# Cohort Profile

*COVIDMENT: COVID-19 cohorts on mental health across six nations*

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# Cohort Profile: COVIDMENT: COVID-19 cohorts on mental health across six nations

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**Key Features**

- COVIDMENT [www.covidment.is] is a NordForsk-funded research collaboration across six nations, with the overarching aim to significantly advance current knowledge on mental morbidity trajectories associated with the coronavirus disease 2019 (COVID-19) in the general population and in specific risk groups.
- From March 2020 through August 2021, 392 817 individuals have been recruited to the seven COVIDMENT cohorts: the Danish Blood Donor Study ($N = 71\,562$), the Estonian Biobank COVID-19 and Mental Health Data Collection cohorts ($N = 13\,329$ and $N = 86\,116$, respectively), the Icelandic COVID-19 National Resilience Cohort ($N = 22\,849$), the Norwegian BRY.DEG2020 ($N = 19\,343$), the Norwegian Mother, Father and Child Cohort Study ($N = 132\,486$), the Scottish Generation Scotland/CovidLife ($N = 18\,518$) and the Swedish Omtanke2020 ($N = 28\,614$). Semi-harmonized questionnaire data have been collected across all COVIDMENT cohorts with longitudinal data available, e.g. through linkage to the national registers.
- The average age of participants ranged from 31.8 to 58.5 years across cohorts. The prevalence of depressive symptoms above cut-off point varied considerably across cohorts (4.2–20.8%). The prevalence of depressive symptoms was highest at COVID-19 incidence of 30 cases per week per 100 000 persons, i.e. 14.3% [95% confidence interval (CI): 9.4–21.8%], which was 61.0% (95% CI: 34.0–94.1%) higher than the prevalence at COVID-19 incidence of 0 cases per week per 100 000 persons ($P = 1.1$ x 10 ^(−6)).
- We welcome proposals for collaboration; please visit our website [www.covidment.is] for further information.

## Why were the cohorts set up?

With more than 218 million cases and 4.5 million deaths worldwide (Worldometers, 31 August 2021), the COVID-19 pandemic has had an unprecedented influence on the global economy and population health. As a potent global disaster, it is likely to significantly affect the incidence of adverse mental health symptoms and psychiatric disorders, particularly in vulnerable and highly affected populations. The World Health Organization and leading scientific journals have alerted concerning the potential adverse mental health impact

of COVID-19 and emphasized the need for multinational research in this area,[1,2] which additionally provides new insights into disease mechanisms.[2]

Although a substantial number of studies on the mental health effects of COVID-19 has been published, the existing literature is largely limited by relatively small studies of convenience samples without pre-pandemic data, longitudinal data or cross-national comparisons.[3,4] Some,[5,6] but not all[7,8] studies have reported evidence for a negative impact on mental health in the general adult population, including a rise in prevalence of symptoms of anxiety[9] and depression[10,11] during the COVID-19 pandemic. Previous history of psychiatric problems,[12] higher age[13] and female sex[14] have been suggested as risk factors for mental health problems during the COVID-19 pandemic, although the weight of these factors is bound to vary over time and geographical areas and largely depends on the severity of outbreaks. Furthermore, COVID-19-mandated restrictions, such as quarantine measures, complete or partial lockdown and isolation, have been associated with deterioration in mental health[15–17] and so has dissatisfaction with governmental pandemic mitigations.[18]

The severity of the pandemic and mitigating strategies has varied considerably across countries. For example, as of 31 August 2021, the cumulative number of deaths due to COVID-19 stands at 1940 per one million inhabitants in the UK, 1440 in Sweden, 973 in Estonia, 444 in Denmark, 149 in Norway and 96 in Iceland (Worldometers, 2021). The variation in national pandemic response efforts and actual disease burden have implications for the proportion of citizens with first-hand exposure to COVID-19. Furthermore, mitigation responses may also affect health behaviours, social interactions, sense of security and trust in authorities, with potential downstream impact on population mental health. A key objective of the COVIDMENT initiative is to investigate whether differences in disease burden and mitigating responses to COVID-19 across countries (displayed in Figure 1) impact on psychiatric symptoms and disorders.

Due to the relatively narrow time window since the start of the pandemic, the long-term mental health consequences in exposed populations during the COVID-19 pandemic (i.e. patients, loved ones and front-line workers), as well as among those suffering unemployment or income losses, have not yet been sufficiently explored. Although research is still limited to small studies with short follow-up period, high prevalence of post-traumatic stress disorder (PTSD)[19,20] and other mental health symptoms,[21] along with elevated rates of diagnosed psychiatric disorders, have been observed during the first weeks after hospital discharge of COVID-19 inpatients.[22] For how long such adverse mental health effects remain after recovery from COVID-19 is yet to be investigated. Moreover, considerable mental health impact has been noted among family members of COVID-19 patients,[3] with as yet unknown long-term consequences. Taken together, well-designed studies with long-term follow-up of COVID-19 patients, their loved ones and other high-risk groups are imperative for a comprehensive understanding of the mental health impact of the pandemic.[1]

Based on the extensive research experience and existing infrastructures within the CoMorMent collaboration (an ongoing Horizon2020 programme on psychiatric and cardiometabolic comorbidities), we set out to establish new cohorts focusing on mental health indicators across six European nations during the pandemic. Funded by NordForsk (project No. 105668), the overarching aim of the COVIDMENT collaboration is to significantly advance current knowledge of long-term mental morbidity trajectories in the COVID-19 pandemic, both in the general population and in the specific risk groups.

## Who is in the cohorts?

A total of 392 817 individuals have now been recruited to the cohorts and the timeline of each data collection is shown in Figure 1. Background characteristics of all cohorts with currently available data for analysis ($N$ = 389 925) are shown in Table 1 and the main sociodemographic characteristics of responders compared with the total population of each nation are shown in Supplementary Table S1, available as Supplementary data at *IJE* online. The design and recruitment process of each cohort are described below.

### The Danish Blood Donor Study (DBDS)

DBDS is an ongoing national cohort study currently comprising about 120 000 blood donors[23] with about 95% participation rate among invited blood donors.[24] All participants answer a health-related questionnaire and provide a blood sample for research purposes. Prospective assessment of long-term health changes related to COVID-19 has been obtained thrice through the governmental, personal, password-protected e-mail-system e-boks.[25] The first wave of the COVID-19 questionnaire was sent out in May 2020 (participation rate 63.5%), the second was sent out in October 2020 (participation rate 63.7%) and the third was sent ultimo May 2021 and is still ongoing (medio August 2021). A total of 71 562 participants have answered at least one of the COVID-19 questionnaires, and among active DBDS blood donors, approximately 87 700 had been tested for SARS-CoV-2 antibodies by April 2021.

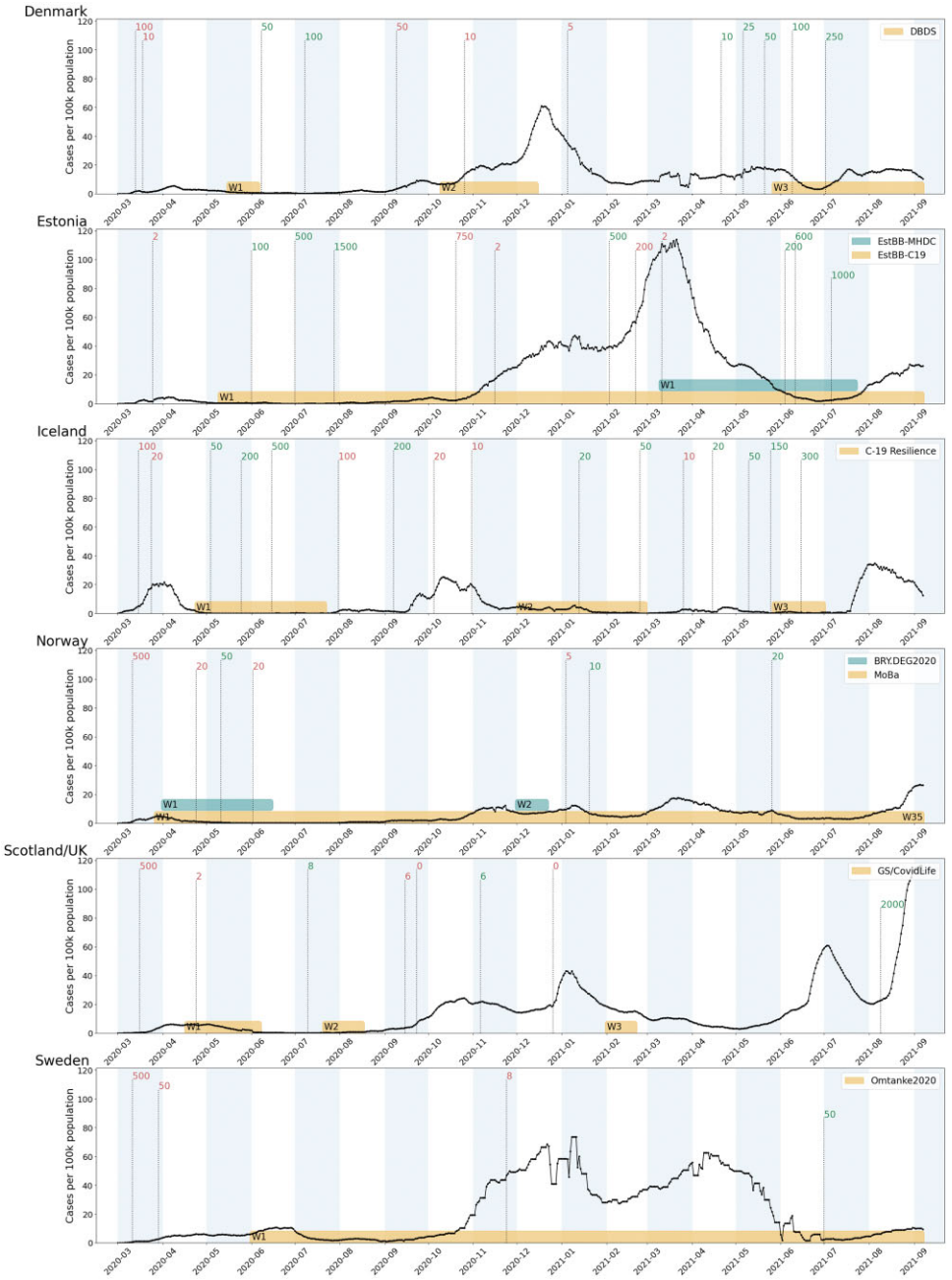


**Figure 1** Daily COVID-19 cases per 100 000 persons, changes in social gathering restrictions (green means looser restrictions and red means stricter, according to Oxford COVID-19 Government Response Tracker) and timeline of waves (W) of data collections in each cohort

Participants lost to follow-up were slightly younger and less educated compared with those who remained in the cohort. Compared with the Danish national population above 18 years of age, the DBDS slightly over-sampled men, individuals of higher age (70+ years) and highly educated individuals. Written informed consents were collected from all participants. The study was funded by the Danish regions and the Independent Research Fund Denmark (0214-00127B).

## The Estonian Biobank (EstBB) cohorts (EstBB-C19 and EstBB-MHDC)

EstBB is a population-based cohort ($N$ = 200 000) with genotype and a rich variety of phenotypic and health-related information.[26] At recruitment, participants signed a broad consent form allowing follow-up linkage of their electronic health records (EHR) and contact for future studies, thereby providing a longitudinal collection of their phenotypic information. A COVID-19-related data

**Table 1** Sociodemographic characteristics of the COVIDMENT cohorts

| | Denmark (DBDS) ($N$ = 68 973) | Estonia (EstBB-C19) ($N$ = 13 329) | Estonia (EstBB-MHDC) ($N$ = 86 116) | Iceland (C19-Resilience) ($N$ = 22 849) | Norway (BRY.DEG2020) ($N$ = 19 343) | Norway (MoBa)[b] ($N$ = 132 486) | Scotland/UK (GS/CovidLife) ($N$ = 18 518) | Sweden (Omtanke2020) ($N$ = 28 311) |
|---|---|---|---|---|---|---|---|---|
| Gender | | | | | | | | |
| Male | 34 999 (50.7%) | 4061 (30.5%) | 25 278 (29.4%) | 6872 (30.1%) | 4640 (24.0%) | 56 934 (42.3%) | 6014 (32.5%) | 5234 (18.5%) |
| Female | 33 974 (49.3%) | 9268 (69.5%) | 60 838 (70.7%) | 15 933 (69.7%) | 14 584 (75.4%) | 75 552 (57.7%) | 12 375 (66.8%) | 23 077 (81.5%) |
| Other | – | – | – | 44 (0.2%) | 119 (0.6%) | – | – | 0 (0.0%) |
| Missing | 0 (0.0%) | 0 (0.0%) | 0 (0.0%) | 0 (0.0%) | 0 (0.0%) | 0 (0.0%) | 129 (0.7%) | 0 (0.0%) |
| Age (years) | | | | | | | | |
| Mean age (SD) | 58.5 (17.0) | 44.1 (13.4) | 48.4 (14.6) | 54.4 (14.3) | 31.8 (12.8) | 46.7 (5.5) | 56.4 (14.3) | 48.6 (15.8) |
| 18–29 | 5547 (8.0%) | 1778 (13.3%) | 8897 (10.3%) | 1472 (6.4%) | 11 716 (60.6%) | – | 986 (5.3%) | 3940 (13.9%) |
| 30–39 | 6878 (10.0%) | 3779 (28.4%) | 17 863 (20.7%) | 2238 (9.8%) | 2861 (14.8%) | 11 193 (8.5%) | 1798 (9.7%) | 5218 (18.4%) |
| 40–49 | 9265 (13.4%) | 3329 (25.0%) | 19 412 (22.5%) | 4043 (17.7%) | 2315 (12.0%) | 83 164 (62.8%) | 2567 (13.9%) | 5411 (19.1%) |
| 50–59 | 11 303 (16.4%) | 2518 (18.9%) | 18 968 (22.0%) | 5871 (25.7%) | 1609 (8.3%) | 36 195 (27.3%) | 4055 (21.9%) | 6043 (21.4%) |
| 60–69 | 8656 (12.5%) | 1379 (10.4%) | 13 505 (15.7%) | 5890 (25.8%) | 656 (3.4%) | 1801 (1.4%) | 5526 (29.8%) | 4462 (15.8%) |
| 70+ | 27 324 (39.6%) | 546 (4.1%) | 7471 (8.7%) | 3334 (14.6%) | 186 (1.0%) | 98 (0.0%) | 3376 (18.2%) | 3237 (11.4%) |
| Missing | – | – | – | – | – | 35 (0.0%) | 210 (1.1%) | – |
| Education | | | | | | | | |
| Compulsory | 3956 (5.7%) | 277 (2.1%) | 3057 (3.6%) | 3305 (14.5%) | 91 (0.5%) | 3536 (2.7%) | 1538 (8.3%) | [d] |
| Upper secondary, Vocational, or other[c] | 2252 (3.3%)[*] | 5101 (38.3%) | 34 475 (40.0%) | 7080 (31.0%) | 3194 (16.5%) | 43 137 (32.6%) | 6153 (33.2%) | |
| Bachelor's/diploma university degree | 47 056 (68.2%) | 3638 (27.3%) | 20 816 (24.2%) | 7161 (31.3%) | 7468 (38.6%) | 43 426 (32.8%) | 4204 (22.7%) | |
| Master's or PhD | 14 502 (21.0%) | 4155 (31.2%) | 27 125 (31.5%) | 5148 (22.5%) | 3739 (19.3%) | 29 358 (22.2%) | 4526 (24.4%) | |
| No formal education | 818 (1.2%) | – | 185 (0.2%) | – | – | – | 385 (2.1%) | |
| Missing | 389 (0.6%) | 158 (1.2%) | 458 (0.5%) | 155 (0.7%) | 4510 (25.1%) | 13 029 (9.8%) | 1712 (9.2%) | |
| Marital status | | | | | | | | |
| In a relationship | 41 721 (60.5%) | – | 62 546 (72.6%) | 17 455 (76.4%) | 8690 (43.3%) | – | 13 962 (75.4%) | 20 500 (72.4%) |
| Single | 26 554 (38.5%) | | 22 960 (26.7%) | 5292 (23.2%) | 10 974 (56.7%) | | 4185 (22.6%) | 7664 (27.1%) |
| Missing | 698 (1.0%) | | 610 (0.7%) | 102 (0.4%) | 0 (0.0%) | | 371 (2.0%) | 147 (0.5%) |
| Body mass index (BMI, kg/m$^2$) | | | | | | | | |
| <25, normal weight | 30 681 (44.4%) | 5840 (43.8%) | 38 147 (44.3%) | 6601 (28.9%) | – | 34 910 (43.5%) | 7190 (38.8%) | 14 467 (51.1%) |
| 25–30, overweight | 26 599 (38.6%) | 4002 (30.0%) | 27 586 (32.0%) | 8797 (38.5%) | | 30 300 (37.7%) | 6296 (34.0%) | 8169 (28.9%) |
| >30, obese | 10 985 (15.9%) | 2531 (19.0%) | 18 139 (21.1%) | 6881 (30.1%) | | 13 876 (17.3%) | 4644 (25.1%) | 3707 (13.1%) |
| Missing | 708 (1.0%) | 956 (7.2%) | 2244 (2.6%) | 570 (2.5%) | | 1188 (1.5%) | 388 (2.1%) | 1968 (6.9%) |

(Continued)

**Table 1** Continued

| | Denmark (DBDS) ($N$ = 68 973) | Estonia (EstBB-C19) ($N$ = 13 329) | Estonia (EstBB-MHDC) ($N$ = 86 116) | Iceland (C19-Resilience) ($N$ = 22 849) | Norway (BRY.DEG2020) ($N$ = 19 343) | Norway (MoBa)[b] ($N$ = 132 486) | Scotland/UK (GS/CovidLife) ($N$ = 18 518) | Sweden (Omtanke2020) ($N$ = 28 311) |
|---|---|---|---|---|---|---|---|---|
| Current smoking | | | | | | | | |
| No | 62 345 (90.4%) | 10 944 (82.1%) | 63 877 (74.2%) | 19 900 (87.1%) | 15 643 (80.9%) | 84 523 (63.8%) | 16 413 (88.6%) | 22 824 (80.6%) |
| Yes | 6549 (9.5%) | 1787 (13.4%) | 19 049 (22.1%) | 2808 (12.3%) | 3700 (19.1%) | 8383 (6.3%) | 1317 (7.1%) | 4662 (16.5%) |
| Missing | 79 (0.1%) | 598 (4.5%) | | 141 (0.6%) | – | 39 580 (29.9%) | 788 (4.3%) | 825 (2.9%) |
| Somatic diseases[a] | | | | | | | | |
| None | 15 452 (22.4%) | 7469 (56.0%) | [d] | 13 359 (58.5%) | – | 94 375 (71.2.%) | 11 231 (60.6%) | 18 726 (66.1%) |
| One | 15 786 (22.9%) | 3914 (29.4%) | | 6577 (28.8%) | | 17 671 (13.3%) | 5076 (27.4%) | 6500 (23.0%) |
| Two | 10 046 (14.6%) | 1004 (7.5%) | | 2112 (9.2%) | | 2141 (1.6%) | 1501 (8.1%) | 1731 (6.1%) |
| >Two | 7716 (11.2%) | 410 (3.1%) | | 650 (2.8%) | | 302 (0.2%) | 425 (2.3%) | 604 (2.1%) |
| Missing | 19 973 (29.0%) | 532 (4.0%) | | 151 (0.7%) | | 17 997 (13.6%) | 285 (1.5%) | 750 (2.6%) |
| COVID-19 diagnosis | | | | | | | | |
| No | 49 460 (71.7%) | 9863 (74.0%) | [d] | 21 916 (95.9%) | 16 625 (86.0%) | 130 889 (98.8%) | 15 109 (88.9%) | 11 887 (42.0%) |
| Yes | 3000 (4.3%) | 3356 (25.2%) | | 933 (4.1%) | 2671 (13.8%) | 1597 (1.2%) | 1706 (10.1%) | 2387 (8.4%) |
| Missing | 16 513 (24.0%) | 110 (0.8%) | | 0 (0.0%) | 47 (2.4%) | 0 (0.0%) | 182 (1.1%) | 14 037 (49.6%)[c] |

Missing means not tested in Sweden.

SD, standard deviation.

[a]Somatic diseases include hypertension, heart disease, lung disease, chronic renal failure, cancer, diabetes or immune suppression/immunosuppressive therapy.

[b]Amount of missing in MoBa data also reflects MoBa Corona data collections with varying response rate.

[c]Vocational school was in the same category as Bachelor's/diploma university degree for Danish cohort.

[d]Will be obtained from registers.

collection (EstBB-C19) was established in May 2020 when invitations to fill in web-based questionnaires, including questions on COVID-19 symptoms and associated risk factors as well as mental health assessments, were sent out to EstBB participants who had been tested for SARS-CoV-2 with a reverse transcription polymerase chain reaction (RT-PCR) test, based on EHR updates. Personal invitations were sent out between May and December 2020, and thereafter the questionnaire was available to the full EstBB cohort upon login to the online participant survey environment. Currently, 13 329 individuals have responded (participation rate 12.4%). A more comprehensive mental health questionnaire-based data collection (EstBB-MHDC, $N = 86\,116$ responders) was carried out in the full EstBB cohort from March to July 2021 and is currently in preparation for analysis (participation rate 46.7%). A total of 184 622 invitations were sent out by e-mail to all living EstBB participants with a valid e-mail address and the recruitment was accompanied by a media campaign to increase participation rate. The EstBB C19 and MHDC cohorts over-represent women, individuals between 30 and 59 years of age and those with higher education, when compared with the general population of Estonia. The research in the Estonian Biobank was supported by the European Union through the European Regional Development Fund (project no. 2014-2020.4.01.15-0012), and the Estonian Research Council through grant no. PSG615, the programme Mobilitas Pluss (MOBTP142), funding of Estonian sub-project of NordForsk project no. 105668, and National Programme for Addressing Socio-Economic Challenges through R&D (RITA), supported by the Estonian Government and European Regional Development Fund (RITA1/02-112).

## The Icelandic COVID-19 national resilience cohort (C-19 Resilience)

C-19 Resilience was established in April 2020, with the overarching aim of understanding the long-term public health impact of the COVID-19 pandemic in Iceland. Eligible for participation were all Icelandic and English-speaking individuals 18 years or older who had an Icelandic electronic ID (as of 1 January 2020, the total adult population was 282 770). Recruitment was obtained via social media and invitations were sent to participants in ongoing cohort studies in Iceland [the SAGA cohort ($N = 31\,795$ women), iStopMM ($N = 80\,730$ men and women) and Health and Well-being of Icelanders ($N = 6102$ men and women)]. In addition, all individuals in Iceland who tested positive for SARS-CoV-2 by RT-PCR in Iceland through 2020 received an invitation in June 2020 and February 2021 ($N = 4262$; response rate 21.8%). All participants signed an electronic informed consent and subsequently answered a web-based questionnaire. To August 2021, two waves of follow-ups have been completed with 24 917 providing informed consent (8.8% of the total population); 22 849 of these participants have complete data, of whom 15 832 (63.5%) have provided data at more than one time point). Participants lost to follow-up are slightly younger (mean age 52.3 years vs 55.1 years) but only minor differences were found for sex and education. The C-19 Resilience cohort is over-represented by women and participants are on average of higher age and education compared with the general population. The study was originally supported with funds from the Icelandic government.

## The Norwegian BRY.DEG2020

BRY.DEG2020 (TAKE.CARE2020) is a longitudinal survey study established in March 2020 at the University of Bergen and Haukeland University Hospital, with the overarching aim to monitor the effect of the pandemic and its restrictions on mental health, using self-report data. Participants were recruited via social media and e-mail lists for universities across Norway and from patient organizations. Participants aged 18 years and older signed an informed consent before answering the survey. The first study wave was sent out in April 2020 ($N = 19\,343$, of whom 13 500 agreed to be recontacted), the second in December 2020 ($N = 6320$) and the third is planned in October 2022.[27] Compared with the general Norwegian population, women and young individuals with higher education are ove-rrepresented in BRY.DEG2020. The group lost to follow-up differed from those remaining by having a lower age (mean age 30.6 vs 34.7 years), more men, more students and fewer with a completed bachelor's degree. The project was funded by the University of Bergen and Helse Bergen.

## The Norwegian Mother, Father and Child Cohort study (MoBa)

MoBa is a population-based pregnancy cohort study conducted by the Norwegian Institute of Public Health.[28] Pregnant women attending a routine ultrasound examination were invited and recruited from all over Norway in 1999–2008. The participation rate is 41%. During the pregnancy and with regular follow-up questionnaires, participants (mothers, fathers and children) have completed extensive questionnaires on lifestyle, health and well-being. The cohort now includes 114 500 children (aged 12–22 years), 95 200 mothers and 75 200 fathers. Since March 2020, all adult MoBa participants have been invited to complete short bi-weekly COVID-19 surveys,

with some repeated questions. As of August 2021, 35 waves of data collection have been completed, including responses from more than 132 486 adults (participation rate ranging from 46% to 83%). Like in other pregnancy cohorts, MoBa participants have healthier lifestyle and higher socioeconomic position than the general population. Younger women, smokers and women with low educational level were less likely to participate.[29] MoBa is supported by the Norwegian Ministry of Health and Care Services and the Ministry of Education and Research. MoBa researchers and the COVID-19 data collection in MoBa are supported by the Research Council of Norway (223 273, 273 291, 312 721, 324 620).

### The Scottish Generation Scotland study

The Scottish Generation Scotland study (GS)[30] is a population- and family-based cohort with broad consent for genetic, health, well-being and lifestyle studies. The main recruitment (24 096 individuals in 5501 family groups) took place during 2006–11. In 2020, a series of CovidLife surveys[31] were conducted to measure mental health during the COVID-19 pandemic. Survey invitations were sent to 22 796 members of GS who provided an e-mail address for recontact, as well as to other adults in the UK through collaborators and social media channels. The first wave ran from April 2020 [$N$ = 18 518, of whom 16 995 resided in Scotland, 1395 elsewhere in the UK and 4847 were GS participants (21.3% of those invited)], the second from July 2020 ($N$ = 11 319) and the third from February 2021 ($N$ = 10 386). Women, participants aged over 50 and those with higher qualifications were over-represented in the CovidLife sample compared with the Scottish population. Except for age, demographics (e.g. sex and education) remained largely consistent with those reported at baseline, suggesting minimal effects of attrition. The mean age was higher in follow-ups (FU) (FU1 = 58.6 years, FU2 = 59.0 years) than at baseline (56.4 years). GS received support from the Chief Scientist Office of the Scottish Government Health Directorates (CZD/16/6) and the Scottish Funding Council (HR03006) and is currently supported by the Wellcome Trust (216767/Z/19/Z). Recruitment to the CovidLife study was facilitated by SHARE, the Scottish Health Research Register and Biobank. SHARE is supported by NHS Research Scotland, the Universities of Scotland and the Chief Scientist Office of the Scottish Government.

### The Swedish Omtanke2020

With funding from Swedish Research Council (grant number D0886501), Omtanke2020 started in June 2020 and is an ongoing prospective, longitudinal cohort study with monthly data collections from volunteering participants through online surveys. It is open to participation to all residents of Sweden who are 18 years or older, and have the electronic identification BankID. Participants are recruited through mass media or invitations sent to participants of existing cohorts [mainly LifeGene ($N$ = 3592), KARMA ($N$ = 5342, all women), Swedish Twin Registry ($N$ = 3460); participation rate is 7–11%, depending on the cohort]. Recruitment ended on 8 June 2021. To August 2021, up to 12 waves (baseline and 11 follow-ups) have been completed [baseline ($N$ = 28 293 completed/28 614 started), FU1 ($N$ = 20 543), FU2 ($N$ = 17 743), FU3 ($N$ = 14 619), FU4 ($N$ = 12 790), FU5 ($N$ = 11 506), FU6 ($N$ = 10 629, long follow-up), FU7 ($N$ = 9496), FU8 ($N$ = 7107), FU9 ($N$ = 4757), FU10 ($N$ = 3303) and FU11 ($N$ = 2208, last monthly follow-up)]. Waves 2–12 are still open, but currently participants aged 50 years or younger and men are slightly more likely to drop out. Mean age for those who dropped out after baseline is 45.3 years and the mean age for those who filled out at least one follow-up survey is 49.5 years. Compared with the general population of Sweden, women, persons aged between 40 and 69 years and urban residents are over-represented in the cohort. Further information will be obtained through annual follow-ups (starting Winter 2021/22) and linkage to Swedish population and health registers as well as the existing cohorts.

## What has been measured?

Questionnaires in all cohorts include several validated mental health instruments, including screening measures for depressive symptoms [measured with Patient Health Questionnaire-9 (PHQ-9),[32] Emotional State Questionnaire (EST-Q2)],[33,34] anxiety [General Anxiety Disorder-7 (GAD-7),[35] EST-Q2,[34] the Dimensional Obsessive-Compulsive Scale (DOCS-SF)],[36] PTSD [the Primary Care PTSD Screen for DSM-5 (PC-PTSD-5),[37] PTSD Checklist for DSM-5 (PCL) short form],[38] stress [Perceived Stress Scale 4 (PSS-4),[39] Perceived Stress Scale 10 (PSS-10),[40] Impact of Event Scale—Revised (IES-R-15)],[41] loneliness [UCLA Loneliness Scale version 3 (UCLA-3),[42] EST-Q2)][34] sleep [Pittsburgh Sleep Quality Index (PSQI),[43] EST-Q2,[34] Bergen Insomnia Scale (BIS)],[44] fatigue [EST-Q2,[34] Chalder Fatigue Questionnaire (CFQ)],[45] cognitive function [Patient-Reported Outcomes Measurement Information System (PROMIS) short form][46] as well as happiness (summarized in Table 2). In addition, participants in each cohort answered extensive questionnaires on general health and working and life conditions during COVID-19, as well as questions on COVID-19-specific factors, such as COVID-19 symptoms, SARS-CoV-2 infection status and hospitalization (see Supplementary Table S2, available as

**Table 2** Validated mental health instruments in the COVIDMENT cohorts, including register data

| | Denmark DBDS | Estonia EstBB-C19 | Estonia EstBB-MHDC | Iceland C19-Resilience | Norway BRY.DEG2020 | Norway MoBa | Scotland/UK GS/CovidLife | Sweden Omtanke2020 |
|---|---|---|---|---|---|---|---|---|
| Depression | PHQ-9 | EST-Q2 | EST-Q2 | PHQ-9 | PHQ-9 | PHQ-9 | PHQ-9 | PHQ-9 |
| Anxiety | ASS | EST-Q2 | EST-Q2 | GAD-7 | GAD-7; DOCS-SF | GAD-7 | GAD-7 | GAD-7 |
| PTSD | PC-PTSD-5 | | PCL short form | PC-PTSD-5 (modified) | | PC-PTSD-5 | | PC-PTSD-5 (modified) |
| Stress | PSS-10 | | Single item | PSS-4 | IES-R-15 | PSS-4 | PSS-4; Stressed by C19 | PSS-4 |
| Mental health (general) | SF-12 | | Single item | SRMH | | HSCL-5 | SWEMWBS | SRMH |
| Pre-existing psychiatric conditions | * | * | x/* | x/* | x | x | x | x |
| Happiness | Single item | | Single item | Single item | | SWLS | | Single item |
| Loneliness | UCLA-3 | Single item from EST-Q2 | Single item from EST-Q2 | Single item from UCLA | UCLA-3 | | Single item | Single item |
| Sleep | Sleep quality; insomnia; daytime fatigue; restless legs; average hours | EST-Q2 | EST-Q2 | 5 items from the PSQI | BIS | PSQI | Average hours, sleep quality | 5 items from PSQI |
| Fatigue | Daytime fatigue (3 items) | EST-Q2 | EST-Q2 | Single item | Single item | CFQ; long Covid items | | Single item (since July 2021) |
| Cognitive function | | | Four items | PROMIS short form | | Difficulty concentrating; harder to find the right word; memory | Digit-symbol, verbal fluency, vocabulary, logical memory | Difficulty concentrating (since July 2021) |

Data from surveys are marked with x; register data are marked with *.

PHQ-9, Patient Health Questionnaire;[29] EST-Q2, Emotional State Questionnaire;[30] GAD-7, General Anxiety Disorder;[31] ASS, Angst-Symptom-Spørgeskemaet;[44] DOCS-SF, Dimensional Obsessive-Compulsive Scale;[32] PC-PTSD-5, Primary Care PTSD Screen for DSM-5;[33] PCL, PTSD Checklist;[34] PSS-4[35]/PSS-10,[36] Perceived Stress Scale; IES-R-15, Impact of Event Scale—Revised;[37] SRHM, Self-rated Mental Health;[45] SF-12, Short-Form Health Survey;[46] HSCL-5[47], Hopkins Symptom Checklist; SWEMWBS, Short Warwick-Edinburgh Mental Well-being Scale;[48] SWLS, Satisfaction With Life Scale;[49] UCLA-3, Loneliness Scale Version 3;[50] PSQI-9, Pittsburgh Sleep Quality Index[39] BIS, Bergen Insomnia Scale;[40] CFQ, Chalder Fatigue Scale;[41] PROMIS, Patient-Reported-Outcomes-Measurement Information System.[42]

Supplementary data at *IJE* online, for a detailed overview of measures).

Pre-COVID mental health data are available for participants of all cohorts through self-reports or record linkage to population registers. Most cohorts are linked to national health registries, with lifelong data on mental disorders and comorbid diseases including pre-COVID conditions and long-term post-COVID outcomes. Several cohorts also include biobanks that will be used to study genetic and biological risk factors.

## What has it found? Key findings

Table 1 shows the sociodemographic characteristics of the COVIDMENT cohorts. Most of the cohorts had higher levels of female participation (57.7–81.5%), except the Danish DBDS with 50.7% males. The mean age of cohort participants ranged from 44.1 years (Estonian EstBB-C19) to 58.5 years (Danish DBDS) and the majority were in a relationship (60.5–76.4%). An exception is the Norwegian BRY.DEG2020 where the mean age was 31.8 years and 56.7% of participants were single. The highest educational level varied between cohorts, e.g. university education or higher was reported by 89.2% in the Danish DBDS and 47.1% in the Scottish CovidLife.

In terms of health-related risk factors, the highest prevalence of obesity was observed in the Icelandic C-19 Resilience (30.1%) and the lowest prevalence was observed in the Swedish Omtanke2020 (13.3%). The highest prevalence of current smoking was in the Norwegian BRY.DEG2020 (19.1%) and the lowest in the Norwegian MoBa (6.3%). The proportion with chronic somatic diseases (e.g. hypertension, lung disease) varied considerably across cohorts, ranging from 15.1% in the Norwegian MoBa to 48.7% in the Danish DBDS. The highest proportion of participants infected with SARS-CoV-2 was in the Estonian EstBB-C19 (25.2%) and the Norwegian BRY.DEG2020 (13.8%). The corresponding proportion was 10.1% in the Scottish CovidLife, 8.4% in the Swedish Omtanke2020, 4.3% in the Danish DBDS, 4.1% in the Icelandic C-19 Resilience and 1.2% in the Norwegian MoBa.

Table 3 shows the prevalence of depressive symptoms above cut-off (measured as $\geq$10 on PHQ-9/>11 on EST-Q2) across cohorts adjusted for or stratified by age and sex. The overall prevalence of reporting depressive symptoms above cut-off ranged from 4.2% to 20.8% across the cohorts, namely 20.8% in Scottish CovidLife, 17.1% in Norwegian BRY.DEG2020, 17.1% in Swedish Omtanke2020, 16.6% in Icelandic C-19 Resilience, 15.0% in Estonian EstBB-C19, 7.6% in Danish DBDS and 4.2% in Norwegian MoBa. Across all cohorts, the average prevalence of depressive symptoms was 12.7% (95% CI: 8.0–19.8%) after adjusting for age, sex and season. The highest prevalence of depressive symptoms was consistently noted among young adults, i.e. 18–29 years of age, declining sharply thereafter in a stepwise fashion. Similarly, the prevalence of depressive symptoms was higher among females (5.0–24.4%) than males (3.5–17.7%) after adjusting for age.

Figure 2 shows the prevalence of depressive symptoms above cut-off for all cohorts (excluding COVID-19 cases) by nationwide incidence of weekly COVID-19 cases per 100 000 persons during the 2 preceding weeks before responding to the PHQ-9/EST-Q2. We used a generalized additive mixed model to fit a multi-level model to the data, with a random effect for each study to account for correlations in the data within each study. The association between the prevalence of depressive symptoms with COVID-19 incidence was modelled using penalized regression spline for week (Supplementary Figure S1, available as Supplementary data at *IJE* online). The distribution of the outcome was assumed quasi-binomial and each observation was weighted with the accompanying sample size. The adjustment for season was made by using a penalized spline for week (Supplementary Figure S2, available as Supplementary data at *IJE* online). Trends varied across countries (Supplementary Table S3, available as Supplementary data at *IJE* online) but overall we found the association to be non-linear. The prevalence of depressive symptoms was highest at 14.3% (95% CI: 9.4–21.8%) when the COVID-19 incidence was around 30 weekly cases per 100 000 persons. This represents 61.0% (95% CI: 34.0–94.1%) higher prevalence of depressive symptoms than the prevalence, 8.9% (95% CI: 5.6–13.6%), at a COVID-19 incidence of 0 weekly cases per 100 000 persons. When the COVID-19 incidence was 60 weekly cases per 100 000 persons, the prevalence of depressive symptoms was 12.4% (95% CI: 7.9–19.4%), close to the average prevalence (Supplementary Figure S3, available as Supplementary data at *IJE* online). Combined, these results suggest some influence of weekly COVID-19 incidence on population depressive symptoms primarily at the lower range of incidence rates, possibly reflecting early rise or the end of an epidemic wave.

## What are the main strengths and weaknesses?

The COVIDMENT project is a large-scale multinational collaboration between Denmark, Estonia, Iceland, Norway, Scotland and Sweden, which was established to significantly advance current knowledge of mental morbidity trajectories during and beyond the COVID-19 pandemic, by using ongoing semi-harmonized batteries of validated mental health assessments with longitudinal follow-up of 392 817 individuals, as well as large, data-rich record linkages to the national

**Table 3** Proportion above cut-off for depressive symptoms across categories of gender and age in the COVIDMENT cohorts

| | Denmark DBDS ($N$ = 68 973) | | Estonia EstBB-C19 ($N$ = 11 289) | | Iceland C19-Resilience ($N$ = 22 849) | | Norway BRY.DEG2020 ($N$ = 19 343) | | Norway MoBa ($N$ = 91 950) | | Scotland/UK CovidLife ($N$ = 16 356) | | Sweden Omtanke2020 ($N$ = 27 952) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $N \geq 10$ PHQ-9 | % (95% CI) | $N > 11$ EST-Q2 | % (95% CI) | $N \geq 10$ PHQ-9 | % (95% CI) | $N \geq 10$ PHQ-9 | % (95% CI) | $N \geq 10$ PHQ-9 | % (95% CI) | $N \geq 10$ PHQ-9 | % (95% CI) | $N \geq 10$ PHQ-9 | % (95% CI) |
| Total | 5946 | 7.6% (7.4–7.9%)[a] | 2335 | 15.0% (14.2–15.8%)[a] | 4084 | 16.6% (16.0–17.2%)[a] | 7059 | 17.1% (16.1–18.1%)[a] | 4482 | 4.2% (4.0–4.3%)[a] | 3268 | 20.8% (20.0–21.6%)[a] | 4946 | 17.1% (16.5–17.7%)[a] |
| Gender | | | | | | | | | | | | | | |
| Male | 2189 | 6.1% (5.9–6.4%)[b] | 476 | 11.9% (10.9–13.0%)[b] | 778 | 13.5% (12.7–14.4%)[b] | 1411 | 15.1% (14.2–16.2%)[b] | 1364 | 3.5% (3.3–3.7%)[b] | 732 | 17.7% (16.6–18.9%)[b] | 720 | 14.8% (14.0–15.7%)[b] |
| Female | 3757 | 9.5% (9.2–9.8%)[b] | 1859 | 18.8% (17.8–19.8%)[b] | 3287 | 20.2% (19.6–20.8%)[b] | 5587 | 19.2% (18.2–20.3%)[b] | 3118 | 5.0% (4.8–5.2%)[b] | 2536 | 24.4% (23.6–25.2%)[b] | 4226 | 19.8% (19.2–20.3%)[b] |
| Other | – | – | – | – | 19 | 35.8% (26.0–49.3%)[b] | 61 | 24.4% (20.5–29.0%)[b] | – | – | – | – | – | – |
| Missing | – | – | – | – | – | – | – | – | – | – | – | – | – | – |
| Age (years) | | | | | | | | | | | | | | |
| 18–29 | 1292 | 21.1% (21.1–22.2%)[c] | 506 | 30.7% (28.4–33.1%)[c] | 630 | 37.0% (34.7–39.5%)[c] | 5332 | 42.5% (41.5–43.6%)[c] | – | – | 366 | 45.0% (41.6–48.6%)[c] | 1322 | 38.5% (36.88–40.1%)[c] |
| 30–39 | 919 | 12.7% (12.0–13.5%)[c] | 758 | 21.5% (20.1–23.0%)[c] | 702 | 27.0% (25.2–28.9%)[c] | 895 | 29.2% (27.6–30.9%)[c] | 541 | 7.8% (7.2–8.5%)[c] | 535 | 31.5% (29.2–33.9%)[c] | 1190 | 26.2% (24.9–27.5%)[c] |
| 40–49 | 840 | 8.7% (8.2–9.3%)[c] | 552 | 17.6% (16.3–19.0%)[c] | 877 | 19.2% (18.0–20.4%)[c] | 457 | 18.2% (16.7–19.8%)[c] | 2729 | 4.4% (4.3–4.6%)[c] | 644 | 25.5% (23.8–27.4%)[c] | 886 | 19.0% (17.9–20.1%)[c] |
| 50–59 | 765 | 6.6% (6.1–7.0%)[c] | 331 | 13.3% (12.0–14.8)[c] | 928 | 14.3% (13.4–15.2%)[c] | 277 | 16.0% (14.3–17.8%)[c] | 1159 | 4.2% (4.0–4.5%)[c] | 794 | 20.2% (18.9–21.6%)[c] | 830 | 14.9% (14.0–15.9%)[c] |
| 60–69 | 393 | 4.5% (4.1–4.9%)[c] | 143 | 10.7% (9.2–12.5%)[c] | 714 | 11.2% (10.5–12.0%)[c] | 79 | 11.4% (9.3–14.0%)[c] | 53 | 4.4% (3.4–5.7%)[c] | 669 | 12.7% (11.8–13.6%)[c] | 437 | 10.0% (9.2–10.9%)[c] |
| 70+ | 1737 | 6.4% (6.2–6.7%)[c] | 45 | 8.8% (6.7–11.7%)[c] | 233 | 6.7% (5.9–7.6%)[c] | 19 | 10.2% (6.4–15.0%)[c] | – | – | 260 | 8.1% (7.3–9.1%)[c] | 281 | 8.0% (7.2–9.0%)[c] |

Data until 12 August 2021 for all cohorts. Total number of participants is less than in Table 1 due to missing responses or ongoing inclusion in all cohorts.

[a]Adjusted to age 50 years and gender distribution (males 49.9%, females 49.9%, other 0.2%).

[b]Adjusted to age 50 years.

[c]Adjusted for gender distribution (males 49.9%, females 49.9%, other 0.2%).

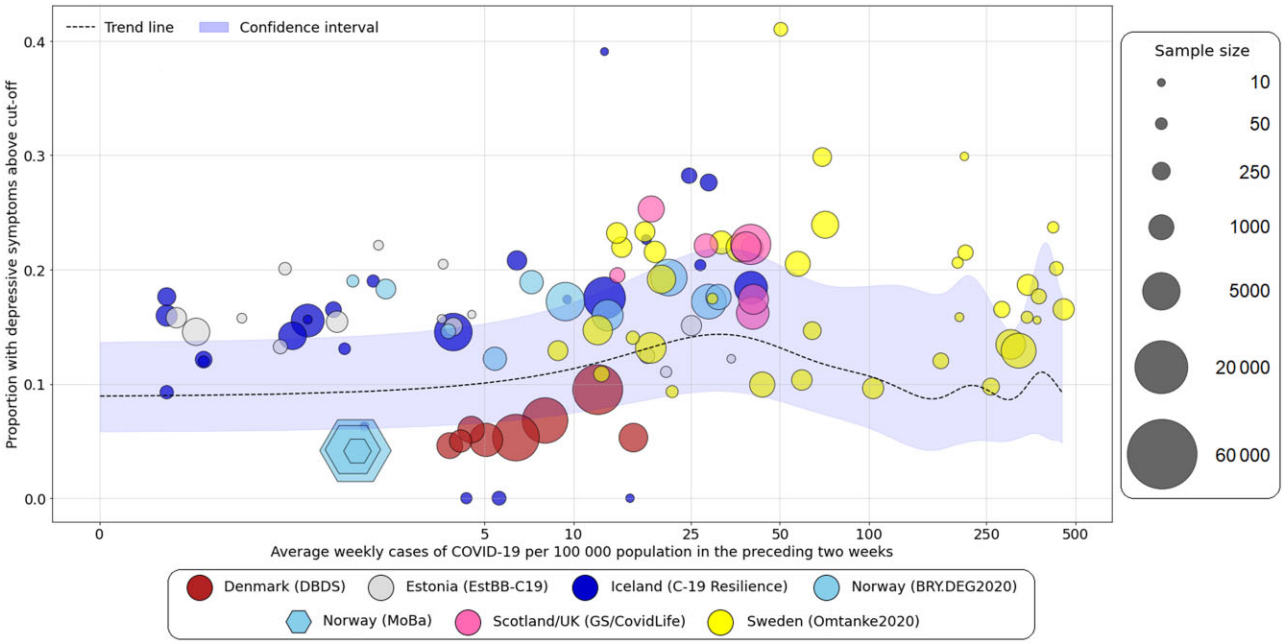


**Figure 2** National COVID-19 incidence and depressive symptoms across cohorts. The COVID-19 incidence is defined as the average number of confirmed cases per week per 100 000 persons in the 2 weeks prior to participants' response to the PHQ-9/EST-Q2 (COVID-19 cases excluded). Dotted black line represents trend with 95% confidence interval (blue area)

health registry resources. These resources are well powered for a systematic exploration of trans-national heterogeneity in pandemic effects, including how variations in mitigating responses to COVID-19 pandemic and disease burden across countries impact on psychiatric symptoms and disorders, both in exposed populations and on a population level.

A weakness of the COVIDMENT project is that different strategies were used for recruitment to the various cohorts. Some cohorts, for example MoBa, EstBB-C19 and DBDS, consist of already established cohorts, some perhaps with over-representation of healthy individuals (e.g. blood donors and parents). Other cohorts, such as Omtanke2020, BRY.DEG2020 and C-19 Resilience, sent invitations to existing cohort members but also opened for volunteering participants through social media, which may have resulted in selection bias. Indeed, compared with the general populations, most of the cohorts include an over-representation of women as well as individuals of older age and higher education.[48–59] Recruitment differences may to some extent explain the differences in prevalence of depressive symptoms above cut-off across cohorts. Yet, prevalence differences in depressive disorders have been observed across European countries using similar recruitment.[47] Also, some cohorts targeted invitations to individuals diagnosed with SARS-CoV-2 or tested for SARS-CoV-2 with an RT-PCR test (i.e. C-19 Resilience and EstBB-C19), whereas other cohorts did not. The different recruitment strategies across cohorts may to some extent explain the higher levels of depressive symptoms when tested individuals are targeted for inclusion. Second, the cohorts rely on self-reported questionnaire data with associated risks of measurement errors. However, this risk is mitigated by also obtaining data on clinical diagnoses of psychiatric disorders from the population registers, which is a distinctive feature of the participating cohorts and countries.

## Can I get hold of the data? Where can I find out more?

The individual-level data underlying this article were subject to ethical approval and cannot be shared publicly due to data protection laws in each participating country. The data can be shared on reasonable request to the corresponding author. We encourage scientists who are interested in collaboration with the COVIDMENT project to contact investigators via the study website [www.covidment.is] or reach out to the principal investigator of the project. Prof. Valdimarsdóttir [unnurav@hi.is], for further information.

## Ethics approval

The DBDS was approved by the Zealand and Central Denmark Regional Committees on Health Research Ethics (SJ-740 and M-2009237) and the Data Protection Agency (P-2019–99). The EstBB-C19 and EstBB-MHDC were approved by the Estonian Committee on Bioethics and Human Research (1.1–12/1277 and 1.1–12/2860). The C-19 Resilience was approved by the National

Bioethics Committee (NBC no. 20–073, 21–071) as well as the National Data Protection Authority. The BRY.DEG2020 was approved by the Regional Committees for Medical and Health Research Ethics (123324). The MoBa was approved by the Regional Committees for Medical and Health Research Ethics (127708/14140/20138); this also includes approval to link the MoBa data with data from national health registries (including psychiatric and COVID-19 diagnostic information). The GS was approved by the East of Scotland Research Ethics Service (EoSRES). The Omtanke2020 ethical approval no. is 2020–01785.

## Supplementary Data

Supplementary data are available at *IJE* online.

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## Author Contributions

The COVIDMENT cohorts and/or their data collections were designed by A.B.U., A.L., C.F-R., H.A., K.K., K.H., M.D., D.J.P., F.F., K.L., R.M., L.M., O.A.A., O.B.V.P., S.L.H., U.A.V. and their respective teams. U.A.V. and A.B.U. directed the combined effort of this study implementation. U.A.V. and T.A. designed the analytical strategy in close collaboration with all team members, and all authors helped to interpret the findings. A.B.U., A.L., C.F-R., H.A., K.K., K.H., M.D. and L.A.N.C. conducted the literature review and drafted the manuscript under supervision of U.A.V. All authors revised the manuscript for critical content and approved the final version of the manuscript.

## Conflict of Interest

A.M. has received speakers' fees from Illumina and Janssen and has received research grant funding from the Sackler Trust, outside of the current work. All other authors declare no conflict of interest.

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