Health-related quality-of-life in the Swedish general population during COVID-19 based on pre- and post-pandemic outbreak measurements

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Abstract: The outbreak of the pandemic COVID-19 (Coronavirus) has resulted in various international and national strategies, including non-pharmaceutical interventions (NPIs) such as social distancing and travel bans, which have purportedly mitigated the health loss due to the pandemic but also given rise to a severe economic crisis. Both factors, the pandemic and the NPIs, can be expected to have an impact on the Health-Related Quality-of-Life (HRQoL) of the population. The objective of this study was to estimate the impact on HRQoL of the Swedish adult population during the outbreak of the COVID-19 pandemic. A web-based survey was sent to randomised samples of the adult Swedish population before the outbreak of the pandemic in Sweden in February 2020 (n=1,016) and during the outbreak of the pandemic. The first wave pandemic data was collected in April 2020 (n=1,003), one-month after the outbreak and, the second wave data was collected in January 2021 (n=1,013), after 10-months living under the pandemic. HRQoL was measured using the EQ-5D-5L in the pandemic surveys, whereas the Visual Analogue Scale (VAS) was used in all surveys. The results suggested a reduction in average HRQoL as measured by VAS in the adult Swedish population, with 0.059 points reduction in VAS in April 2020 and 0.074 points reduction in January 2021, compared to the pre-pandemic measurement in February 2020. The loss in HRQoL was significant among respondents in the working age population (<65 years), suggesting that the social and economic impact of NPIs were the primary drivers for this specific cohort. Findings of this study supports a wide public health perspective and future HRQoL measurements at the population level throughout the pandemic.

JEL classification: D6, I3

Keywords: COVID-19, pandemic, quality of life, HRQoL, QALY, Sweden, EQ-5D-5L

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1 Introduction

On March 11, 2020, the first death with COVID-19 (Coronavirus) was reported in Sweden. On the same day, the World Health Organization (WHO) classified the virus outbreak as a pandemic. Within two weeks, almost all EU and OECD countries had banned public gatherings, closed schools, workplaces, and implemented restricted travel policies within and between the countries. Unlike many other countries, Sweden did not introduce a mandatory lockdown policy to limit the spread of COVID-19. Instead, various types of less restrictive strategies were carried out, such as recommending limited social gatherings and travels. In the beginning of 2021, however, a temporary pandemic law was introduced (Act (2021: 4) on special restrictions to prevent the spread of COVID-19 disease, which gives the government the opportunity to close public transport, shops and public places to prevent the spread of infection.

The Oxford COVID-19 stringency index is a composite measure based on nine response indicators including school closures, workplace closures, and travel bans, rescaled to a value from 0 to 100 (0 being the least strict and 100 is the strictest) (Hale et al., 2021). The stringency index rose sharply to around 65 in Sweden during the first wave in April 2020 (Figure 1). During the summer, when the rate of transmission was low, the stringency index decreased somewhat due to the relaxation of some of the restrictions. However, the index never got below 55. During the second wave, the index rose again to almost 70 and remained high until March 2021.

Figure 1: Number of patients in intensive care with COVID-19 (Folkhälsomyndigheten, 2021) and Oxford COVID-19 stringency index* (Hale et al., 2021) between March 2020 and April 2021 in Sweden

*The nine metrics used to calculate the Government Stringency Index are: school closures; workplace closures; cancellation of public events; restrictions on public gatherings; closures of public transport; stay-at-home requirements; public information campaigns; restrictions on internal movements; and international travel controls. If policies vary at the subnational level, the index is shown as the response level of the strictest sub-region.

Compared to other comparative countries, the initial response during the first wave was lower in Sweden according to the Oxford COVID-19 stringency index. However, while other countries relaxed restrictions during the summer months, Sweden has had a relatively stable stringency index throughout the entire period. For example, in Norway, a neighbouring country to Sweden, the stringency index went down sharply from around 80

in April to around 30 in September 2020 before rising again to a new peak of around 75 in February 2021.

The outbreak of the COVID-19 pandemic has had a direct impact on the health and well-being of the general population by causing either illnesses, or concerns and worries about getting sick. The outbreak may also have an indirect impact on the health and well-being of the general population through the use of drastic non-pharmaceutical interventions (NPIs) such as closed borders, travel bans, school closures, and wide scale social distancing (Flaxman et al., 2020, Reddy, 2020). These measures have already had a large impact on factors known to traditionally impact the population health and health-related quality of life (HRQoL), such as rising unemployment and loneliness.

Although health consequences from a wider public health perspective are increasingly acknowledged in the Nordic countries (Folkhälsomyndigheten, 2020, Helsekdirektoratet, 2020), there are few studies that have estimated HRQoL at the population level during the pandemic using standardized instruments for health economic studies (Hay et al., 2021, Ping et al., 2020, Samlani et al., 2020) and, to our knowledge, no study that has estimated the difference in HRQoL compared to pre-pandemic measurements in a European country.

The aims of this study are to 1) estimate the size of the losses in HRQoL in the Swedish general population during the pandemic and, 2) to identify some of the causes for a potential loss in HRQoL based on a measurement pre- and post-pandemic outbreak in Sweden.

2 Methods

2.1 Sample

A web-based questionnaire was sent by Enkätfabriken (<https://www.enkatfabriken.se/>) to stratified, randomized samples of the adult general population in Sweden in internet panels in April 2020 (the first wave pandemic data collection shortly after the pandemic outbreak in Sweden) and in January 2021 (the second wave data collection after 10-months living under pandemic). The samples were stratified based on gender, age and place of residence (NUTS statistical regions) to be representative of the Swedish general population. These surveys were part of a larger study also performed in Norway and the US (results reported in separate publications (Hay et al., 2021)). The results of the surveys during the pandemic were compared to a survey in February 2020 (before the start of the pandemic outbreak as part of a rare disease study) in Sweden using the same data collection approach as applied in the pandemic surveys.

The pre-pandemic February survey (February, 18-25) was sent to 3,096 individuals and 1,016 (33%) completed the questionnaire. The pandemic April survey (April, 7-14) was sent to 4,792 individuals and 1,003 (21%) completed the questionnaire in Sweden. The pandemic January survey (January, 17-22) was sent to 4,002 individuals and 1,013 (25%) completed the questionnaire. All individuals in each sample received the web-based questionnaire at the same date (first date in the intervals) and data were collected until 1,000 responses had been reached (last date in the intervals). A maximum of two reminders were sent out during the time of data collection to potential and eligible respondents among those who had not yet responded. Each survey was sent to different samples, i.e., each respondent received only one of the three questionnaires (cross-section comparison).

The stringency index during our first measurement was 64.81 and 69.44 during the second survey (January 17-22, 2021). During the summer of 2020, when there was a low rate of transmission in Sweden, the stringency index never got below 55, indicating

important impacts on the general populations' behaviour during the entire period since the outbreak started.

2.2 Questionnaire

The questionnaire included informed consent, background questions (age, sex, number of household members, education, occupation and income) and a question on HRQoL using the VAS, a rating scale from 0 (worst imaginable health state) to 100 (best imaginable health state) where the respondent is asked to rate their current health. The two pandemic surveys in April 2020 and January 2021 also included the EQ-5D-5L, a questionnaire that can be used to indirectly derive the health state utility values using value sets that was developed based on a Time-Trade- Off (TTO) technique survey on the general population. The PHQ-4 (The four-item Patient Health Questionnaire for anxiety and depression¹) and questions that related to perception and experience of COVID-19 were also included (concern about COVID-19 with respect to own economic situation for the foreseeable future, own health and own social situation).

2.3 Analysis

The VAS scores comparisons were made using the measurements from all 3 surveys. To control for differences in sample characteristics, the impact of the pandemic based on VAS measurement was estimated by performing OLS regression with HRQoL measured using VAS as a dependent variable and background variables and time of measurement as independent variables.

Since the EQ-5D-5L was not included in the pre-pandemic survey, the EQ-5D-5L comparisons were performed by using a baseline estimate from a 2017 survey conducted in parts of Sweden (CDUST=Uppsala, Sörmland, Västmanland, Värmland and Örebro) by Burstrom et al., 2020 (Burstrom et al., 2020). However, since there was no EQ-5D index reported from the 2017 study, we calculated a weighted mean index by using the following method:

- i. multiplying the share of respondents with a level below 1 on the EQ-5D-5L with the loss in HRQoL according to the TTO value set in Devlin et al. 2018 (Devlin et al., 2018),
- ii. summarizing the loss in quality-of-life, and
- iii. subtracting the total weighted loss from 1.

An estimation of the number of quality-adjusted life-years (QALYs) lost in the population is included in the Appendix (Table A2). The estimation was not included in the main result as it is partly based on sample data from 2017 (Burstrom et al., 2020) (pre-pandemic EQ-5D measurement).

¹ Over the last 2 weeks, how often have you been bothered by (1) feeling nervous, anxious or on edge, (2) not being able to stop or control worrying? (3) little interest or pleasure in doing things? (4) feeling down, depressed, or hopeless? (Not at all 0, several days 1, more than half the days 2, nearly every day 3). Score is the sum of all responses (0-12). Scores are rated as normal (0-2), mild (3-5), moderate (6-8), and severe (9-12).

3 Results

3.1 Sample

The sample in the first pandemic survey in April 2020 had a lower mean age, lower share with higher education and a lower income compared to the sample in the pre-pandemic survey in February 2020 (Table 1). The sample from the pandemic January 2021 measurement also had a lower mean age compared to the sample in the pre-pandemic February 2020 measurement, but the level of education, current health and income were more similar. The rate of job seeking respondents and respondents on sick leave were higher in the pandemic measurements. The rate of respondents from the Stockholm region was slightly lower and more in line with the national average.

Compared to the samples included, the entire Swedish adult population has a similar mean age (49.6 (SCB, 2021a)), share of females (50% (SCB, 2021a)) and geographical distribution but a lower share with university education ≥ 3 years (28% (SCB, 2021b)).

3.2 Loss in HRQoL based on pre- and post-pandemic outbreak measurements

Compared with pre-pandemic measures, the mean HRQoL measured by VAS showed a significant reduction in both pandemic measures, namely, 8.4 and 8.9 percentage points reduction for April 2020 and January 2021 measures, respectively (Table 1). After adjusting for controls, this resulted in a reduction of HRQoL by 5.6 and 7.7 percentage points respectively (Table 2). Comparing the unadjusted mean of April 2020 and January 2021, results showed a non-significant difference of 0.5 (Table 1). However, when adjusting for controls, the HRQoL was significantly lower in January 2021 (-2.07, $p=0.020$, regression not shown).

The pre-pandemic measurement in February 2020 did not include the EQ-5D. However, both pandemic measurements were lower compared to the latest measurement using the EQ-5D in Sweden (0.838) in 2017. Adjusting for differences in calculating means, resulted in a difference of 0.042 in April 2020 and 0.031 in January 2021. The pandemic outbreak EQ-5D-5L measurements also showed a higher share of respondents reporting some level of anxiety or depression compared to the 2017 survey. There was no difference in HRQoL between April 2020 and January 2021 based on the EQ-5D index (Appendix, Table A1, pooled sample).

Table 1: Respondent characteristics

Variable	(1) February 2020 (n=1,016)	(2) April 2020 (n=1,003)	p-value 1-2	(3) January 2021 (n=1,013)	p-value 1-3	p-value 2-3
Mean age (SD)	50,0 (17.6)	47.8 (17.1)	0.0040	46.7 (16.6)	0.0000	0.1475
Female	56.1%	50.6%	0.0140	50.7%	0.0155	0.9670
One adult in household	34.7%	38.0%	0.1301	32.1%	0.2040	0.0055
Child(ren) in household	30.5%	31.4%	0.6642	30.9%	0.8504	0.8058
Completed education:						
- Elementary school	7.7%	18.8%	0.0000	6.8%	0.4522	0.0000
- High school	37.3%	36.3%	0.6375	43.5%	0.0042	0.0009
- University<3 yrs	16.0%	12.8%	0.0358	13.5%	0.1101	0.6127
- University≥3 yrs	35.4%	30.6%	0.0212	35.2%	0.9283	0.0269
- Other	3.5%	1.5%	0.0034	0.9%	0.0000	0.2091
Occupation:						
- Employed	56.2%	51.2%	0.0446	56.2%	0.9888	0.0463
- Self-employed	2.5%	4.8%	0.0051	3.3%	0.2816	0.0807
- Retired	26.4%	23.1%	0.0911	20.5%	0.0019	0.1582
- Student	7.8%	8.7%	0.4627	9.3%	0.2254	0.6347
- Job seeking	2.4%	5.8%	0.0001	6.0%	0.0000	0.8200
- Sick leave	3.2%	8.4%	0.0000	4.9%	0.0550	0.0019
- Parental leave	2.3%	1.3%	0.1005	1.6%	0.2619	0.5934
- Other	1.8%	0.1%	0.1368	1.5%	0.6047	0.3267
Mean household income per month in SEK (SD)	45,950 (22,259)	40,034 (22,022)	0.0000	43,301 (20,965)	0.0108	0.0014
Region (NUTS2)						
- Southern Sweden	13.9%	14.7%	0.6174	14.9%	0.5096	0.8743
- Småland and the Islands	7.3%	9.1%	0.1424	8.4%	0.3536	0.5878
- Western Sweden	20.3%	18.1%	0.2247	19.9%	0.8509	0.3050
- Stockholm	26.3%	21.3%	0.0091	21.0%	0.0054	0.8651
- Eastern Middle Sweden	16.4%	16.9%	0.7578	16.6%	0.9288	0.8266
- Northern Middle Sweden	7.5%	9.4%	0.1261	9.3%	0.1438	0.9431
- Middle Norrland	3.9%	4.1%	0.8631	4.0%	0.8990	0.9634
- Upper Norrland	4.4%	6.0%	0.1162	5.8%	0.1543	0.8806
Current health:						
- Very good	22.8%	-	-	23.0%	0.9290	-
- Quite good	50.3%	-	-	47.7%	0.2389	-
- Fairly good	19.5%	-	-	20.0%	0.7553	-
- Quite bad	6.0%	-	-	6.3%	0.7688	-
- Very bad	0.9%	-	-	2.2%	0.0182	-
- No answer	0.5%	-	-	0.8%	0.4011	-
Mean HRQoL (SD):						
- VAS	77.1 (17.7)	68.7 (21.4)	0.0000	68.2 (20.3)	0.0000	0.2188
- EQ-5D-5L index	-	0.802 (0.208)	-	0.813 (0.188)	-	0.5638
Mean concern (on scale 0-10) about COVID-19 with respect to you own:						
- health	-	4.65 (2.88)	-	4.36 (2.64)	-	0.0206
- economy	-	4.49 (2.89)	-	3.86 (2.75)	-	0.0000
- social life	-	-	-	4.15 (2.68)	-	-

Bold figures refer to statistically significant differences across samples.

Table 2: Regressions of HRQoL on VAS scale, Pooled samples

VARIABLES	
25-34 yrs vs. 18-24 yrs	1.685 (1.625)
35-44 yrs vs 18-24 yrs	1.623 (1.703)
45-54 yrs vs 18-24 yrs	2.316 (1.677)
55-64 yrs vs 18-24 yrs	5.074*** (1.749)
65-74 yrs vs 18-24 yrs	13.85*** (2.193)
75 yrs+	14.80*** (2.469)
Gender (Female=1)	-1.705** (0.703)
One adult in household=1	-1.671* (0.862)
Child(ren) in household=1	-1.513* (0.885)
High school vs elementary school	2.934** (1.195)
University < 3 yrs vs elementary school	4.066*** (1.398)
University ≥ 3 yrs vs elementary school	3.626*** (1.258)
Other education vs elementary school	-1.420 (2.710)
Self-employed vs employed	-4.836** (1.906)
Retired vs employed	-9.566*** (1.586)
Students vs employed	2.023 (1.567)
Unemployed vs employed	-4.010** (1.711)
Sick leave vs employed	-21.71*** (1.644)
Parental leave vs employed	0.137 (2.727)
Other occupation vs employed	-15.82*** (2.943)
SEK20,000-29,900 vs <19,900	1.790 (1.322)
SEK30,000-39,900 vs <19,900	3.783*** (1.355)
SEK40,000-49,900 vs <19,900	3.894*** (1.490)
SEK50,000-59,900 vs <19,900	5.668*** (1.630)
SEK60,000-69,900 vs <19,900	5.289*** (1.761)

Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 2: Regressions of HRQoL on VAS scale, Pooled samples (continued)

VARIABLES	
SEK70,000-70,900 vs <19,9000	6.001*** (1.854)
SEK>80,0000 vs <19,9000	8.798*** (1.824)
No answer on income vs <19,900	5.271*** (1.396)
April 20 vs Feb 20	-5.646*** (0.862)
Jan 21 vs Feb 20	-7.696*** (0.848)
Constant	69.77*** (2.310)
Observations	2,988
R-squared	0.172

Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

3.3 Possible explanations for the reduction in HRQoL

HRQoL did not differ by age in the pre-pandemic measurement in February 2020. However, in the measurements during the pandemic, the older age groups had a significantly higher HRQoL compared to the younger age groups (Table 3). Figure 2 shows the reduction in HRQoL based on coefficients generated with pooled regressions similar to the regression in Table 2 but performed separately for each age cohort. The reduction in HRQoL, as measured by VAS, was greater among younger respondents and only significant for respondents in the working age groups younger than 65 years (Figure 2). Moreover, there was a larger reduction in HRQoL during the second wave (January 2021) than in the first wave (April 2020) for respondents 18-54 years old when compared to the pre-pandemic outbreak measurement in February 2020 (Figure 2) proposing that the negative impact of the pandemic on the Swedish population's HRQoL exacerbates over time.

Table 3: Regressions of HRQoL on VAS scale

VARIABLES	February 2020	April 2020	January 2021
25-34 yrs vs. 18-24 yrs	-0.957 (2.757)	2.173 (2.969)	1.852 (2.691)
35-44 yrs vs 18-24 yrs	0.566 (2.913)	2.105 (3.069)	1.465 (2.845)
45-54 yrs vs 18-24 yrs	2.759 (2.906)	3.765 (3.013)	0.896 (2.779)
55-64 yrs vs 18-24 yrs	3.095 (2.952)	5.496* (3.154)	6.340** (2.981)
65-74 yrs vs 18-24 yrs	6.816* (4.029)	16.97*** (3.749)	13.56*** (3.814)
75 yrs+ vs 18-24 yrs	7.632* (4.368)	18.43*** (4.239)	16.83*** (4.607)

Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. ^aThe question on VAS was not mandatory

Table 3: Regressions of HRQoL on VAS scale (continued)

VARIABLES	February 2020	April 2020	January 2021
Gender (Female=1)	-0.852 (1.127)	-2.181* (1.308)	-1.406 (1.211)
One adult in household=1	-0.732 (1.341)	-3.414** (1.544)	-1.827 (1.586)
Child(ren) in household=1	-1.237 (1.478)	-1.942 (1.574)	-1.992 (1.536)
High school vs elementary school	-0.00163 (2.202)	3.426* (1.815)	4.820* (2.468)
University < 3 yrs vs elementary school	2.084 (2.432)	3.196 (2.290)	6.207** (2.831)
University ≥ 3 yrs vs elementary school	2.892 (2.268)	2.090 (2.002)	5.567** (2.558)
Other education vs elementary school	3.073 (3.612)	-7.047 (5.302)	-11.51* (6.698)
Self-employed vs employed	-5.194 (3.486)	-3.735 (3.080)	-5.612* (3.391)
Retired vs employed	-5.995* (3.156)	-12.43*** (2.584)	-6.973** (2.717)
Students vs employed	2.597 (2.618)	0.941 (2.915)	1.362 (2.623)
Job seeking vs employed	-0.472 (3.703)	-0.734 (2.913)	-7.691*** (2.690)
Sick leave vs employed	-28.78*** (3.388)	-18.83*** (2.571)	-21.45*** (2.895)
Parental leave vs employed	2.062 (3.814)	-5.168 (5.664)	0.874 (4.880)
Other occupation vs employed	-11.09*** (4.192)	-21.34*** (6.389)	-16.48*** (4.992)
SEK20,000-29,900 vs <19,900	-0.617 (2.365)	4.104* (2.166)	0.737 (2.397)
SEK30,000-39,900 vs <19,900	3.184 (2.291)	5.396** (2.415)	1.169 (2.378)
SEK40,000-49,900 vs <19,900	5.729** (2.465)	3.053 (2.757)	1.127 (2.612)
SEK50,000-59,900 vs <19,900	5.312* (2.775)	5.352* (2.824)	2.955 (2.916)
SEK60,000-69,900 vs <19,900	4.672 (2.982)	8.147** (3.274)	1.819 (2.972)
SEK70,000-79,900 vs <19,900	5.293* (3.052)	7.147** (3.349)	2.545 (3.272)
SEK>80,000 vs <19,900	8.431*** (2.855)	5.859* (3.315)	8.709** (3.498)
No answer on income vs <19,900	3.951* (2.355)	6.398*** (2.451)	4.411* (2.519)
Concern about COVID-19 related to own health		-0.778*** (0.276)	-0.325 (0.299)
Concern about COVID-19 related to own economic situation		-0.557** (0.275)	-0.342 (0.291)
Concern about COVID-19 related to own social situation			-0.778** (0.317)
Constant	72.62*** (3.928)	70.25*** (3.946)	67.98*** (4.135)
Observations	972 ^a	1,003	1,013
R-squared	0.139	0.190	0.188

Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. ^aThe question on VAS was not mandatory

Figure 2: Reduction in QoL based on pooled VAS regression by age (horizontally striped bars indicate no significant change, vertically striped bars indicate significant at $p < 0.1$, all other changes significant at $p < 0.01$)

Concerns about COVID-19 related to one's own health and own economy had a significant impact on the HRQoL as measured by VAS in April 2020 (Table 3). These concerns were significantly reduced in January 2021 (Table 1) and no longer significantly related to HRQoL (Table 3). Concern about the impact of COVID-19 on social life was, however, significantly related to HRQoL in January 2021 (Table 3). Being the only adult in the household had a significant impact on HRQoL in the post-pandemic outbreak measurement in April 2020 (Table 2), suggesting that less socialization may have contributed to a lower HRQoL. HRQoL, measured using the EQ-5D index, was also significantly related to concern about one's own health and economy in April 2020 and to concern about own social life in January 2021 (Appendix, Table A1).

Figure 3 shows concern about COVID-19 by age and over time. While concern about COVID-19 related to own health increases by age, concern about COVID-19 related to own economy decreases by age. As stated above, these concerns have been reduced between April 2020 and January 2021. Concern about COVID-19 related to own social life varies less by age but is highest among the younger age groups.

Figure 3: Mean concern about COVID-19 with respect to own economy, health and social life by age and time of measurement

4 Discussion

The purpose of this study was to estimate the impact on the HRQoL of the population during the COVID-19 pandemic. The study suggest that the Swedish adult population has experienced a loss in HRQoL during the peak of the first (April 2020) and second (January 2021) wave of the COVID-19 pandemic. The loss in HRQoL, based on VAS, was larger in January 2021 compared to in April 2020 and only significant for respondents in the working age population (<65 years of age). Consistent with a similar study in the US (Hay et al., 2021), the loss in HRQoL was largest for the youngest respondents (18-24 years).

Assuming the reduction in HRQoL can be extrapolated to the whole month for when the HRQoL was measured, the total QALY loss for *one month* at the peak of the pandemic was estimated to be around 32,800-44,400 QALYs based on VAS and around 21,000-28,500 QALYs based on EQ-5D-5L (Appendix, Table A2). The estimated QALY loss due to excess mortality for the entire year of 2020 amounts to 42,800 (Appendix, Table A3). In addition to this, there will be QALYs lost due to non-fatal cases of COVID-19. However, to our knowledge, there is currently no studies available on the HRQoL or QALYs lost due to COVID-19 illness. Even so, these rough assessments imply that the QALY loss in the population contributes to a large share of the disease burden associated with COVID-19.

The reduction in HRQoL may be due to the pandemic itself (e.g., through fear of becoming ill) or due to the consequence of the NPIs. This study was not designed to separate the impact of these factors. However, since the loss in HRQoL was non-significant among respondents at most risk of COVID-19 (i.e., respondents 65 years or older), it appears that the pandemic itself is not the primary explanatory factor for the reduction in HRQoL. Consequently, a hypothesis is that it is the social and economic impact of the NPIs that are the major driver behind the loss in HRQoL.

The HRQoL in the Swedish population was unchanged (EQ-5D) or reduced (VAS) between April 2020 and January 2021. This would imply that there was no adaptation to the NPIs over time. Another explanation for this finding is that there were more restrictions in

January 2021, as shown by the increase in the stringency index. Moreover, the unemployment had increased in January 2021 (from 8.2% in April 2020 to 9.3% in January 2021 (Ekonomifakta, 2021)), thus making it harder for job seeking individuals to find a job. This explanation is supported by the result showing a significantly lower HRQoL among job seeking respondents in January 2021 compared to the employed (-7.7 , $p < 0.01$), whereas no difference in HRQoL was found in the measurements during 2020.

A limitation of this study is that we only conducted two measurements, one was about one month after the pandemic and one was a little shy from one year living under pandemic. Consequently, these results may not be directly extrapolated to the entire period with the pandemic. However, as the stringency index suggest, the level of NPIs have been quite stable throughout the pandemic in Sweden. This might imply that we could expect some level of loss throughout the whole period, although maybe not at the same level as at the peak of the waves.

Another limitation of this study is the lack of individual-based data for the EQ-5D measurement before the pandemic. Consequently, the analysis is primarily based on the VAS measurement. Both approaches suggest a loss in HRQoL, however, the loss was larger when measured using VAS. This is in line with previous research (Feng et al., 2014) and might suggest that VAS is more responsive to changes in dimensions such as concern about your own economy. Another explanation is that VAS is in part due to self-perceived HRQoL while the EQ-5D-5L captures societally weighted preferences for HRQoL. Although VAS typically leads to lower HRQoL ratings as no trade-off is required, changes between health states may not be overestimated as suggested by the similar slope for VAS and TTO in a previous study (Burstrom et al., 2020). Since this study was based on data from separate cohorts, there may be confounding factors. The VAS measurement allowed for some control of this, while it was not possible to take any account for this for the EQ-5D-5L measurement.

Comparing the pre-pandemic outbreak VAS measurement in February 2020 to previous population norms (Burstrom et al., 2001, Burstrom and Rehnberg, 2006, Janssen and Szende, 2014, Reddy, 2020, Szende et al., 2014) suggests that the HRQoL is relatively stable for the population in the age groups 45-64 years, while it appears to have decreased among the younger age groups (18-44 years) and increased for the older age groups (65 years+). However, for all ages below 75, all VAS scores from the pre-pandemic surveys are higher than the scores in the pandemic surveys.

To our knowledge, this is the first study that has estimated the impact of a pandemic on the HRQoL of the population using pre- and post-outbreak measurements in a European country. The findings support the use of a wider public health perspective that consider health losses due to all sources. Future research should continue monitoring HRQoL in the population throughout the pandemic to see how it changes with the pandemic and the mitigation strategies. Providing a more complete picture of the HRQoL impact during the pandemic may help to achieve more appropriate trade-offs across alternative mitigation/suppression strategies included in future economic evaluations.

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References

- Burström, K., Johannesson, M. and Diderichsen, F. (2001) 'Swedish population health-related quality of life results using the EQ-5D', *Qual Life Res*, 10(7), pp. 621-35.
- Burström, K. and Rehnberg, C. (2006) 'Geografiska skillnader i hälsorelaterad livskvalitet i Stockholms län 2002 - Resultat per kommun och stadsdel, geografisk beredning samt beställaravdelning - en befolkningsundersökning med EQ-5D ', *Centrum för folkhälsa - Enheten för Socialmedicin och Hälsoekonomi* Rapport 2006:2.
- Burström, K., Teni, F. S., Gerdtham, U. G., Leidl, R., Helgesson, G., Rolfson, O. and Henriksson, M. (2020) 'Experience-Based Swedish TTO and VAS Value Sets for EQ-5D-5L Health States', *Pharmacoeconomics*.
- Devlin, N. J., Shah, K. K., Feng, Y., Mulhern, B. and van Hout, B. (2018) 'Valuing health-related quality of life: An EQ-5D-5L value set for England', *Health Econ*, 27(1), pp. 7-22.
- Ekonomifakta (2021) *Arbetslöshet* Available at: <https://www.ekonomifakta.se/fakta/arbetsmarknad/arbetsloshet/arbetsloshet/> (Accessed: 29 juni 2021).
- Feng, Y., Parkin, D. and Devlin, N. J. (2014) 'Assessing the performance of the EQ-VAS in the NHS PROMs programme', *Qual Life Res*, 23(3), pp. 977-89.
- Flaxman, S., Mishra, S., Gandy, A., Juliette, H., Unwin, T., Coupland, H., Mellan, T., Zhu, H., Berah, T., Eaton, J., Guzman, P., Schmit, N., Callizo, L., Ainslie, K., Baguelin, M., Blake, I., Boonyasiri, A., Boyd, O., Cattarino, L., Ciavarella, C., Cooper, L., Cucunubá, Z., Cuomo-Dannenburg, G., Dighe, A., Djaafara, B., Dorigatti, I., van Elsland, S., FitzJohn, R., Fu, H., Gaythorpe, K., Geidelberg, L., Grassly, N., Green, W., Hallett, T., Hamlet, T., Hinsley, W., Jeffrey, B., Jorgensen, D., Knock, E., Laydon, D., Nedjati-Gilani, G., Nouvellet, P., Parag, K., Siveroni, I., Thompson, H., Verity, R., Volz, E., Walker, P., Walters, C., Wang, H., Wang, Y., Watson, O., Whittaker, C., Winskill, P., Xi, X., Ghani, A., Donnelly, C., Riley, S., Okell, L., Vollmer, M., Ferguson, N. and Bhatt, S. (2020) *Report 13 - Estimating the number of infections and the impact of non-pharmaceutical interventions on COVID-19 in 11 European countries*. Imperial College COVID-19 Response Team. Available at: <https://www.imperial.ac.uk/media/imperial-college/medicine/mrc-gida/2020-03-30-COVID19-Report-13.pdf> (Accessed: April 14 2020).
- Folkhälsomyndigheten (2020) *Covid-19-pandemins tänkbbara konsekvenser på folkhälsan*. Available at: file:///C:/Users/so/Downloads/covid-19-pandemins-tankbara-konsekvenser-pa-folkhalsan.pdf (Accessed: July 21 2020).
- Folkhälsomyndigheten (2021) *Bekräftade fall i Sverige – daglig uppdatering*. Available at: <https://www.folkhalsomyndigheten.se/smittskydd-beredskap/utbrott/aktuella-utbrott/covid-19/statistik-och-analyser/bekraftade-fall-i-sverige/> (Accessed: April 15 2021).
- Hale, T., Angrist, N., Goldszmidt, R., Kira, B., Petherick, A., Phillips, T., Webster, S., Cameron-Blake, E., Hallas, L., Majumdar, S. and Tatlow, H. (2021) *A global panel database of pandemic policies (Oxford COVID-19 Government Response Tracker)*: Nature Human behaviour. Available at: <https://www.bsg.ox.ac.uk/research/research-projects/covid-19-government-response-tracker> (Accessed: April 15 2021).
- Hay, J., Gong, P., Jiao, X., Zawadzki, R., Zawadzki, N., Pickard, A., Xie, F., Crawford, S. and Gu, N. (2021) 'A US population health survey on the impact of COVID-19 using the EQ-5D-5L', *J Gen Intern Med*
- Helsedirektoratet (2020) *Covid-19 – samfunnsøkonomisk vurdering av smitteverntiltak – andre rapport*. Rapport fra ekspertgruppe på oppdrag for Helsedirektoratet 22. mai 2020 (versjon etter korrektur levert 26. mai). Available at: <https://www.helsedirektoratet.no/rapporter/samfunnsokonomisk-vurdering-av-smitteverntiltak-covid-19> (Accessed: June 15 2020).

- Janssen, B. and Szende, A. (2014) 'Population Norms for the EQ-5D', in Szende, A., Janssen, B. & Cabases, J. (eds.) *Self-Reported Population Health: An International Perspective based on EQ-5D*. Dordrecht (NL), pp. 19-30.
- Ping, W., Zheng, J., Niu, X., Guo, C., Zhang, J., Yang, H. and Shi, Y. (2020) 'Evaluation of health-related quality of life using EQ-5D in China during the COVID-19 pandemic', *PLoS One*, 15(6), pp. e0234850.
- Reddy, S. G. (2020) 'Population health, economics and ethics in the age of COVID-19', *BMJ Glob Health*, 5(7).
- Samlani, Z., Lemfadi, Y., Errami, A., Oubaha, S. and Krati, K. (2020) 'The impact of the COVID-19 pandemic on quality of life and well-being in Morocco ', *Arch Community Med Public Health*, 6(2), pp. 130-134.
- SCB (2020) *Statistikdatabasen: Befolkning efter ålder och kön. År 1860 - 2019. Utdrag för 2019.* . Available at: http://www.statistikdatabasen.scb.se/pxweb/sv/ssd/START_BE_BE0101_BE0101A/BefolkningR1860/ (Accessed: June 15 2020).
- SCB (2021a) *Folkmängden efter region, civilstånd, ålder och kön. År 1968 - 2020.* Available at: http://www.statistikdatabasen.scb.se/pxweb/sv/ssd/START_BE_BE0101_BE0101A/BefolkningNy/?loadedQueryId=102786&timeType=top&timeValue=1 (Accessed: April 20 2021).
- SCB (2021b) *Utbildningsnivån i Sverige.* Available at: <https://www.scb.se/hitta-statistik/sverige-i-siffror/utbildning-jobb-och-pengar/utbildningsnivan-i-sverige/> (Accessed: April 20 2021).
- Szende, A., Janssen, B. and Cabases, J. (2014) *Self-Reported Population Health: An International Perspective based on EQ-5D.* Available at: https://eq-5dpublications.euroqol.org/download?id=0_54006&fileId=54415 (Accessed: June 24 2020).

Appendix

Table A1: Regressions of HRQoL on EQ-5D-5L

VARIABLES	(1) April 2020	(2) January 2021	(3) Pooled sample (April 2020 + Jan 2021)
25-34 yrs vs. 18-24 yrs	-0.00873 (0.0286)	0.0203 (0.0252)	0.00928 (0.0189)
35-44 yrs vs 18-24 yrs	0.0294 (0.0296)	0.0198 (0.0267)	0.0279 (0.0198)
45-54 yrs vs 18-24 yrs	0.0509* (0.0290)	0.0377 (0.0261)	0.0499** (0.0194)
55-64 yrs vs 18-24 yrs	0.0651** (0.0304)	0.0392 (0.0280)	0.0555*** (0.0204)
65-74 yrs vs 18-24 yrs	0.127*** (0.0361)	0.117*** (0.0358)	0.124*** (0.0252)
75 yrs+ vs 18-24 yrs	0.134*** (0.0409)	0.138*** (0.0432)	0.137*** (0.0293)
Gender (Female=1)	-0.0124 (0.0126)	-0.0165 (0.0114)	-0.0142* (0.00838)
One adult in household=1	-0.0230 (0.0149)	0.00751 (0.0149)	-0.0107 (0.0104)
Child(ren) in household=1	-0.0526*** (0.0152)	-0.0265* (0.0144)	-0.0402*** (0.0104)
High school vs elementary school	0.0154 (0.0175)	0.0130 (0.0231)	0.0106 (0.0135)
University < 3 yrs vs elementary school	-0.0300 (0.0221)	-0.0145 (0.0265)	-0.0238 (0.0163)
University ≥ 3 yrs vs elementary school	-0.00534 (0.0193)	0.0143 (0.0240)	0.000992 (0.0144)
Other education vs elementary school	-0.108** (0.0511)	-0.0915 (0.0628)	-0.102*** (0.0391)
Self-employed vs employed	-0.0536* (0.0297)	-0.0491 (0.0318)	-0.0507** (0.0215)
Retired vs employed	-0.0781*** (0.0249)	-0.0802*** (0.0255)	-0.0780*** (0.0177)
Students vs employed	-0.0567** (0.0281)	0.0357 (0.0246)	-0.0113 (0.0185)
Job seeking vs employed	0.0167 (0.0281)	-0.0108 (0.0252)	0.000187 (0.0187)
Sick leave vs employed	-0.170*** (0.0248)	-0.174*** (0.0272)	-0.170*** (0.0181)
Parental leave vs employed	0.0400 (0.0546)	0.0461 (0.0458)	0.0460 (0.0352)
Other occupation vs employed	-0.131** (0.0616)	-0.123*** (0.0468)	-0.119*** (0.0374)

Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table A1: Regressions of HRQoL on EQ-5D-5L (continued)

VARIABLES	(1) April 2020	(2) January 2021	(3) Pooled sample (April 2020 + Jan 2021)
SEK20,000-29,900 vs <19,900	0.0357* (0.0209)	0.0634*** (0.0225)	0.0446*** (0.0151)
SEK30,000-39,900 vs <19,900	0.0598** (0.0233)	0.0521** (0.0223)	0.0490*** (0.0159)
SEK40,000-49,900 vs <19,900	0.0347 (0.0266)	0.0733*** (0.0245)	0.0478*** (0.0177)
SEK50,000-59,900 vs <19,900	0.0413 (0.0272)	0.0902*** (0.0273)	0.0585*** (0.0190)
SEK60,000-69,900 vs <19,900	0.0812** (0.0316)	0.0821*** (0.0279)	0.0750*** (0.0205)
SEK70,000-79,900 vs <19,900	0.0566* (0.0323)	0.0948*** (0.0307)	0.0687*** (0.0220)
SEK>80,000 vs <19,900	0.112*** (0.0320)	0.120*** (0.0328)	0.109*** (0.0226)
No answer on income vs <19,900	0.0592** (0.0236)	0.0887*** (0.0236)	0.0702*** (0.0165)
Concern about COVID-19 related to own health	-0.0141*** (0.00266)	-0.00338 (0.00281)	-0.0107*** (0.00182)
Concern about COVID-19 related to own economic situation	-0.00619** (0.00265)	-0.00331 (0.00273)	-0.00668*** (0.00178)
Concern about COVID-19 related to own social situation		-0.00848*** (0.00297)	
January 2021 vs April 2020			-0.00699 (0.00838)
Constant	0.874*** (0.0380)	0.797*** (0.0388)	0.843*** (0.0266)
Observations	1,003	1,013	2,016
R-squared	0.202	0.162	0.170

Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Estimation of QALYs lost in the population

The number of quality-adjusted life-years (QALYs) lost per month was calculated for both pandemic surveys based on a point estimate of the HRQoL at any time from April 7th to 14th, 2020, and from January 17th to 22nd, 2021. It was assumed that the loss in HRQoL would be representative for all of April 2020 and all of January 2021. At the population level, we calculated the loss by multiplying the loss in HRQoL (difference between February and April 2020 or January 2021) by the population in each age group (SCB, 2020) and then divided it by 12 (months). The EQ-5D comparison is only performed at the population level and not for different age groups due to limitations in the data available for the baseline estimate.

Table A2: QALY loss per month based on measurement in April 2020 and January 2021

Age	Population ^a	HRQoL loss in April 2020	QALY-loss in April 2020	HRQoL loss in January 2021	QALY-loss in January 2021
18-24 år	810,921	0.0941 ^b	6,359	0.1274 ^c	8,609
25-34 år	1,455,587	0.0396 ^b	4,803	0.0712 ^c	8,636
35-44 år	1,281,861	0.0772 ^b	8,247	0.0888 ^c	9,486
45-54 år	1,344,847	0.0620 ^b	6,948	0.1076 ^c	12,059
55-64 år	1,188,498	0.0655 ^b	6,487	0.0565 ^c	5,596
65-74 år	1,100,463	0.0423 ^{bc}	-	0.0177 ^{ec}	-
75 år +	964,904	0.0451 ^{bc}	-	0.0297 ^{ec}	-
ALL VAS	8,147,081		32,845		44,386
ALL EQ-5D	8,147,081	0.042^d	28,515	0.031^d	21,046

^aSCB, 2019.

^bRegression coefficient for VAS scale April vs Feb 2020.

^cNot significant.

^dBased on comparison of weighted means.

^eRegression coefficient for VAS scale Jan 2021 vs Feb 2020.

Estimation of QALYs lost due to excess mortality 2020

The number of QALYs lost due to excess mortality was calculated for the entire year of 2020 based on the mortality data reported by Statistics Sweden (Statistiska centralbyrån, SCB).

Table A3: QALY loss due to excess mortality 2020

Age	QALYs lost per premature death ^a	Number of deaths based on excess mortality ^b	Total QALY-loss due to excess mortality 2020
0-9 years	26.09	4	113
10-19 years	23.28	2	56
20-29 years	21.55	11	229
30-39 years	20.11	23	456
40-49 years	18.11	54	978
50-59 years	15.30	179	2,737
60-69 years	12.09	494	5,975
70-79 years	8.17	1,576	12,878
80-89 years	4.71	2,874	13,538
90 years+	3.19	1,831	5,842
TOTAL		7,049	42,802

^aEstimation of the number of the discounted remaining quality-adjusted life years. See more details in IHE Report 2020:8. https://ihe.se/wp-content/uploads/2020/10/IHE-Report-2020_8_.pdf

^bExcess mortality 2020 compared to average 2015-2019 according to statistics from SCB. Distributed by age according to statistics from the Public Health Agency of Sweden (Folkhälsomyndigheten).