

Health-related quality of life and mental well-being during the COVID-19 pandemic in five countries: a one-year longitudinal study

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Abstract

Background

Two years after its onset, the COVID-19 pandemic is far from over. Many studies reported negative consequences from COVID-19 in the general population on a range of health dimensions. However, few studies have reported HRQoL and mental well-being longitudinally in the general population during the pandemic and on a multi-country level. This study aimed to investigate how HRQoL and mental well-being developed one year after the first wave of the COVID-19 pandemic. Second, we explored the relation between socioeconomic- and health-related determinants as well as recent life events related to health, work, income and living situation and changes in HRQoL and mental well-being over the follow-up period.

Methods

This study is part of the second wave of the POPulation health impact of the CORoNavirus disease 2019 (COVID-19) pandemic (POPCORN) study. In this longitudinal study, a web-based survey was administered to the participants at T1 (April-May, 2020) and T2 (May-June, 2021). The study participants completed the web-based questionnaire at T1 and T2 and resided in the following five countries: Greece, Italy, Netherlands, United Kingdom, and United States. Primary outcome measures were HRQoL (measured by EQ-5D-5L), and mental well-being (measured by WHO-5). Linear regression analyses were performed to estimate the impact of determinants on HRQoL and well-being.

Results

A total of 6,765 (41%) respondents completed the questionnaire at T1 and T2. Of all respondents between T1 and T2, 65% to 91% reported the same EQ-5D-5L dimension scores. Change was most prevalent in the Anxiety/Depression dimension with 21% improving and 14% deteriorating. About one third of respondents showed improved HRQoL scores at T2 (EQ-5D-5L level sum score: 31% improved; EQ-5D-5L index: 33% improved; and EQ VAS: 32% improved), whereas 29-41% deteriorated (EQ-5D-5L level sum score: 29% deteriorated; EQ-5D-5L index: 31% deteriorated; and EQ VAS: 39% deteriorated). Country-specific analysis showed HRQoL improvement to be most common in Greece (35-40%),

whereas deterioration was most prevalent in the UK (31-41%). In terms of mental well-being, 44% improved and 16% showed no difference, while 41% reported deterioration. The greatest deterioration in HRQoL and mental well-being from T1 to T2 was observed with an increasing number of chronic conditions. On average, the effect of negative recent life events on HRQoL and mental well-being was larger than the effect of positive recent life events

Conclusions

Collection of repeated HRQoL and mental well-being data among multi-country general population samples allows investigating HRQoL and mental well-being over time and exploring cause-effect relationships between a wide range of possible determinants of health and HRQoL and mental well-being of the general population, both during and after the acute phase of the COVID-19 pandemic.

Keywords: Health-related Quality of Life, mental well-being, EQ-5D-5L, WHO-5, longitudinal, COVID-19

Introduction

Two years after its onset, the COVID-19 pandemic is far from over, through insufficient containment measures, stagnating vaccination coverage, lack of resources, and new virus variants emerging. Consequences are noticeable on the global economy level[1, 2], health care level[3, 4], and on the daily life of individuals[5, 6], going beyond the impact on those acutely infected.

Many studies have reported negative consequences from COVID-19 in the general population on a range of health dimensions such as physical symptoms and sequelae[7], psychological problems[8], social functioning[9, 10], sleep[11], and fatigue[12].

Since the first wave of the pandemic, the patterns of incidence of COVID-19 infection and government responses have become irregular across countries, with vaccination as an important modifier[13]. While the focus of health care is usually on treatment of acute infection and post-infection states, the impact on the general population in terms of health-related quality of life (HRQoL) and mental well-being may outsize the impact of those individuals infected. HRQoL, defined as the degree to which a person functions in their life, is a multidimensional concept and reflects his or her perceived well-being in physical, mental, and social domains of health[14]. Mental well-being is defined by the World Health Organization (WHO) as “a state of well-being in which the individual realized his or her own abilities, can cope with the normal stresses of life, can work productively and fruitfully, and is able to make a contribution to his or her community”[15].

The impact of the pandemic on HRQoL and mental well-being varies across region and demographic and epidemiological characteristics. Apart from country of residency and local restriction measures against the spread of the COVID-19 virus, several determinants contribute to HRQoL and mental well-being differences such as pre-existing chronic illness, age and gender, socioeconomic status, and race and ethnicity, as well as negative recent life events related to determinant changes, such as job loss and loss of health insurance [16-24]. In addition, as symptoms after the acute phase of COVID-19 infection – often referred to as “long COVID” – may persist long after acute COVID-19[25], the noticeable presence of long COVID may impact the trajectory of HRQoL and mental well-being changes in the general population.

Information on the longitudinal evolution of HRQoL and mental well-being could indicate which vulnerable groups need to be monitored more closely in the post-COVID era and what

potentially modifiable factors must be addressed in the frail population. Few studies have reported HRQoL and mental well-being longitudinally in the general population during the pandemic on a multi-country level. Such studies were small or focused on a single country[26-30], unable to detect the balance of impacts in disadvantaged groups. Therefore, the aims of this study were twofold. First, we investigated how HRQoL and mental well-being developed one year after the first wave of the pandemic. Second, we explored the relation between socioeconomic- and health-related determinants as well as recent life events related to health, work, income and living situation and changes in HRQoL and mental well-being over the follow-up period.

Data and Methods

Study design and population

This study is part of the second wave of the POPulation health impact of the CORoNavirus disease 2019 (COVID-19) pandemic (POPCORN) study. In this longitudinal study, a web-based survey was administered to the participants at T1 (between April 22 and May 5, 2020)[31] and T2 (between May 3 to June 29 2021) in five countries: Greece, Italy, the Netherlands, the United Kingdom (UK) and the United States (US).

Data collection procedure and consent

The participants were recruited by an international market research agency (Dynata) that distributed and launched the questionnaire. A representative sample by age and sex in several countries were invited to participate in the first questionnaire at T1, and the respondents that completed the first questionnaire at T1 were invited to fill out the questionnaire again at T2. The participants were members of the market research agency's existing voluntary panels. As panel members, the participants had already provided written informed consent to participate in online surveys upon registration. Once participating, the data capture system did not allow for missing values. Participants received an incentive in the form of cash or points from the market research company upon completion of the survey. Data were anonymized.

The questionnaire was translated into the main official language of each country using translation software and subsequently translated back into English, except when validated

translated versions of the instruments were available. Bilingual native speakers verified the translations independently.

Primary outcome measures

The questionnaire included items on demographic and socioeconomic determinants, health-related and COVID-19-related determinants, the EQ-5D-5L and World Health Organisation-Five Well-being (WHO-5), and other instruments (see also [30]). We defined the change in HRQoL (measured by the EQ-5D-5L) and changes in mental well-being (measured by the WHO-5) as the primary outcomes in this study. Since these outcome measures provide numerical scores, the changes were calculated as the score difference between T2 and T1 (T2 minus T1) for each outcome measure, which can have a positive (improvement) or negative (deterioration) sign.

The EQ-5D-5L assesses five dimensions of HRQoL today[32]. The EQ-5D-5L consists of five dimensions: Mobility, Self-Care, Usual Activities, Pain/Discomfort, and Anxiety/Depression. The ordinal response options range from “No problems” (“1”) to “Extreme problems/Unable to (“5”). The EQ-5D-5L level sum score is the summary of the scores of each dimension that ranges from 5 (best) to 25 (worst). The EQ-5D-5L index is a weighted sum of the level scores using a value set (i.e. five dimension-specific weights), which reflects societal preferences for EQ-5D-5L health states for a country-specific population [33]. As value sets are country-specific, for comparative purposes we selected the US value set [34] to be used for all countries. The EQ-5D-5L US index ranges from below -0.573 (all dimensions at worst level 5) to 1 (“Full health”), where 0 reflects the threshold to states considered worse than dead. The EQ VAS, as part of the EQ-5D-5L instrument, is a self-rated visual analogue scale assessing the respondents’ health state today. It ranges from 0 (“The worst imaginable health state”) to 100 (“The best imaginable health state”).

The WHO-5 measures mental well-being in the past two weeks[35]. The WHO-5 consists of five items: “I have felt cheerful and in good spirits,” “I have felt calm and relaxed,” “I have felt active and rigorous,” “I woke up feeling fresh and rested,” and “my daily life has been filled with things that interest me”. The ordinal response options range from “all the time” (“5”) to “at no time” (“0”). The WHO-5 index is the summary of the scores of each item,

multiplied by 4, hence all items have the same weight. It ranges from 0 (“Worst imaginable mental well-being”) to 100 (“Best imaginable mental well-being”).

Respondent characteristics

Information was collected on age, sex, highest level of education, income, occupational status, chronic disease status, COVID-19 status, COVID-19 vaccination status, and living situation. The highest level of education achieved is categorized into three groups according to the International Standard Classification of Education (ISCED) 2011: ISCED 0-2 (“Low”), ISCED-3-4 (“Middle”), and ISCED5-8 (“High”). Two income variables were collected: monthly personal income (Greece) and annual household income (all other countries). Income was categorized into four groups: lower 20% (‘low’), middle 60% (‘middle’), higher 20% (‘high’), and prefer not to answer. Chronic disease status was measured by the presence of up to 11 chronic conditions (asthma or chronic bronchitis, heart disease, stroke, diabetes, arthritis, severe back complaints, arthrosis, cancer, memory problems, depression or anxiety disorder, and/or other problems). The number of chronic diseases was categorized into five groups: “Zero,” “One,” “Two,” “Three,” and “Four or more”.

Life events related to related to health, work, income and living situation

For the purpose of this study, changes in determinants were also included, namely changes in number of chronic conditions categorized, COVID-19 status, occupation status and living situation. These determinants were measured at both T1 and T2, and the changes were captured by recording the difference between T1 and T2 and then re-categorized into meaningful groups that were referred to as recent life event. Change in number of chronic conditions was categorized into three groups: “Decreased,” “Same,” and “Increased”. Change in COVID-19 status was categorized into three groups: “No (past) COVID-19 infection at T1 and T2,” “(past) COVID infection at T1,” and “(past) COVID infection between T1 and T2”. Change in occupation status was assessed only for those who were (self-)employed or unemployed at T1 and was categorized into four groups: “Gained job,” “Kept job,” “Lost job,” and “Remained unemployed”. Change in living situation was categorized into “Not living alone at T1 and T2,” “Living alone at T1 and not living alone at T2,” “Not living alone at T1 and living alone at T2,” and “Living alone at T1 and T2”. Change in household income in

the past year was assessed with a separate question with answering options “improved,” “remained the same,” “decreased,” and “don’t know”. COVID-19 vaccination was not yet approved and available at T1 data collection. Consequently, change in COVID-19 vaccination was categorized into two groups: “Received COVID-19 vaccine” and “Did not receive COVID-19 vaccine”.

Statistical analysis

Descriptive analyses were performed for sociodemographic data at baseline (T1). Kruskal-Wallis tests and chi-square tests, for numerical and categorical variables respectively, were used to test the difference in the distribution of complete vs. incomplete data-pairs in terms of sociodemographic characteristics.

For analysis, the EQ-5D-5L level sum score and EQ-5D-5L index were transformed on a 0–100 scale (with 0 as worse anchor) in order to be comparable with the EQ VAS and WHO-5 index. Formulas were:

Transformed EQ-5D-5L level sum score (tEQ-5D-5L level sum score) = [(EQ-5D-5L level sum score – 25) x -5];

Transformed EQ-5D-5L index score (tEQ-5D-5L index score) = (EQ-5D-5L index score x 100).

For HRQoL and mental well-being outcome changes, we used the computed difference score. For some analyses, we converted the T1-T2 change of all outcome measures into improved (score T1 < score T2), no change (score T1 = score T2), and deteriorated (score T1 > score T2). Outcome change was first graphically displayed by Sankey plots.

Univariate linear regression analysis was then applied with as *dependent* the difference scores of the tEQ-5D-5L level sum score, tEQ-5D-5L index, EQ VAS, WHO-5 index, and as *independents* all determinants separately.

Next, for each outcome measure, multivariate stepwise regression analyses models (using backwards elimination) were performed, including sex, age, level of education, occupational status, income, chronic disease status, COVID-19 status and living situation as potential explanatory variables. Backwards elimination was used until significant variables remained. Multivariable regression coefficient estimates (beta's) were reported in tables. The size of the EQ-5D-5L level sum score and index score were comparable due to having been transformed.

Differences in mean tEQ-5D-5L level sum score, tEQ-5D-5L index, EQ VAS and WHO-5 index by life event category were calculated and displayed in a table. We tested for differences in tEQ-5D-5L level sum score, tEQ-5D-5L index, EQ VAS and WHO-5 index by life event category with ANOVA and independent t-tests.

Statistical significance was determined by a $p < 0.05$.

All statistical analyses were carried out using R version 4.0.5 and SPSS version 25 for Windows (IBM SPSS Statistics, SPSS Inc., Chicago, IL).

Results

Study population

Out of the 16,683 respondents that completed the questionnaire at T1, 6,765 (response rate: 41%) completed the questionnaire at T2. The response rate ranged from 32% among the US respondents to 56% among Italian respondents. Table 1 shows the baseline characteristics at T1 and changes from T1 to T2 among the 6,765 respondents. At T1, the median (IQR) age of all respondents was 56(20). Slightly more than half of all respondents were female (52%), high-educated (55%) or without chronic conditions (57%). Comparison between complete data-pairs and incomplete data-pairs (T1 only) can be found in Appendix Table A1.

Changes in HRQoL and mental well-being between T1 and T2

Figures 1 and 2 depict the difference score in the EQ-5D-5L dimensions, EQ-5D-5L level sum score, EQ-5D-5L index, EQ VAS and WHO-5 index, for all respondents. Of all respondents, going from T1 to T2 65% to 91% reported the same EQ-5D-5L dimension scores (Figure 1). Change in scores was most prevalent in the Anxiety/Depression dimension, with 21% improving, and 14% deteriorating. About one third of respondents showed improved HRQoL scores at T2 (tEQ-5D-5L level sum score: 31% improved; tEQ-5D-5L index: 33% improved; and EQ VAS: 32% improved), whereas 29-41% deteriorated (tEQ-5D-5L level sum score: 29% deteriorated; tEQ-5D-5L index: 31% deteriorated; and EQ VAS: 39% deteriorated). Country-specific analysis showed HRQoL improvement to be most common in Greece (tEQ-5D-5L level sum score: 38% improved; tEQ-5D-5L index: 40% improved; and EQ VAS: 35%

improved), whereas deterioration was most prevalent in the UK (tEQ-5D-5L level sum score: 31% deteriorated; tEQ-5D-5L index: 34% deteriorated; and EQ VAS: 43% deteriorated). In terms of mental well-being, 44% improved, 16% showed no difference, while 41% reported deterioration. Improvement of WHO-5 index occurred most frequently in the United States (50%), whereas deterioration was most frequent among respondents residing in Greece (54%).

Determinants of change in HRQoL and mental well-being

Table 2 shows the univariate regression outcomes for the change in tEQ-5D-5L level sum score, tEQ-5D-5L index, EQ VAS and WHO-5 index. Negative coefficients represent a greater deterioration compared to the reference group. Compared to respondents with a high income, low income levels were associated with a greater deterioration in HRQoL measured with tEQ-5D-5L level sum score, tEQ-5D-5L index and EQ VAS. In addition, compared to respondents who lived with others, living alone was associated with a greater deterioration in HRQoL measured with the tEQ-5D-5L level sum score and tEQ-5D-5L index. By contrast, compared to their healthy counterparts, having one or more chronic diseases and (past) infection with COVID-19 at T1 were associated with a greater improvement in HRQoL measured with the tEQ-5D-5L level sum score and tEQ-5D-5L index.

Compared to respondents with a high education level, a low education level was associated with a greater deterioration in mental well-being, measured with the WHO-5. Being a student, having one or more chronic conditions and (past) COVID-19 infection at T1 were associated with a greater improvement in mental well-being, as measured with the WHO-5.

Table 3 shows the results of the multivariable analyses. After controlling for other factors, (past, early) COVID-19 infection at T1 was consistently associated with improved HRQoL, measured with the tEQ-5D-5L level sum score, tEQ-5D-5L index and EQ VAS, and improved mental well-being, measured with the WHO-5. Other factors that were independently associated with improved HRQoL were older age (tEQ-5D-5L level sum score) and having one or more chronic conditions (tEQ-5D-5L level sum score and tEQ-5D-5L index). Factors associated with greater deterioration of HRQoL were lower income level (tEQ-5D-5L level sum score and tEQ-5D-5L index) and living alone (tEQ-5D-5L index). Lower educational level was independently associated with deteriorated mental well-being.

Association between life events and change in HRQoL and mental well-being

Most respondents experienced no change in terms of number of chronic conditions (69%); 13% reported more chronic conditions at T2, 18% less. At T1, 98% of all respondents reported no (past) COVID-19, whereas at T2 this percentage decreased to 95%. At T2 the majority of the respondents (58%) reported being vaccinated.

With regards to household income, 67% of respondents experienced no changes (12% higher income at T2; 20% lower income at T2). Of the respondents who were (self-)employed at T1, 97% kept their job and 3% lost their job. Of those who were unemployed at T1, 66% remained unemployed and 34% gained employment.

The number of chronic conditions, and changes thereof, had the highest impact on all health outcomes (Table 4). Additionally, (past) COVID-19 infection at T2 (and not T1) and job loss resulted on average in the greatest deterioration measured with the EQ VAS and WHO-5. On average, the effect of negative recent life events on HRQoL and mental well-being was larger than the effect of positive recent life events (in absolute terms).

Discussion

Summary of main findings

The majority of the respondents reported the same EQ-5D-5L dimension scores at T1 and T2. Still, slightly more respondents showed improved rather than deteriorated HRQoL and mental well-being, with some variation by outcome measure and country. Respondents residing in the US experienced the most deterioration in HRQoL but the largest improvement in mental well-being, whereas the opposite was found for respondents residing in Greece. In addition, in this study positive recent life events related to health, income and work apparently were related to improved HRQoL and mental well-being, and the reverse. The effect of negative recent life events was, however, larger than the effect of positive recent life events (in absolute terms).

Interpretation

Our study highlights the importance of measuring HRQoL longitudinally during the pandemic. We found no difference to slight deterioration in HRQoL among most of the

respondents in different countries in our study. Many studies have suggested that HRQoL and mental well-being during the pandemic are persistently poorer than compared to pre-pandemic[29, 36-38]. Our study shows that the effects of the pandemic have persisted, even among those that are not COVID-19 infected[39, 40].

Our study found opposite patterns for mental well-being and HRQoL among respondents from different countries. Mental well-being deteriorated among respondents residing in Greece, the Netherlands and the UK, where, on average, HRQoL did not change; whereas mental well-being improved in Italy and the US, where no changes or deterioration of HRQoL were found. The opposing patterns of HRQoL and mental well-being over time could be due to differences in epidemiological profile of COVID-19 infections as well as stringency in government measures against the spread of COVID-19 that varied over time and across countries during the course of the pandemic [41, 42]. The impact of the COVID-19 infections and government measures on the physical domain may persist[43], while the impact on the mental domain may have eased slightly because of mental adaptation[44]. One study has found that exposure to major stressful events can lead to large short-term effects on mental health, but mental adaptation (resilience or recovery) to these major events often occurred gradually and mental health may even return to pre-event level[45]. This is also reflected by our results on Anxiety/Depression dimension of the EQ-5D-5L, which showed a similar pattern to mental well-being measured with the WHO-5.

Our study found significant relations between socioeconomic and health determinants and HRQoL and mental well-being changes. Moreover, we found that positive and negative recent life events related to health, income and work significantly impacted HRQoL and mental well-being changes, and the impact of negative recent life events were larger than the positive events. These findings are in line with other studies, which found negative recent life events to have both short-term and long-term impact on people's well-being[46], and the impact is often larger than positive life events[47]. In general, mechanisms of (positive or negative) adaptation, anticipation, and selection provide a buffer against the impact of life events on health outcomes, while the rate of these mechanisms varied considerably between different life events[47, 48]. However, while other studies have consistently reported on the relation between negative life events and ill health (physical and mental), contradictory findings have been reported regarding positive life events[49].

Factors such as self-esteem moderate the relation between positive life events and health outcomes[50]. Furthermore, our findings may suggest that interventions that prevent or limit negative life events and subsequently negative changes in HRQoL and mental well-being in the general population are most likely to be more effective than interventions that enhance positive life events or changes. However, people with few resources or marginalised due to their socioeconomic status are experiencing a greater negative impact of the pandemic and fewer positive recent life events[51]. In turn, these populations may become more vulnerable due to low overall health and smaller resultant improvements in HRQoL and mental well-being.

Reporting an increased number of chronic conditions during the pandemic yielded the most negative effect on HRQoL and mental well-being. During the pandemic, care for chronic conditions was often postponed, cancelled or neglected due to prioritising acute COVID patients[52]. Our results further found an association between receiving COVID-19 vaccine and improvements in mental well-being, consistent with other studies[53]. Nevertheless, with the possible long-term consequence of COVID-19, any chronic sequela of COVID-19 infection has the potential to impair HRQoL and mental well-being of the general population [54].

Strengths and limitations

This study is one of the first large multi-country longitudinal studies to assess HRQoL changes during the COVID-19 pandemic.

There are several limitations to the study. First, respondents that did not fill out the questionnaire at T2 were significantly younger and more often reported having chronic conditions. Previous studies have suggested these sub-groups had a higher risk of poorer health and especially Anxiety/Depression[55]. Therefore, we might have missed relevant groups that might have experienced larger changes in HRQoL and mental well-being.

Second, even though our sample at T1 was representative of the general population by age and sex, participants who were more highly educated were over-represented. This lack of representativeness might underestimate HRQoL and mental well-being changes, given that persons with lower levels of education have been noted to be more vulnerable to worse HRQoL and mental well-being during the pandemic[56]. Fourth, in different countries,

HRQoL and mental well-being changes may follow the pandemic trajectories with different COVID-19 incidence, restrictions and vaccination distributions. Therefore, only two measurements may only have partially captured the changes in HRQoL and mental well-being during the pandemic. Frequent estimations may offer a better image on pattern changes[57].

Conclusion

Our multi-country study on the course of HRQoL and mental well-being from the first wave of COVID-19 showed that slightly more respondents showed improved rather than deteriorated HRQoL and mental well-being, with some variation by outcome measure and country.

Collection of repeated HRQoL and mental well-being data among multi-country general population samples allows investigating HRQoL over time and cause-effect relationships between a wide range of possible determinants of health and HRQoL of the general population, both during and after the acute phase of COVID-19 pandemic.

Authors' contributions

All authors contributed to the conception and design of the study. JH, GB, EL and MJ designed the questionnaire and collected the data. Material preparation, analysis, and interpretation of data were performed by DL and JH. DL and JH wrote the first draft of the manuscript. All authors reviewed and critically revised the manuscript. All authors read and approved the final manuscript as submitted and agreed to be accountable for all aspects of the work.

Ethical approval

Ethical approval was obtained from the Erasmus MC ethics review board (approval MEC-2020-0266). Data were collected and processed anonymously. Written individual consent was obtained from all participants upon registration to the online survey panel of Dynata.

Conflict of interest

The authors declared that they have no conflict of interest.

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TABLES & FIGURES

Table 1. Characteristics of respondents at T1 (April-May 2020)

	Greece	Italy	Netherlands	UK	US	Total
Number of respondents at T2	511	1784	1143	1448	1879	6765
Response rate (T2/T1)	50%	56%	35%	45%	32%	35%
Baseline characteristics (T1)						
Age						
Median (IQR)	43.3 (12.5)	46.8 (13.7)	54.1 (13.9)	51.5 (14.2)	54.3 (13.0)	50.8 (14.2)
Mean (SD)	43(18)	45(21)	57(21)	53(24)	56(20)	51(23)
Age groups						
18-24 yrs.	43 (8%)	74 (4%)	40 (3%)	47 (3%)	25 (1%)	229 (3%)
25-34 yrs.	91 (18%)	296 (17%)	84 (7%)	171 (12%)	142 (8%)	784 (12%)
35-44 yrs.	135 (26%)	464 (26%)	172 (15%)	273 (19%)	287 (15%)	1331 (20%)
45-54 yrs.	128 (25%)	413 (23%)	227 (20%)	281 (19%)	425 (23%)	1474 (22%)
55-64 yrs.	88 (17%)	291 (16%)	295 (26%)	344 (24%)	498 (27%)	1516 (22%)
65-75 yrs.	26 (5%)	246 (14%)	325 (28%)	332 (23%)	502 (27%)	1431 (21%)
Sex						
Male	263 (51%)	859 (48%)	526 (46%)	709 (49%)	869 (46%)	3226 (48%)
Female	248 (49%)	925 (52%)	617 (54%)	739 (51%)	1010 (54%)	3539 (52%)
Education level						
High	343 (67%)	726 (41%)	464 (41%)	807 (56%)	1393 (74%)	3733 (55%)
Middle	153 (30%)	786 (44%)	351 (31%)	608 (42%)	434 (23%)	2332 (34%)
Low	15 (3%)	272 (15%)	328 (29%)	33 (2%)	52 (3%)	700 (10%)
Occupation status						
Employed	289 (57%)	1008 (57%)	552 (48%)	797 (55%)	976 (52%)	3622 (54%)

	Greece	Italy	Netherlands	UK	US	Total
Student	31 (6%)	77 (4%)	34 (3%)	17 (1%)	15 (1%)	174 (3%)
Unemployed	134 (26%)	415 (23%)	124 (11%)	160 (11%)	234 (12%)	1067 (16%)
Retired	52 (10%)	269 (15%)	305 (27%)	365 (25%)	559 (30%)	1550 (23%)
Unable to work	5 (1%)	15 (1%)	128 (11%)	109 (8%)	95 (5%)	352 (5%)
Income level						
High	177 (35%)	227 (13%)	215 (19%)	327 (23%)	490 (26%)	1448 (22%)
Middle	162 (32%)	998 (56%)	513 (45%)	616 (43%)	986 (52%)	1879 (28%)
Low	121 (24%)	369 (21%)	182 (16%)	383 (26%)	290 (15%)	1143 (17%)
Unwilling to tell	39 (8%)	190 (11%)	233 (20%)	122 (8%)	113 (6%)	1784 (27%)
Number of chronic conditions						
0	304 (59%)	1128 (63%)	545 (48%)	830 (57%)	1081 (58%)	3888 (57%)
1	153 (30%)	461 (26%)	369 (32%)	379 (26%)	508 (27%)	1870 (28%)
2	36 (7%)	118 (7%)	139 (12%)	152 (10%)	181 (10%)	626 (9%)
3	11 (2%)	41 (2%)	54 (5%)	57 (4%)	67 (4%)	230 (3%)
4 or more	7 (1%)	36 (2%)	36 (3%)	30 (2%)	42 (2%)	151 (2%)
COVID-19 status at T1						
Not infected	507 (99%)	1756 (98%)	1115 (98%)	1421 (98%)	1823 (97%)	6662 (98%)
Infected	4 (1%)	28 (2%)	28 (2%)	157 (2%)	56 (3%)	143 (2%)
Living situation						
Not living alone	437 (86%)	1615 (91%)	810 (71%)	1143 (79%)	1472 (78%)	5477 (81%)
Living alone	74 (14%)	169 (9%)	333 (29%)	305 (21%)	407 (22%)	1288 (19%)

Table 2. Univariate analyses of respondent characteristics and the change in EQ-5D-5L transformed level sum scores, EQ-5D-5L transformed index, EQ VAS and WHO-5 index

Characteristic	Change between T1 (April-May 2020) and T2 (May-June 2021)							
	tEQ-5D level sum score*		tEQ-5D index*		EQ VAS		WHO-5 index	
	Coeff.	P-value	Coeff.	P-value	Coeff.	P-value	Coeff.	P-value
Age group								
Intercept	0.1	0.89	0.5	0.64	-1.5	0.13	0.2	0.88
18-24 (ref)								
25-34	-0.1	0.93	-0.3	0.75	0.6	0.60	1.1	0.44
35-44	0.0	1.00	-0.5	0.64	-0.2	0.85	-1.0	0.46
45-54	0.1	0.94	-0.1	0.96	0.0	0.99	0.6	0.67
55-64	-0.2	0.82	-0.5	0.61	0.2	0.83	0.5	0.73
65-75	-0.4	0.55	-0.9	0.37	-0.1	0.89	0.4	0.77
Sex								
Intercept	-0.1	0.76	-0.1	0.72	-1.1	0.00	0.2	0.56
Male (ref)								
Female	0.0	0.88	0.2	0.64	-0.7	0.06	0.5	0.34
Education level								
Intercept	-0.1	0.50	-0.1	0.55	-1.5	0.00	1.0	<0.001

High (ref)								
Middle	0.2	0.56	0.3	0.45	0.4	0.24	-1.0	0.07
Low	0.2	0.62	0.3	0.59	-0.3	0.58	-2.0	0.01
Occupation status								
Intercept	0.1	0.58	0.2	0.47	-1.3	0.00	1.3	0.00
Employed (ref)								
Student	-0.3	0.68	-0.6	0.61	0.5	0.64	0.1	0.04
Unemployed	-0.2	0.49	-0.4	0.42	-0.4	0.47	0.0	0.45
Retired	-0.5	0.12	-0.7	0.10	-0.3	0.49	0.0	0.12
Unable to work	0.5	0.35	1.2	0.13	-0.1	0.94	0.0	0.72
Living situation								
Intercept	0.1	0.46	0.2	0.28	-1.3	0.00	1.2	0.00
Not living alone (ref)								
Living alone	-0.7	0.02	-1.2	0.01	-0.5	0.24	0.0	0.79
Income								
Intercept	0.4	0.07	0.5	0.12	-0.97	0.00	0.4	0.40
High (ref)								
Middle	-0.4	0.20	-0.4	0.35	-0.41	0.30	0.5	0.35
Low	-1.3	<0.001	-1.6	<0.001	-1.19	0.02	-0.8	0.25
Chronic disease status								
Intercept	-0.3	0.04	-0.5	0.04	-1.6	0.00	1.2	0.00
No chronic disease (ref)								
With chronic disease	0.7	0.01	1.1	<0.001	0.5	0.18	0.0	0.01
COVID-19 status								
Intercept	-0.10	0.41	-0.14	0.44	-1.42	0.00	0.33	0.17
Not infected at T1 (ref)								
Infected at T1	3.11	<0.001	6.23	<0.001	0.27	0.83	5.40	<0.001

Living situation								
Intercept	0.1	0.46	0.2	0.28	-1.3	0.00	1.2	0.00
Not living alone (ref)								
Living alone	-0.7	0.02	-1.2	0.01	-0.5	0.24	0.0	0.79

* Transformed scores

Table 3. Multivariate analyses of respondent characteristics and the change in EQ-5D-5L transformed level sum scores, EQ-5D-5L transformed index, EQ VAS and WHO-5 index

Characteristic	Change between T1 (April-May 2020) and T2 (May-June 2021)							
	tEQ-5D level sum score*		tEQ-5D index*		EQ VAS		WHO-5 index	
	Coeff.	P-value	Coeff.	P-value	Coeff.	P-value	Coeff.	P-value
Intercept	1.0	0.05	-0.01	0.97	0.3	0.173	0.9	0.01
Age	0.0	0.03						
Education level								
High (ref)								
Middle							-0.9	0.07
Low							-1.9	0.02
Income								
High (ref)								
Middle	-0.4	0.19	-0.3	0.44				
Low	-1.4	<0.001	-1.4	<0.001				
Chronic disease status								
No chronic disease (ref)								
With chronic disease	0.8	<0.001	1.2	0.001				
COVID-19 status								
Not infected at T1 (ref)								
Infected at T1	2.9	<0.001	6.1	<0.001	5.4	0.001	5.3	<0.001
Living situation								
Not living alone (ref)								
Living alone			-1.0	0.03				

F- value	8.1	<0.001	10.0	<0.01	10.5	0.001	5.9	<0.001
R-square	0.08		0.01		0.04		0.05	

* Transformed scores

Table 4. Mean change in health-related quality of life and mental well-being by life event

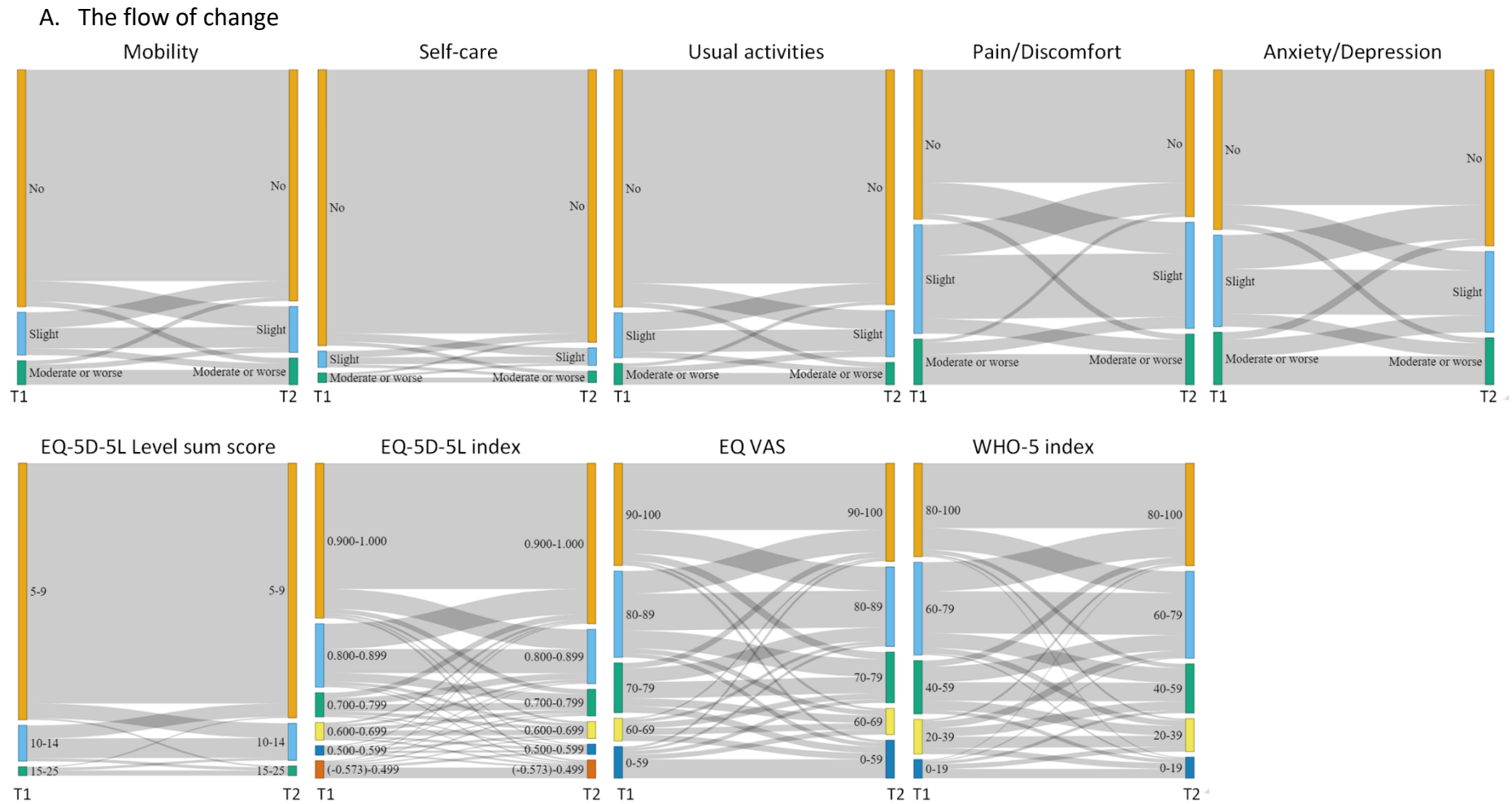
Life event	n	Mean change in scores between T1 and T2			
		tEQ-5D-5L level sum score	tEQ-5D-5L index	EQ VAS	WHO-5
Number of chronic disease(s)					
Decreased	1202	1.90	2.86	0.09	3.57
Same	4672	-0.003	0.02	-1.20	0.59
Increased	891	-2.81	-4.03	-4.53	-4.53
COVID-19 status					
No (past) COVID-19 infection at T1 and T2	6442	0.04	0.07	-1.33	0.52
(past) COVID-19 infection at T1	27	0.74	1.26	-4.44	-4.74

(past) COVID-19 infection between T1 and T2	296	-1.69	-1.93	-2.86	-0.72
Vaccination status					
Received vaccine at T2	3945	-0.17	-0.22	-1.58	1.36
Not received vaccine at T2	2820	0.16	0.28	-1.17	-0.83
Change in work status*					
Gained job	218	1.35	1.91	-0.21	2.44
Kept job	3361	0.30	0.42	-1.08	0.70
Lost job	116	-1.77	-1.12	-4.59	-3.10
Remained unemployed	422	-0.37	-0.71	-0.98	-0.59
Change in income in past year (T1-T2)					
Improved	782	-0.25	-0.41	-2.02	1.70
Remained the same	4564	0.16	0.27	-0.95	1.39
Worsened	1322	-0.60	-0.77	-2.61	-3.44
Don't know	97	0.31	0.39	-1.55	-1.40
Living situation					
Living with others at T1 and T2	5314	0.14	0.27	-1.30	0.68
Living alone at T1 and T2	1164	-0.52	-0.81	-1.69	-0.10
Living alone at T1 and with others at T2	124	-1.41	-2.28	-3.17	-1.81
Living with others at T1 and alone at T2	163	-1.17	-1.58	-1.53	-1.74

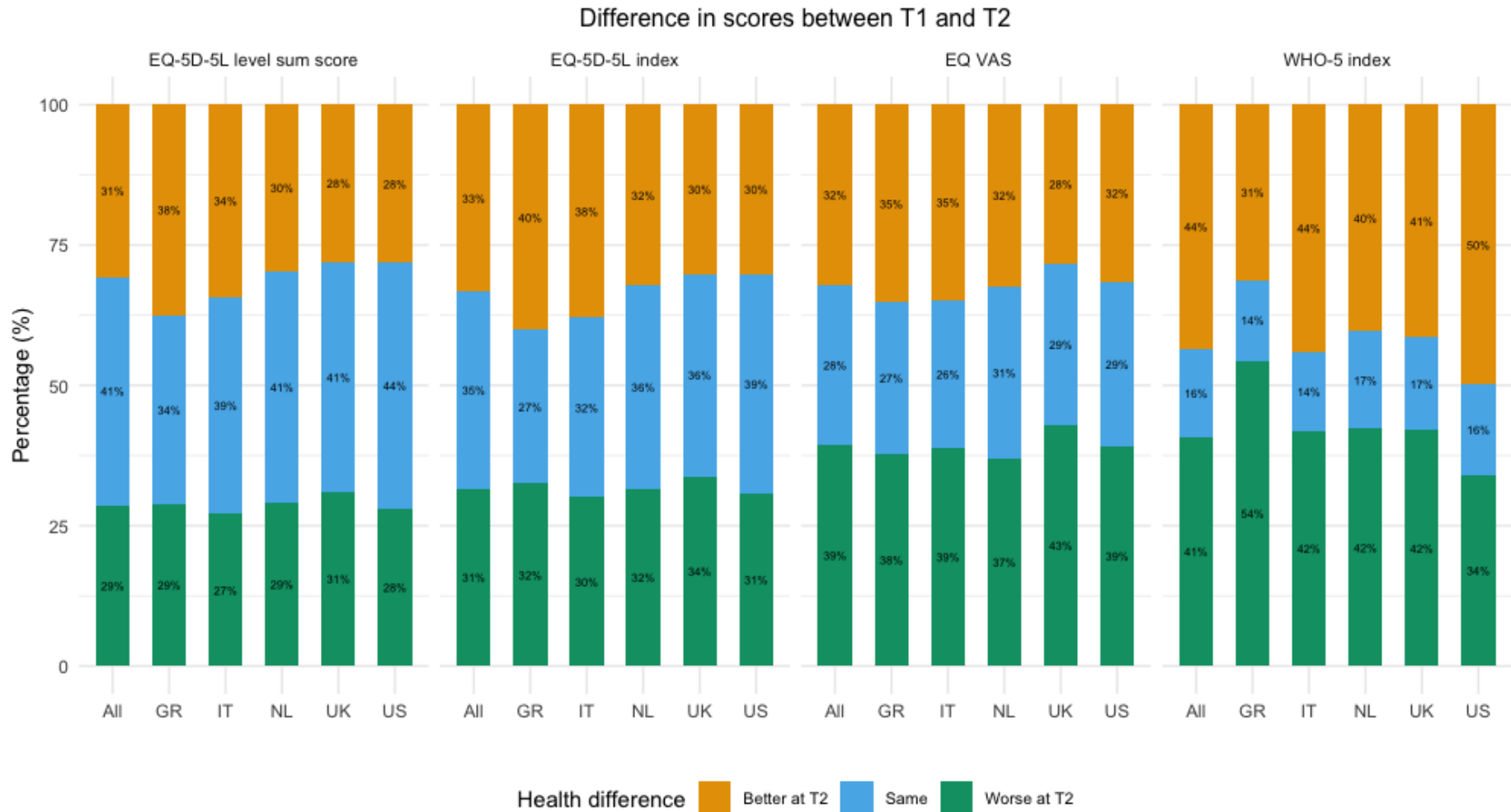
*Only those who were (self-)employed or unemployed at T1 and T2

Significant differences in mean EQ-5D-5L transformed level sum scores, EQ-5D-5L transformed index, EQ VAS and WHO-5 index are shown in **bold**.

Figure 1. Changes in EQ-5D-5L scores (dimensions, level sum score, index, and EQ VAS) and WHO-5 index between T2 and T1 in all countries (N=6,765)



B. Percentage changes



Note to figure 1-B: Same: score at T1 = score T2, better: better health at T2(T2 score >T1 if positive score), worse health at T2(T2 score <T1). “ALL”, “GR”, “IT”, “NL”, “UK”, “US” represents “All countries”, “Greece”, “Italy”, “The Netherlands”, “The UK”, and “The US”.

Appendix

Table A1 shows the characteristics of respondents who completed the questionnaire at T2 and T1. Overall, 16,683 completed the questionnaire at T1, and 6,765 (41%) of them completed the questionnaire at T2. Compared to completers at T1, completers at T2 were significant older, different in education level and occupation status, and have significantly less chronic conditions.

Table A1. Characteristics of respondents at T2 and T1.

	Greece		Italy		Netherlands		UK		US	
	T2 (N=511)	T1 (N=1022)	T2 (N=1784)	T1 (N=3212)	T2 (N=1143)	T1 (N=3296)	T2 (N=1448)	T1 (N=3234)	T2 (N=1879)	T1 (N=5919)
Response rate	50%		56%		35%		45%		32%	
Age	<0.001		<0.001		<0.001		<0.001		<0.001	
Median (IQR)	44 (18)	40 (20)	46 (21)	43 (22)	58(21)	49 (29)	54 (24)	44 (27)	57 (20)	47 (27)
Mean (SD)	44.1 (12.6)	40.4 (13.2)	47.6 (13.8)	44.0 (14.2)	55.0 (14.0)	47.8 (16.6)	52.5 (14.2)	45.5 (15.9)	55.2 (13.1)	46.9 (15.8)
Sex	0.083		0.568		0.310		0.909		0.019	
Male	264 (52%)	480 (47%)	858 (48%)	1537 (48%)	526 (46%)	1587 (48%)	709 (49%)	1558 (48%)	869 (46%)	2613 (44%)
Female	247 (48%)	542 (53%)	926 (52%)	1673 (52%)	617 (54%)	1706 (52%)	739 (51%)	1672 (52%)	1010 (54%)	3283 (55%)
Education level	0.076		0.468		0.037		0.002		0.019	
High	343 (67%)	626 (61%)	726 (41%)	1334 (42%)	464 (41%)	1463 (44%)	807 (56%)	1976 (61%)	1393 (74%)	4079 (69%)
Middle	153 (30%)	357 (35%)	786 (44%)	1429 (44%)	351 (31%)	1001 (30%)	608 (42%)	1182 (37%)	434 (23%)	1510 (26%)
Low	15 (3%)	39 (4%)	272 (15%)	449 (14%)	328 (29%)	832 (25%)	33 (2%)	76 (2%)	52 (3%)	330 (6%)
Occupation status	<0.001		<0.001		<0.001		<0.001		<0.001	
Employed	324 (63%)	551 (54%)	1047 (59%)	1849 (58%)	550 (48%)	1684 (51%)	799 (55%)	1934 (60%)	1025 (55%)	3134 (53%)
Student	19 (4%)	93 (9%)	55 (3%)	223 (7%)	29 (3%)	248 (8%)	16 (1%)	100 (3%)	12 (1%)	186 (3%)
Unemployed	106 (21%)	279 (27%)	386 (22%)	727 (23%)	102 (9%)	379 (11%)	156 (11%)	396 (12%)	174 (9%)	979 (17%)
Retired	59 (12%)	82 (8%)	282 (16%)	385 (12%)	337 (29%)	651 (20%)	382 (26%)	575 (18%)	580 (31%)	1193 (20%)
Unable to work	3 (1%)	17 (2%)	14 (1%)	28 (1%)	125 (11%)	334 (10%)	95 (7%)	229 (7%)	88 (5%)	427 (7%)
Chronic conditions	<0.001		<0.001		<0.001		<0.001		<0.001	
None	328 (64%)	608 (59%)	1176 (66%)	1984 (62%)	607 (53%)	1641 (50%)	888 (61%)	1830 (57%)	1230 (65%)	3099 (52%)
One	115 (23%)	317 (31%)	369 (21%)	858 (27%)	301 (26%)	1026 (31%)	319 (22%)	883 (27%)	414 (22%)	1756 (30%)
Two or more	68 (13%)	97 (9%)	239 (13%)	370 (12%)	235 (21%)	629 (19%)	241 (17%)	521 (16%)	235 (13%)	1064 (18%)

	Greece		Italy		Netherlands		UK		US	
	T2 (N=511)	T1 (N=1022)	T2 (N=1784)	T1 (N=3212)	T2 (N=1143)	T1 (N=3296)	T2 (N=1448)	T1 (N=3234)	T2 (N=1879)	T1 (N=5919)
COVID-19 status	<0.001		<0.001		0.009		<0.001		<0.001	
Not infected	461 (90%)	957 (94%)	1565 (88%)	2880 (90%)	998 (87%)	2837 (86%)	1278 (88%)	2747 (85%)	1669 (89%)	4869 (82%)
Likely infected	28 (5%)	63 (6%)	115 (6%)	316 (10%)	77 (7%)	420 (13%)	112 (8%)	446 (14%)	113 (6%)	873 (15%)
Infected	22 (4%)	2 (0%)	104 (6%)	16 (0%)	68 (6%)	39 (1%)	58 (4%)	41 (1%)	97 (5%)	177 (3%)
Living situation	0.600		0.025		<0.001		0.015		<0.001	
Living with others	429 (84%)	859 (84%)	1585 (89%)	2826 (88%)	801 (70%)	2371 (72%)	1113 (77%)	2519 (78%)	1435 (76%)	4345 (73%)
Living alone	75 (15%)	142 (14%)	184 (10%)	328 (10%)	339 (30%)	871 (26%)	317 (22%)	639 (20%)	412 (22%)	1328 (22%)
Other	7 (1%)	21 (2%)	15 (1%)	58 (2%)	3 (0%)	54 (2%)	18 (1%)	76 (2%)	32 (2%)	246 (4%)
Experience on access to healthcare	0.533		<0.001		<0.001		<0.001		<0.001	
Always good	163 (32%)	322 (32%)	571 (32%)	958 (30%)	623 (54%)	1266 (38%)	513 (35%)	1088 (34%)	1007 (54%)	2944 (50%)
Usually good	208 (41%)	382 (37%)	709 (40%)	1457 (45%)	374 (33%)	1502 (46%)	531 (37%)	1264 (39%)	629 (33%)	2027 (34%)
Sometimes good	86 (17%)	203 (20%)	358 (20%)	625 (19%)	103 (9%)	414 (13%)	265 (18%)	670 (21%)	202 (11%)	753 (13%)
Usually not good	38 (7%)	85 (8%)	114 (6%)	135 (4%)	23 (2%)	95 (3%)	93 (6%)	164 (5%)	17 (1%)	138 (2%)
Never good	16 (3%)	30 (3%)	32 (2%)	37 (1%)	20 (2%)	19 (1%)	46 (3%)	48 (1%)	24 (1%)	57 (1%)

Note to table 1. Kruskal-Wallis tests and Chi-square tests, for numerical and categorical variables respectively, were used to test the difference in the distribution of completers between T1 at T2 in terms of sociodemographic characteristics. P values are showed on top of each distribution with significant p values marked bold and italic.