseases). In fact, the slope differences in Table 3 suggest that, for both men and women in the age group 50–64, only inequality in mortality from these causes statistically significantly decreased between 1996 and 2016. Furthermore, the magnitude of the difference in this category (–0.040 for women and –0.052 for men; see Table 3, column 9) is almost equal to difference of total mortality (–0.052 for women and –0.061 for men; see Table 2, column 9), indicating that the larger drop in deaths among the poor in this category drove the total decrease in mortality disparities in the age group 50–64.

There does not seem to be any dominant cause-of-death category driving the increasing inequalities in the oldest two age groups. For women in the age group 65–79, the rise in preventable mortality was higher among the poorest groups than among the wealthier groups. Along with increasing inequalities in mortality from other causes, this statistically significantly contributed to increasing inequalities in total mortality in this age group. For men, unequal changes in mortality from other (or potentially unavoidable causes) seem to have increased inequalities within this age group.

In addition, the results in Table 3 suggest that, for women in the oldest age group (80+), again unequal rises in preventable mortality contributed to increasing disparities at this age. However, also mortality from causes labelled both preventable and treatable and mortality from other causes seem to have played a role. Among men, it is mainly changes in mortality from other causes that are driving the results in column 9 of Table 2.

## V. Discussion

Our study has documented substantial improvements in all-cause mortality in the Netherlands from 1996 to 2016. We find that age- and gender-specific mortality rates decreased for all groups between 1996 and 2016 regardless of municipal poverty share. While all groups benefited, improvements were

largest among men, and particularly for those over the age of 65, thereby leading to a reduction in the gender gap in mortality. However, these mean mortality improvements mask very different inequality trends across age groups. Our results paint a different picture for the under-65s and the over-65s. On the one hand, absolute disparities in mortality decreased among those younger than 65 (that is, larger declines in mortality occurred in the poorest groups). On the other hand, poverty-related inequalities in mortality rates increased among older age groups: larger mortality drops were observed in the better-off deciles with lower poverty shares.

Our results for under-65s indicate that poverty gradients of mortality declined for the youngest age group (0–4), those in the prime age group (20–49) and those close to retirement (50–64). The decline in the gradient was generally greater for women, except for the prime age group in which the reduction among men dominated that among women. This shows that even though the gender gap in mortality was reduced from 1996 to 2016, poverty gaps in mortality did not fall as much for men as for women. We observed no change in disparities for the children/adolescent group (5–19), which is not surprising as it is the age range with lowest mortality rates across the life cycle. Among those aged 65 and older, the inequality rise was present for all age groups, but largest among women aged 80 and older, and imprecisely estimated for men older than 80. Taken together, our findings suggest that trends in mortality inequality over time differ across age groups.

Our results are in part in line with those from Currie and Schwandt (2016) in the United States between 1990 and 2010: they found a strong reduction in mortality inequalities for individuals below the age of 20, but rising inequalities for individuals at older ages. However, where the ‘good news’ on inequality reduction in the United States derives from these young groups only, we also find reductions in inequalities for those in prime age and near retirement. This highlights that, in contrast to the United States, Dutch mortality inequalities improved across a much wider range of pre-retirement ages.

We further analyse the poverty gradients of mortality by potentially avoidable causes of death (preventable, treatable, both) and other causes of death that are, according to the OECD/Eurostat (2019) definition, not classified as avoidable. Deaths below the age of 20 were too infrequent for a meaningful analysis of changes in the poverty gradients by causes of deaths. Analysis for those between 20 and 64, however, revealed that the improvements in all-cause mortality gradients were driven by all four categories, but mostly by trends in preventable mortality and by both preventable and treatable causes of death. Especially, the contribution of preventable mortality is worth noting as these causes of death did not show the largest average mortality drop between 1996 and 2016 (see the estimated intercepts in Table A.2 in the online Appendix). Among older ages, the role of

the avoidable causes of death was less straightforward as the 'other' category played a dominant role, but women nevertheless experienced a substantial increase in the poverty gradient due to preventable causes of death.

Overall, the analysis by cause of death points to the importance of lifestyle interventions and cardiovascular treatments for those below the age of 65. The gender difference in the contribution of preventable (and treatable) causes of death for older ages is in line with differences in the life-cycle profile of lifestyle, such as, for instance, smoking prevalence: in the considered period, this was still increasing among women but declining or stable among men. Another potential factor is the faster growing access to preventive cardiovascular medication amongst men.<sup>25</sup> We speculate that the larger mortality reductions among women in low-poverty versus high-poverty groups are related to the importance of different phases of lifestyle prevalence for men and women.

The finding of differential results for age groups implies that any composite population measure, such as life expectancy, could fail to unravel the more nuanced patterns that may have occurred in different age groups. Previous studies for the Netherlands have not been able to distinguish these patterns due to their use of a general population summary measure. Additionally, our use of poverty shares allows us to maintain equally sized deciles across the study period, which is not feasible for studies relying on education as a socio-economic status stratifier.<sup>26</sup> Finally, another strength of the study is the use of administrative records for the whole population of the Netherlands, which provides a more representative estimate than previous studies that used samples.

There are some limitations to acknowledge. First, as inequalities are likely to exist not only between, but also within municipalities, we expect that aggregation to these geographical units may underestimate inequalities observed at a lower geographical, or individual, level. Moreover, because municipalities with fewer inhabitants are generally less poor, we expect a stronger underestimation of inequalities among poorer municipalities. Second, our analysis of mortality gradients by cause of death, which relies on the OECD classification of avoidable mortality, is less valid for deaths occurring after the age of 75. This limitation may, to some extent, explain why we find no clearly discernible pattern amongst the oldest age group.<sup>27</sup> Given the limitations of this (inevitably somewhat arbitrary) classification scheme, it is difficult to fully explain the observed 75+ mortality patterns. One possibility is that death beyond the age of 75 was mostly random in 1996, but that it has become more socio-economically patterned since then. Another possible

<sup>25</sup>Mackenbach et al., 2011.

<sup>26</sup>Kulhánová et al., 2014; Mackenbach et al., 2019.

<sup>27</sup>OECD/Eurostat, 2019.

reason for the non-discernible pattern could be that the relative importance of causes of death changes for this older age group. In any case, the limitation of this classification scheme may be more severe for deaths after the age of 75 and it hampers the interpretation of those results.

A third limitation of our study is the focus on absolute inequalities. While our study provides strong evidence of how absolute inequalities in mortality have evolved, the picture is likely to be different for relative inequalities. In fact, it has been argued recently that aiming for a reduction of relative inequalities is very difficult when overall rates of mortality are declining.<sup>28</sup> As such, the focus on absolute inequalities in mortality may avoid this ‘inconvenient truth’, which to many has also appeared as a ‘frustration’. As one colleague eloquently put it recently: ‘When we focus on absolute inequalities, tackling health inequalities will no longer be “swimming against the current”, but will be like “riding the waves”.’<sup>29</sup> As such, our focus on absolute inequalities may be considered a strength, not a limitation.

## VI. Conclusion

Overall, our findings highlight that while the Netherlands has witnessed important improvements in overall mortality – and therefore life expectancy – between 1996 and 2016, not all age and gender groups have benefited equally, and neither did they all experience the same changes in the mortality–poverty association. We show that large reductions in mortality inequalities have occurred for those below the age of 65. Our findings suggest that most of those improvements are probably linked to both health care and lifestyle improvements trickling down to the poorer classes, as suggested by the differential mortality gradients by cause of death. By contrast, mortality inequalities for the oldest group have grown. This highlights the fact that either there has been a shift of inequalities from younger to older ages (that is, a survival effect) or, regardless of the accessibility of the Dutch health care system, older individuals in wealthier areas of the Netherlands have benefited more from health improvements. If the latter explanation holds, it provides a strong motivation for further research to understand what has caused these improvements concentrated among the wealthier, and how to make systematic adjustments in order to enable equivalent mortality reductions in the less-advantaged socio-economic groups.

<sup>28</sup>Mackenbach et al, 2016.

<sup>29</sup>Mackenbach, 2020.

## Supporting Information

Additional supporting information may be found online in the Supporting Information section at the end of the article.

- Appendix

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